PROCEEDINGS

OF THE

ROCHESTER ACADEMY OF SCIENCE

VOLUME 8

MAY, 1941 to APRIL, 1943

ROCHESTER, N. Y.
PUBLISHED BY THE ACADEMY
1943

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PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
Vol. 8, No. 1, pp. 1–45 May 15, 1941

SPECIES OF FIREFLIES IN JAMAICA (COLEOPTERA, LAMPYRIDAE)[1]

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The large collection of fireflies brought by Dr. John Bonner Buck from the West Indian island of Jamaica in 1936 as samples of the forms upon which he had made spectroscopic and other observations has been studied together with material from the same island brought back by Dr. G. S. Miller in 1931, by Dr. R. E. Blackwelder and Dr. E. A. Chapin in 1937, and with other material in the National Museum and the American Museum of Natural History. The writer attempted, in 1910, to identify the samples upon which Dr. E. J. Lund had made his studies in the same island, but the few specimens then available for reference (collected in 1877 by H. G. Hubbard) and uncertainties in the literature led him to seek the help of the French authority Ernest Olivier, who kindly examined all the Neotropical species of Lampyridae then in our National Collection. This identified collection was borrowed and used in 1922 by Leng and Mutchler in their revision of the West Indian Lampyridae (Bull. Amer. Mus. Nat. Hist., vol. 46, pp. 431–485), but several of Dr. Lund's forms are below described as new. The twelve Jamaican species hitherto described are now increased to fifty, but several of these are represented by uniques and there are in addition some doubtful forms which are inadequately represented and await samples of males in order that further complication of the literature may be avoided. It is therefore probable that less than half of the species which live on this small island are yet known. Only two of the species are known from other islands also, these belonging to genera our species of which can alight upon and fly from the surface of water. The record of a third species, native in Haiti, but cited as from Jamaica by Ernest Olivier 1912, requires verification.

Except for these three possible adventive forms, the Jamaican Lampyridae seem to accord with the very early isolation of this island, there being no definite affinities with Honduran or other Central American species. The large number of species may be a product of successive re-

[1] Received for publication September 16, 1940.

striction and enlargement of their habitat as Jamaica sank (Oligocene), leaving only the Blue Mountains in the East, and some small low islands in the West for their survival, and later (Miocene) emerged, bearing its great new layer of limestone which covers most of the island. The re-occupation of this new limestone area by vegetation and small animal life presented new environmental opportunities and permitted speciation to a degree not recognized on larger and older lands. Land snails, said to be also very numerous in species, doubtlessly nourish many species of native lampyrids, but actual observations on the preferred prey of glow-worms elsewhere are very few and no such information from Jamaica is available. One minute slender and anomalous firefly, discovered accidentally in a sample of about 30 cc. of chironomid flies from a swarm about Dr. Miller's lantern far back (one-quarter mile or more) within the mouth of an underground passageway, suggests almost recent development of cavernicolous forms in the subterranean drainage systems which honeycomb this great 1,500-foot layer of limestone.

The taxonomy of the Lampyridae has been greatly retarded by the inadequacy and poor quality of samples which are regarded as standard. The softness of the integument permits collapse, distortion, or shrinkage of structures while drying and conceals characters which, if obvious, would have led to a better classification. The results here presented are possible only from the excellence of the fresh alcoholic samples, which have permitted rapid and easy extraction of the genitalia and the fixing of the form of the distended body without permitting its collapse while drying. About 200 samples, containing nearly 500 males, thus prepared contrast strongly with older collections in which these structures are concealed. Their display in ordinary dry specimens is unsatisfactory, even by long and tedious treatment. Although, surprising differences exist in genitalia, even in certain externally similar forms, it is necessary in the key to use color and other superficial recognition characters formerly considered as trivial or merely variational. When thus used, such characters unfortunately associate quite unrelated species or dissociate close allies. A few trinomials have been used to suggest affinity rather than to indicate evidence of intergradation of real subspecies. The males described as three forms of *Photinus* (*lucernula, euphotus, and cinchonae*) agree in genitalic and some other structures and should form a separate genus, but it is suspected that one of the last two will prove to be a synonym of the genotype of *Jamphotus,* here based upon an apterous female. *Photinus amplus* is superficially like but not congeneric with *euphotus.*

This paper is offered to validate names which Dr. Buck needs to use in recording the results of his observations. Except where otherwise stated, the types of the new species are in the U. S. National Museum. Paratype samples will be placed in the American Museum of Natural History and the British Museum. The writer's voluminous notes on the different species, their relationships, bibliographies, diagrams of genitalic structures, consideration of faunal affinities, etc., must remain for the present as rough draft. When, out of the probably large firefly fauna of Jamaica, good samples of other species become available, such a summary of the subject as was planned on this material may become possible. Gratitude is due to Dr. Buck for the quality of his samples and the opportunity of studying them.

Fourteen specific names have been applied prior to 1940 to Lampyridae from Jamaica, but two of these are synonyms correctly suppressed by their author. Only half of the twelve named species are identifiable in the available samples the others must, therefore, be omitted from the key to species actually studied. It is therefore necessary for a student attempting to identify samples to know that some of these unplaced names may eventually be used for species which have here been named as new. In so far as now understood, the data on these unrecognized named species are summarized as follows:

A Luminous organs confined to sternite 8 .... B

Luminous organs well developed in sternites 6–7 C

B (A) Pale yellow; sternites 6, 7, and 9 black in male, but in the female the black color occupying apical margin of sternite 6, all of 7, and apical half of 8. Length 10–12 mm. Type locality, Santo Domingo; the record from Jamaica is doubted. (*Lampyris glaucus* Oliv. 1790; *Pygolampis glauca* Dejean 1833, Ern. Oliv. 1912; *Photinus glaucus* Laporte 1833, L. & M. 1922) .... *Diphotus glaucus* (Oliv. 1790)

Oblong, black-brown, mouth piceous; antennae black, bases piceous, annulate; pronotum deeply canaliculate, yellowish white with two brown discoidal spots; scutellum yellow; elytra brown, suture narrowly, side margin broadly, yellow; feet white, knees and tarsi brown. Length 7–9 mm. Jamaica (probably Dunrobin District). (*Photinus pantoni* Ern. Oliv. 1902, 1907; *Pygolampis pantoni* Ern. Oliv. 1912) .... *Diphotus pantoni* (Ern. Oliv. 1902)

C (A) Elytral margins dark .... D

Elytral margins pale. Elongate, subparallel; head and antennae piceous; pronotum attenuate in front, margins profoundly punctate, yellow, the disc black, thinly punctate and fossulate; elytra not wider than pronotum, black, the external and scutellar margins yellow; breast piceous; abdomen lucid, last segments waxy; feet yellowish white, anterior tarsi and tibiae infuscate. Length 6 mm. Jamaica. .... *Photinus suavis* Ern. Oliv. 1907

D (C) Length 7–8 mm. .... E

Length 12 mm. Oblong oval, yellow; pronotum anteriorly rounded, thinly punctate, disc infuscate; elytra oblong, rugulose, costate, brownish; feet infuscate; male with last three ventral segments long, waxlike; female venter lucid. Jamaica. *Photinus ebriosus* Ern. Oliv. 1907

E (D) Oblong, yellow, elytra black; antennae, tibiae, and tarsi infuscate; scutellum black, its apex narrowly pale; length 7–8 mm. Jamaica. .... *Photinus maritimus* Ern. Oliv. 1899

Oblong, piceous; pronotum short, anteriorly attenuate, rugulose; female with last four segments white, lucid; length 8 mm., male unknown. Jamaica. .... *Photinus contemptus* Ern. Oliv. 1907

Those species which can now be distinguished in the available samples are treated in the following dichotomous table:

1. Tarsal claws simple 2

Anterior claw on each foot bifid, or cleft at apex; head not greatly retracted into prothorax, and partly visible from above; aedeagus with long filiform processes from the side lobes of the tegmen, the lateral lobes connate and without middorsal suture in basal fourth .... (*Photuris*) 49

2. (1) Males known; the females usually fully winged and apparently capable of flight, their elytra rarely shorter than the abdomen in dry samples, but in some species the females degenerate and brachypterous 3

Male unknown, female without wings ...... (*Jamphotus*) 38

3. (2) Males with subintegumentary white reflector of luminous organ occupying all, or at least the median area, of sternites of abdominal segments 6 and 7 4

Sternites 6 and 7 not apparently luminous in either sex; sternite 8 well developed and conspicuously the source of light .... (*Diphotus*) 40

4. (3) Sternite 8 of male bilobed, retracted so that often only the two rounded lobes project beyond apex of the light organ; aedeagus with lateral lobes of diverse forms but apically descending below the tip of the median lobe, which usually curves upward between them .... (*Photinus*) 5

Sternite 8 of male longer, less emarginate; aedeagus more compact, subcylindrical, the lateral lobes short, contiguous dorsally to apices above the longer, projecting median lobe ...... (*Pyractomena*) 39

5. (4) Luminous area of male occupying all of sternites of the 6th and 7th abdominal segments 6

Luminous organ of male reduced in width, occupying median half or third of sternites 6 and 7; pygidium subtruncate, sinuate, lutescent or faintly mottled; pronotum with large, transverse discal infuscation suffusing outwardly and onto the inflated areas over the very large eyes, the margins nearly white; scutellum nearly black at base, the apex paler and very coarsely punctured, elytra reddish brown; female unknown. Length 10 mm., width 4 mm. Kensworth, Feb. 1937 (type and 4 paratypes), and Derry, Feb. 14, 1937, Blackwelder and Chapin (1 paratype); Jamaica, 1877, H. G. Hubbard (1 paratype identified by Ern. Oliv. 1911 and by L. & M. 1922 as *maritimus*) .... *Photinus lucernula*, n. sp.

6. (5) Elytra usually whitish, or mostly pale with well-defined infuscate markings on a generally yellowish ground color 7

Elytra wholly pale brown, brown, or black, or with margins narrowly bordered with yellow 11

7. (6) Elytra entirely pallid or darkened only at base 8
Elytra ornamented with well-defined infuscate areas 9

8. (7) Size large (about 16 mm.); pronotal infuscation consisting of a discal cloud which includes paired paler spots and a pair of small dark spots at lateral fourth and basal third, scutellum white at tip, strongly infuscate at base, the scutum white; frontal interocular space white, the occiput infuscate; antennal joints dark, their apices paler; maxillary palpi, anterior tarsi and tibiae, and fourth tarsal joint of middle and hind legs conspicuously infuscate; aedeagus short, robust, conical, acuminate, with white lateral lobes and no ventrobasal tubercles on median lobe; sternite 9 apically broad and emarginate (*P. melanodactylus* Ern. Oliv. 1888) .... *Photinus pallens* (F. 1798)

Size smaller (under 10 mm.); pronotum with small infuscate paired spots grouped at center of disc and a pair of darker oblique spots at basal fifth and lateral third; scutellum and scutum entirely white; front rufopiceous; antennae shorter, the joints not obviously paler at their ends; aedeagus elongate, depressed, the lateral lobes and the broad median lobe strongly bicolored, the median lobe with well-developed convex ventrobasal tubercles produced inwardly so as nearly to cover the median membranous area. Length 8–9 mm. Stony Hill, Feb. 10, 1937, Blackwelder and Chapin, Sta. 394 (type and 6 paratypes); Moneague, Aug. 5, 1936, Buck no. 140 (1 paratype), Montego Bay, E. J. Lund, 1910 (this paratype of *P. ceratus* L. & M. 1922 apparently belongs here.) .... *Photinus naevus*, n. sp.

9. (7) Elytral infuscation consisting of a narrow, usually entire median vitta, anteriorly slightly excurved in basal third to humerus, thence following base of elytra to and involving base of scutellar lobe, the apex of which is pale 10

Elytral infuscation consisting of two pairs, basal and apical, of slightly oblique curved vittae usually coalescent near middle of elytra, the basal pair joining the suture at middle as well as at base, where it extends from humerus almost to the entirely infuscate scutellar lobe; the apical pair of curved vittae reaching the suture near apex; aedeagus short, compact, rounded, the white lateral lobes strongly curved and broadly truncate at apices, which meet vertically beneath the black, narrowly compressed apical process of the median lobe .... *Photinus commissus* Ern. Oliv. 1907

10. (9) Size larger (8–10 mm.), metasternum pallid; aedeagus strongly bicolored, somewhat resembling that in *naevus* but much more compact and less depressed, the median lobe laterally compressed and black in apical third, its lower side margin expanded near apex and armed with six or more slightly recurved sharp hooks on each side, the lateral lobes robust in basal half, apically depressed, their side margins not abruptly convergent, the excavated inner surface black and asperate in apical third, the apices, sides, upper basal and lower surfaces pale, the latter feebly convex and polished with inner margins produced to meet in a straight line below median lobe in apical half and

strongly angulate at middle so as to expose the median lobe in subbasal third through a subcircular opening. Kensworth, Feb. 19, 1937, Blackwelder and Chapin (♂ type, 1 ♀ paratype), between Mocho and Catadupa, July 19, 1935, Blackwelder (1 ♀ paratype), Pepper, Mar. 12–22, 1931, G. S. Miller (1 ♂ paratype), Chestervale, June 1936, Buck no. 84 (2 ♂ paratypes) .... *Photinus blackwelderi,* n. sp.

Size smaller (5–6 mm.), meso and metasterna piceous; aedeagus feebly bicolored, white except small infuscate subapical spot on inner surface of each lateral lobe and the flattened sides of median lobe in its apical third; median lobe flattened above, emarginate and membranous at apex, the expanded side margins asperate; lateral lobes subulate apically, deflexed and acuminate, meeting only at their tips below the ascending median lobe. Kensworth, Feb. 21, 1937, Blackwelder and Chapin (2 ♂, type and paratype) .... *Photinus chapini,* n. sp.

11. (6) Elytra normally pallescent or very light brown as if immature 12

Elytra normally black, black with a narrow sutural and broader side margin yellow, or in a few forms uniformly dark reddish brown 16

12. (11) Abdomen entirely pale above and below 13

Abdominal tergites mostly or all black 14

13. (12) Size larger (9–10 mm.); aedeagus relatively broader. Type locality, Cumberland district, Clarendon. (Similar forms from Catherines Peak, Cinchona, Bath, etc., now confused under this name are tentatively placed here.) Buck nos. 88, 89 ...... *Photinus ceratus* L. & M. 1922

Size smaller (7–7.5 mm.); aedeagus relatively narrower (see also couplet 38). Montego Bay, Aug. 2, 1936, Buck no. 145 (type and 3 paratypes), June 23, 1910, E. J. Lund (9 paratypes) (*suavis* L. & M. part) .... *Photinus lobatus morbosus,* n. subsp.

14. (12) Anterior mesonotal areas and scutellum dark 15

Anterior mesonotal areas (scutum on either side of the median membranous area) and apical half of scutellum conspicuously pale; elytra pale brown, darker basally; pronotum with discal brown spot occupying median fourth, and a pair of small postmedian spots at lateral fourths; sternites 2–5 and pygidium black, sternites 6, 7, 9, and middle of 8 pale; antennae black, the 11th joint pale at apex; aedeagus white, with slender lateral lobes; length 7–8 mm. Chestervale, 3,200 ft., June 1936, Buck nos. 36, 37, 39, 40, 41, 56, and 131 (type and 16 paratypes); Whitfield Hall, July 13, 1936, Buck no. 102 (2 paratypes) .... *Photinus gracilobus,* n. sp.

15. (14) Pygidium of male and sternites 8 and 9 white; sternite 5 not pallescent near the light organs; pronotum pale with an elongate median brown clouded area occupying median fifth in basal half, and with a pair of small spots at lateral fourth near base. Length 5–6 mm. Mandeville, Mar. 5, 1931, G. S. Miller (type and 16 paratypes), Nov., Dec. 1919, Jan. 1920, Watson (50 paratypes in Amer. Mus. Nat. Hist. as *suavis* L. & M. 1922), Buck no. 159 (1 ♂ paratype), Buck no. 14 (3 ♂ paratypes); Mocho, 1935, Blackwelder (1 ♂ paratype) .... *Photinus leucopyge,* n. sp.

Pygidium black; sternite 5 with sides and base black, the middle area white as if luminous; sternite 8 largely infuscate; sternite 9 white; pronotal infuscation occupying median fourth in basal half without the small supplementary spots. Length 5–6 mm. Near Bath, St. Thomas, Mar. 2, 1937, Chapin and Blackwelder (type and 6 paratypes); Bath, St. Thomas, Jan., Feb. 1920, Watson (16 paratypes as *suavis* L. & M. 1922 in Amer. Mus. Nat. Hist.); Manchioneal, July 23, 1935, Blackwelder (7 paratypes) .... *Photinus melanopyge,* n. sp.

16. (11) Elytra very dark, with sutural and expanded side margins conspicuously yellow; form more elongate 17

Elytra black or brown without yellow margins 19

17. (16) Tergites 1 to 5 black, 6 to 8 white, length 6 to 8 mm. 18

Tergites 1 to 7 wholly black, the 8th with sides and apex pallescent; sternite 5 with apical margin white at middle; pale sutural margin of elytra posteriorly evanescent, not passing middle; pronotal disc entirely infuscate except a pair of reddish transverse spots each about one-fifth of the pronotal width and separated from each other by about the same distance. Length 5 mm. Cinchona to Morces Gap, July 28, 1936, Buck no. 91 (type and paratype ♂), Chestervale, July 25, 1936, Buck no. 162 (1 ♂ paratype), below Woodcutters Gap, July 27, 1936, Buck no. 8 (1 ♂ paratype) ..... *Photinus nothus,* n. sp.

18. (17) Aedeagus somewhat depressed (resembling that of *nothus*), the lateral lobes sinuously tapering with narrowly rounded contiguous apices extending conspicuously below and beyond the black, heavily sclerotized, apically widened and dorsally strongly carinate median lobe. Length 6–7 mm. Catherines Peak, June 26, 1936, Buck no. 87 (type and 11 paratypes), no. 95 (6 paratypes); Morces Gap to Cinchona, Buck nos. 70, 91, (7 paratypes), no. 160 (1 paratype); above Woodcutters Gap, June 27, 1936, Buck no. 16 (1 paratype) *Photinus flavolimbatus,* n. sp.

Aedeagus more cylindrical, the lateral lobes not tapering, their apices vertically obliquely truncate; the narrow cylindrical black median lobe curving upwards to between the truncate apices of the lateral lobes and armed with acute lateral denticles at middle and near apex. 1 ♂, Buck no. 50, Blue Mt. Peak, 7,000–7,300 ft., July 11, 1936 .... *Photinus alticola,* n. sp.

19. (16) Basolateral areas (scutum) of mesonotum pale on each side of the median membranous area, in strong contrast to the deeply infuscate scutellar lobe and elytra 20

Basolateral areas of mesonotum infuscate and concolorous with the scutellum and the elytra 27

20. (19) Aedeagus in ventral aspect distinctly elongate, the length of the lateral lobes greater than the width across their base 21

Aedeagus in ventral aspect distinctly short and blunt, the width across base of lateral lobes greater than their length 26

21. (20) Very large (15–18 mm.) and broad (about 6.5 mm.); the ventrobasal knobs of the median lobe of the aedeagus separated by from one-ninth to one-fourth of the width across base of lateral lobes 22

Size smaller (12 mm. or less) 23

22. (21) Female with elytra shorter, often exposing several segments of the infuscate abdomen; tergite 8 triangular or ogival, luteous, with pair of fuscous spots sometimes coalescent; male with aedeagus relatively shorter. Western Jamaica. (*P. opulentus* Ern. Oliv. 1907.) .... *Photinus xanthophotis* (Gosse 1848)

Female with elytra long, covering the pale abdomen; tergite 8 trapezoidal, its sides sinuate, its apex strongly biemarginate; male form more elongate and with aedeagus relatively longer. Blue Mountains, Catherines Peak, 5,000 ft., June 26, 1936, Buck no. 97 (type and 10 ♂, 3 ♀ paratypes); Cinchona, Morces Gap, 5,000 ft., July 28, Buck no. 91 (2 ♂, 2 ♀ paratypes); Whitfield Hall, 4,300 ft., July 13, Buck no. 99 (2 ♂, 1 ♀ paratypes); Buck no. 102 (1 ♂ paratype); Chestervale, Buck no. 40 (1 ♂ paratype); locality not listed, Buck no. 104 (4 ♂ paratypes), no. 142 (2 ♂ paratypes) .... *Photinus xanthophotis catherinae,* n. subsp.

23. (21) Larger (12 mm.), more elongate and less depressed; elytra reddish brown, all tergites black; aedeagus with ventrobasal membranous area of median lobe narrowly oval and at base (i. e., between the prominent sclerotized knobs) about one-fourth as wide as the base of the lateral lobes. Cinchona, Clydesdale, Blue Mountains, July 28, 1936, Buck no. 94 (2 ♂♂, type and paratype) .... *Photinus brunescens,* n. sp.

Smaller (8 mm. or less), more oval and depressed; aedeagus with ventrobasal membranous area between the prominent sclerotized knobs broadly oval, more than two-fifths as wide as base of lateral lobes, the median lobe shorter, broader, and laterally angulate above the internally angulate lateral lobes 24

24. (23) Larger (8 mm.), sternite 5 mostly luminiferous 25

Smaller (6 mm.), tergites black, sternites 2 to 5 black, 6, 7, 8 white with sides narrowly margined with black; form narrower, elongate, the pronotum narrower at base, conspicuously wider at apical third, the front margin broadly rounded, sometimes straight or almost emarginate at middle. Montego Bay, June 1910, E. J. Lund (type and 8 paratypes) (*suavis* L. & M. part) .... *Photinus lundi,* n. sp.

25. (24) Tergites black, sternites 2, 3, 4, black, 5 mostly lucid, its sides infuscate, 6, 7 white with narrow black side margins, 8 lucid at middle, laterally infuscate. Near Bath in St. Thomas, Mar. 2, 1937, Blackwelder and Chapin (type and 12 paratypes); near (8 mi. NW. of) Manchioneal, July 13, 1935, Blackwelder (16 paratypes) .... *Photinus melanurus,* n. sp.

Abdomen pallid, tergites 6, 7, 8 more or less infuscate at middle, side margins of sternites, 5, 6, 7, 8 not infuscate. Ridge of Blue Mountains, Chestervale (type locality), Whitfield Hall, Cinchona, Morces, Silver Hill, June 10–July 28, 1936 (type ♂, 46 paratypes including 2 ♀♀), Buck nos. 4, 15, 23, 42, 45, 46, 47, 53, 55, 69, 71, 76, 77, 92, 94, 102 .... *Photinus variabilis,* n. sp.

26. (20) Larger (12 mm.), less convex, the lateral elytral punctures confused and not forming a conspicuous sulcus; body and dorsum of abdomen

almost entirely whitish; tergite 8 subtruncate, bisinuate; aedeagus with median lobe broader, subparallel, lateral lobes not internally produced before their apices and below the apex of the median lobe. Mandeville, Aug. 1, 1936, Buck no. 123. (1 ♂) .... *Photinus hypoleucus*, n. sp.

Smaller (9 mm. or less), more convex, elytra with lateral series of punctures forming a distinct submarginal sulcus; aedeagus with median lobe strongly conical in dorsal aspect and with lateral lobes internally angulately produced below apex of median lobe, meeting in a straight line in their apical third. Mandeville, Mar. 2–11, 1931, G. S. Miller (type and 38 paratypes); Buck nos. 18, 119, 122, 134, 157 and probably females 43 and 131 are placed here tentatively. (*maritimus?* Barber det., Miller 1935, Science, vol. 81, p. 590) .... *Photinus synchronans*, n. sp.

27. (19) Large (13–15 mm.), broadly oval, reddish brown; pronotal margins yellow, disc feebly tuberculate, brownish; antennae short 28

Smaller (5–10 mm.), more narrowly oval; antennae longer, reaching the hind coxae; elytra black 31

28. (27) Discal tubercles on pronotum more evident, tergites 1–7 black; the pygidium apically truncate, bisinuate and pallescent; sternites 2–5 shorter, pallescent with sides more or less infuscate, 6–7 unusually large; aedeagus very small, the lobes slender, subcylindrical and free 29

Discal pronotal tubercles feeble; tergites 6–8 yellowish white, sternites 2–5 longer, 6–7 normally developed; aedeagus nearly as in *ceratus*, the lobes flattened above and beneath and compactly fitted together 30

29. (28) Eyes larger, the interocular width below the antennal sockets about two-fifths the width of one eye in the same aspect; sternites 2–5 mostly pale, excessively short, together about as long as the greatly enlarged first luminous segment, sternite 5 more infuscate on hind margin near sides; sternites 6 and 7 of unusual width and length, each with a pair of sublateral foveae unusually large and sharply defined; pygidium infuscate, the apex pale. (♀ unknown). Length 13–14 mm. Whitfield Hall, July 13, 1936, Buck no. 102, ♂ type; doubtfully identical males from near Manchioneal, and Mocho (in U. S. Natl. Mus.) and from Bath (as *ebriosus* L. & M. in Amer. Mus. Nat. Hist.). (This may be a synonym, male, of *Jamphotus tuberculatus*, see couplet no. 44) .... *Photinus euphotus*, n. sp.

Eyes smaller, the interocular width below antennal sockets more than three-fifths the width of one eye in same aspect; sternites 2–5 longer, together about as large as the two luminous sternites united, strongly infuscate except median fourth pallescent; sternites 6–7 not unusually expanded, the foveae normal; pygidium yellow, very faintly infuscate at extreme base. Length 15 mm. Cinchona, 5,000 ft. (type in Amer. Mus. Nat. Hist.). (This may be a synonym, male, of *Jamphotus tuberculatus;* see couplet no. 44.) .... *Photinus euphotus cinchonae*, n. subsp.

30. (28) Habitus, size and color as in *P. euphotus* but abdomen of male of normal proportions; sternites 2–4 brownish, 5–9 whitish; tergites 5–8 whitish, the pygidium rounded; female more broadly oval, the pronotum feebly

emarginate in front; sternites 2–4 pale brownish, 5–7 whitish, the luminous organ occupying median half of sternite 6; sternite 8 nearly equilaterally triangular, pale yellowish white, narrowly emarginate. Length 13–14 mm. Mandeville, Nov. 26, 1919, Watson (*ebriosus* L. & M. 1922, not E. Oliv., type in Amer. Mus. Nat. Hist.); Mandeville, Aug. 1, 1936. Buck no. 127 (♀ allotype) .... *Photinus amplus*, n. sp.

31. (27) Median lobe of aedeagus with a pair of obliquely transverse, oval, subconvex or flattened, contiguous, ventrobasal plates 32

Median lobe of aedeagus beneath broadly membranous to its base, its sclerotized side margins without ventrobasal plates but with very slight broadening of the sclerotized side margin close to base 34

32. (31) Size larger (8–10 mm.); ventrobasal plates of median lobe larger, more flattened and nearly transverse; sternite 5 entirely white. Chestervale, 3,200 ft., June 13, 1936, Buck nos. 21, 42, 45, 54, 90, 161 (type and 14 ♂ paratypes), and nos. 41 and 163 (♀ ♀) .... *Photinus lobatus lobatus*, n. subsp.

Size smaller (6–7 mm.); ventrobasal plates of median lobe strongly oblique and smaller. (A wholly pallid form possibly referable to this group is above named *P. lobatus morobsus*, see couplet 19) 33

33. (32) Sternite 5 pallid, its basolateral areas more or less faintly infuscate; aedeagus shorter with median lobe broad. Stony Hill about 1,400 ft., Feb. 10, 1937, Blackwelder and Chapin (type and 7 ♂ paratypes) .... *Photinus lobatus obscurellus*, n. subsp.

Sternite 5 usually wholly black; aedeagus more attenuate and depressed, the median lobe more slender, its width in ventral aspect about one fourth its length. Windsor, Trelawney, Apr. 1–10, 1931, G. S. Miller (type and 8 ♂ paratypes) .... *Photinus lobatus rapidus*, n. subsp.

34. (31) Sternite 5 pallid 35

Sternite 5 black, the hind margin often pallescent 37

35. (34) Tergites moderately infuscate; aedeagus narrower, more compact, the median lobe in ventral aspect more than three times as long as wide with its sclerotized side margins practically contiguous with inner margins of lateral lobes and with the vestiges of the ventrobasal plates very feeble or wholly obsolete. Length 5½–6½ mm. Chestervale, June 6–13, 1936, Buck nos. 2, 21, 40, 41, 45, 57, 58 (type and 14 paratypes). Cinchona, July 28, Buck no. 91 (1 ♂), Morces, Buck no. 93 (1 ♂), Woodcutters Gap, July 27, Buck no. 12 (3 ♂ paratypes) ... . *Photinus evanescens evanescens*, n. subsp.

Tergites paler (at least the three apical ones); aedeagus broader, the lateral lobes more arcuate, the median lobe broader, about twice as long as wide in ventral aspect with the vestiges of the ventrobasal plates evident and the dorsoapical membranous area more broadly U-shaped 36

36. (35) Slightly larger (7–8 mm.); tergites 6–8 pale; lateral lobes of aedeagus very slender and moderately arcuate in apical third, and usually curving away from or not contiguous with the median lobe, which shows

slight vestiges of the ventrobasal plates. Bath, St. Thomas, Mar. 2, 1937, Chapin and Blackwelder (type and 9 ♂ paratypes) .... *Photinus evanescens dubius,* n. subsp.

Slightly smaller (6–6½ mm.); posterior tergites somewhat infuscate; lateral lobes of aedeagus with outer margin feebly or not arcuate, the apices more flattened internally beneath the apex of the median lobe, the ventrobasal sclerotized margins of which are expanded into narrow convex fusiform areas. Moneague, Aug. 5, 1936, Buck nos. 107, 118, 124 (type and 5 paratypes). Jamaica, H. G. Hubbard, 1877 (identified as *contemptus* by Ern. Oliv. in 1911 and as *maritimus* by L. & M., 1922, 1 paratype) ...... *Photinus evanescens moneague,* n. subsp.

37. (34) Tergites 6–7 infuscate, the pygidium pale or basaly infuscate; aedeagus slightly variable in proportions and in the degree of evanescence of the ventrobasal lobes; possibly two forms in mixed population; in the typical form the aedeagus narrower in all proportions, the outer margins of the narrow apical part of the lateral lobes being straight or feebly emarginate and convergent (40°), the apical part of the median lobe obviously longer than wide with the ventrobasal enlargements usually imperceptible. Montego Bay, Aug. 2, 1936. Buck Nos. 121, 133, 154 (type and 28 paratypes). June 18, 1910, E. J. Lund (8 ♂ paratypes, identified as *contemptus* by Ern. Oliv., 1911, and as *maritimus* by L. & M. 1922; 2 ♀ paratypes referred to *suavis* by L. & M.), Lucea, July 25, 1910, E. J. Lund (2♂ paratypes, identified as *contemptus* by Ern. Oliv. 1911 and as *maritimus* by L. & M. 1922) .... *Photinus evanescens montego,* n. subsp.

38. (2) Large (17 mm.) apterous female, the short dehiscent subtriangular yellow elytra hardly reaching the first tergite and exposing most of the metanotum, which is pale and transversely marked with a dark-brown band; pronotum dark brown, a little wider than long, hind margin nearly straight, the narrowly explanate margins almost evenly rounded; disc shining, very coarsely and irregularly wrinkled but very finely punctulate, and pubescent; scutellum broad and more strongly punctulate, the apex obtusely notched; abdomen broad with fine median carina, the tergites, except the reduced 8th, brown, each with a narrow, apically broader, median stripe, and broad triangular spot at each hind angle pale yellow, the surface densely punctulate with numerous irregular tubercles and with posterior margin strongly acutely tuberculate at outer angle and at median third, forming four equidistant rows of teeth on upper surface of abdomen; tergite 8 trapezoidal, yellow, with disc basally infuscate, apex truncate, feebly bisinuate, hind angles, acute, sides sinuate; sternite 7 almost wholly pale, the subcutaneous whitish reflector emarginate basally and apically but extended laterally beyond the submarginal fold as supplementary luminous areas in the pleural area below the spiracle; sternites 8 and 9 also pale but without the subcutaneous reflector layer. Catherines Peak, July 27, 1936, Buck no. 6, (1 ♀) .... *Jamphotus tuberculatus,* n. gen., n. sp.

39. (4) Color ochreous with darker longitudinal dorsal markings as follows: A pair of entire, closely approximate medial pronotal vittae basally joining a pair of abbreviated basolateral vittae; the discal elytral in-

fuscation divided into a broader submarginal vitta, a narrow median, and a narrower sutural vitta by the ochreous costae, the inner one of which becomes evanescent near the middle of elytral length, the outer one nearly attaining the apex. Length 8 mm. Type locality, Cuba; Montego Bay (1 ♂ in Amer. Mus. Nat. Hist.) .... *Pyractomena gamma* (J. Duval 1857)

40. (3) Prothorax, elytra, and habitus as in *Photinus;* form usually rather broad with margins expanded; sternite 8 whitish with a pair of sublateral oval subcutaneous white reflectors .... (*Diphotus* n. gen., type, *D. bucki,* n. sp.) 41

Habitus not as in *Photinus.* Form slender, size small, 3 mm.), margins not expanded, sternite 8 uniformly pallid .... (*Microdiphot* n. gen., type M. *cavernarum,* n. sp.) 48

41. (40) Pronotum conspicuously tumid on each side of the median sulcus; pronotal disc and elytra very dark, their margins and suture conspicuously pale; male with sternite 9 apically widened and distorted, its apex narrowed and armed dorsally with a pair of recurved hooks, aedeagus unusually long (3 mm.), narrow, apically attenuate. Length 12 mm. Blue Mountain Peak, 7,350 ft., July 11, 1936, Buck no. 50 (type); Cinchona, Aug. 4, 1923, C. C. Gowdey; Catherines Peak, 5,000 ft., July 27, 28, 1936, Buck nos. 66, 67 (6 paratypes) .... *Diphotus bucki,* n. sp.

Pronotal gibbosities and median sulcus feeble or obsolescent; sternite 9 normal; aedeagus short 42

42. (41) Pronotal disc with median line, or entire surface pale 43

Pronotal disc and elytra deep black, only the margins and suture conspicuously pale as in the last species, eyes moderate. Length 7 mm. Blue Mountain Peak, 7,300 ft., July 11, 1936, Buck no. 50 (1 ♂, type), 6,500 ft., on trail up Blue Mountain Peak, July 13, 1936, Buck no. 51 (1 ♀ flying 3.30 p.m.) .... *Diphotus flavomarginatus,* n. sp.

43. (42) Pronotum with infuscate markings 44

Pronotum entirely yellow 47

44. (43) The large pronotal infuscation divided by a narrow median pale line .. 45

Pronotal infuscation reduced to two parallel and widely separated vittae, the latter broad at base over the elytral articulation, abruptly narrowed anteriorly reaching middle of pronotal length; elytra pale brown, the broadly expanded sides slightly paler; basal abdominal segments luteous; segments 6 and 7 of male black 46

45. (44) Mesonotum sharply bicolored, the scutellum and elytral articulations white in contrast to the black sclerotized areas on each side of the anterior notch; elytra and pronotal disc very dark brown with broad pale-yellow margins; legs very pale; body uniformly dark brown, tergite 8 pale in apical two-thirds; first two antennal joints pale, the outer joints wholly piceus. Length 7 mm. Catherines Peak, 5,000 ft., June 12, 1936, Buck no. 85 (1 ♀) .... *Diphotus lucivolans* n. sp.

Mesonotum infuscate only in small lateral area close to elytral articulation, the scutellar lutescence extending forward on each side of the median notch; elytral and pronotal infuscation pale brown; the two pronotal maculae each more or less divided by a vague sinuous pale line, into a larger inner and a narrower outer infuscate area; the median pronotal sulcus feeble; elytral side margins broadly, the suture narrowly margined with yellow and a fainter, somewhat evanescent, oblique median vitta extending from near humerus almost to the apex; pygidium black (female) or apically yellow (male); antennal joints black with base and usually also with apex pallescent. Length 7–12 mm. Cinchona to Morces, 5,000 ft., July 20, 1936, Buck no. 72, 116 (type and 7 paratypes); Whitfield Hall, July 13, Buck no. 96 (10 paratypes); Chestervale, June 8, Buck nos. 21, 39, 81, 82, 115 (16 paratypes); Cinchona, June 10, 1910, E. J. Lund (3 paratypes) .... *Diphotus montanus*, n. sp.

46. (44) Larger (9–12 mm); elytra entirely pallescent but appearing darker over the wings; pronotal infuscate lines very narrow; aedeagus broader, the lateral lobes carinate internally, the carina produced into a lamellate hook applied to the sides of the upcurved, subcylindrical apical part of the median lobe. Mandeville, Aug. 1–4, 1936, Buck nos. 11, 120 (type and 5 paratypes); Mandeville, Dec. 11, 1919, Watson (1 ♀ in Amer. Mus. Nat. Hist. as *P. ebriosus*, (Mutch. 1923); between Mocho and Catadupa, July 7, 1935, Blackwelder (3 paratypes) .... *Diphotus ornicollis*, n. sp.

Smaller (7 mm.); elytra with faint broad median brownish vitta; pronotal infuscation broader; aedeagus narrow, the laterally compressed apex of the median lobe meeting the internally unarmed apices of the lateral lobes. Bath, Feb. 1–4, 1920, Watson (*Photinus pantoni* L. & M., part) (1 ♂) .... *Diphotus mutchleri*, n. sp.

47. (43) Larger (male 10 mm.), the expanded margins of pronotum and elytra broader, the pale margins of the latter shading into the infuscate vitta, which is only about half as wide as the elytron. Catherines Peak, June 26, 1936, Buck no. 65 (type and 2 paratypes); St. Helens Gap to Morces, July 28, 1936, Buck no. 68 (paratype) .... *Diphotus semifuscus*, n. sp.

Smaller (male 5 mm.), the pronotal and elytral margins less expanded, the pale margins of the latter narrow so that the nearly black vitta occupies three-fourths of the width. Cinchona, July 28, 1936, Buck 35; Whitfield Hall, July 13, Buck nos. 3, 32; Silver Hill to Woodcutters Gap, July 27, Buck no. 34 (probably *Photinus unicus Mutchler* 1923, Amer. Mus. Novitates no. 63, p. 4) .... *Diphotus unicus* (Mutch. 1923)?

48. (40) Body yellow, the eyes black, elytra very slender, dark brown, shining, minutely asperate, with very narrow yellow sutural margin, and with outer margin deflexed and not expanded; tergites 4 to 6 infuscate, shining; antennae, stout, cylindrical, about four-fifths as long as elytra. Length 3½ mm. One ♂ in cave at Windsor, Apr. 10, 1931, G. S. Miller .... *Microdiphot cavernarum*, n. sp.

49. (1) Pale, except antennae, labrum, front tibiae and apices of leg joints, an elongate discoidal pronotal spot, and two tapering and posteriorly obsolete vittae on each elytron, which are more or less strongly infuscate. Sexes similar with sternites 6 and 7 strongly luminous. Length 10–14 mm. .... *Photuris jamaicensis* Ern. Oliv. 1886

STUDIES ON THE FIREFLY. III. SPECTROMETRIC DATA ON THIRTEEN JAMAICAN SPECIES[1]

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INTRODUCTION

It is a matter of common observation that the light emitted by different species of fireflies seems to differ in color. Among our common North American lampyrids, for example, the light of *Photuris pennsylvanica* appears greenish, while that of *Photinus pyralis* is definitely yellowish. On the other hand the intensity of firefly light is very low (ca 1/400 candle, Coblentz, 1912) suggesting the possibility (Knab, 1905) that the color "differences" may be a partly subjective consequence of the physiology of the human retina. As is well known, with light sources of less than 10 millilamberts brightness (which is of the order of magnitude of firefly light) the region of maximum sensitivity of the eye, i. e., the apparent color, shifts toward the blue, as vision shifts from the foveal cone vision to peripheral rod vision ("Purkinje phenomenon"). Thus a carefully controlled spectroscopic study is necessary to give objective proof of the range of color of the light of a given species or of a difference between species. Several such studies have been made, beginning with the relatively crude observations of Pasteur (1864) and culminating in the precise measurements of Coblentz (1912). These are summarized in table 1. The net result of these investigations has been to establish that the light emitted by fireflies consists of a broad structureless band, differing in extent in different species, but lying always wholly within the visible spectrum.[2]

The results tabulated in table 1 were obtained by such a variety of investigators and methods that they are of doubtful comparative value. In the present study advantage was taken of the excellent opportunity offered by the tropics for studying many species of living fireflies simultaneously, and the questions of species and sex differences in emission were investigated under comparable conditions.

[1] Received for publication October 1, 1940.

[2] For the sake of completeness, mention should be made of the fantastic reports that fireflies emit a penetrating radiation similar to X-rays. Thus Muraoka (1896) described the light of fireflies as penetrating sheets of copper, brass, zinc, etc., while Singh and Maulik (1911) found them to penetrate leather, paper and meat. Present-day photographic experience makes it nearly certain that the above-mentioned effects, like many of the so-called "mitogenetic ray" effects, were due simply to chemical vapors from the wood, paper or cardboard used to mask the photographic plates, as would have been apparent had not the investigators neglected to perform control experiments without fireflies.

TABLE 1.

Summary of Literature on Spectral Extent of Firefly Light

"V" = visual spectrometry, "P" = spectrophotography

Observer	Species	Method	Result (Å)
Pasteur, 1864	Pyrophorus (th.)	V	continuous band in visible
Young, 1870	Photinus?	V	>6560–4870*
Secchi, 1872	Glow-worm	V	continuous band in visible
Severn, 1881	Indian firefly	V	"
Conroy, 1882	English glow-worm	V	6560–5180
Dubois, 1886	Pyrophorus noctilucus (th.)	V	>6870–4870*
Langley and Very, 1890	Pyrophorus noctilucus (th.)	V	6400–4680
"	" (abd.)	V	6630–4630
Ives and Coblentz, 1910	Photinus pyralis	P	>6400– <5250
McDermott, 1910	Photinus pyralis	V	ca. 6200–5350*
"	Photuris pennsylvanica	V	ca. 6150–5400*
"	Photinus consanguineus	V	ca. 6150–5500*
McDermott, 1911	Phengodes laticollis	V	>6450– <5110*
Coblentz, 1911, 1912	Photinus consanguineus	P	>6400– <5250*
"	Photuris pennsylvanica	P	>6100– <5100*
"	Glow-worm (P. penn.)	P	>6150– <5300*
Ramdas and Venkiteshwaran, 1931	Glow-worm	P	5860–5290
Brooks, 1940	Glow-worm	P	5879–4690

* These measurements are approximations, either converted into Ångstrom units by the present writer from data furnished in other units (usually compared to Frauenhofer lines), or recalculated from figures, graphs or arbitrary spectroscope scale units given by the original authors.

The author is greatly indebted to the late Professor D. S. Johnson for opportunity to use the facilities of the Seventh Tropical Expedition of The Johns Hopkins University; to Dr. C. E. Brambel for the loan of the spectroscope; to Professor A. H. Pfund for aid in calibrating the spectroscope; to Mr. H. S. Barber for undertaking the very laborious task of identifying the species used; and to the National Research Council of the U. S. A. for a grant-in-aid for traveling and laboratory expenses.

MATERIALS AND METHODS

Twelve species of lampyrid and one elaterid firefly, native to Jamaica, B. W. I. were investigated. With the exception of *Photinus synchronans,*[3] which is primarily a seacoast form, the species studied were those common during June, July, and August, 1936 around Chestervale, the expedition's headquarters, located at an altitude of 3,200 feet in the Blue Mountains.

The spectroscope used (text-figure 1) was a Browning straight-tube type, 9 cm. long, of just sufficient dispersion to separate the yellow doublet at 5770 Å and 5791 Å in the spectrum of the mercury arc. This spectroscope had an arbitrary scale, extending from 0 to 10 in tenths, and

[3] For taxonomy of forms studied see Barber, H. S. "Species of fireflies in Jamaica (Coleoptera, Lampyridae)" in the present number of these Proceedings.

this was standardized by adjusting the scale by means of the sliding lever (fig. 1, "A") until the 2 ("200") line of the scale coincided with the strong sodium D lines at 5893 Å (plate 1, fig. 1). The scale was then calibrated against the red lithium line at 6708 Å, and the principal lines in

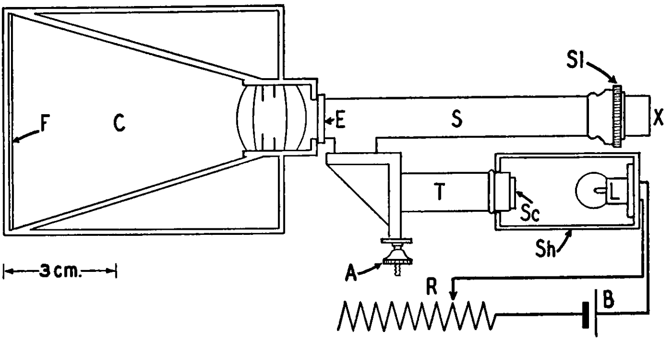

FIG. 1. Apparatus for measuring spectra of fireflies; top-view; semidiagrammatic. S, spectroscope; E. eyepiece; S1, slit adjustor; X, position of firefly; T, side tube for scale; Sc, scale; Sh, shield for lamp; L, flashlight lamp; A, adjustor for setting scale; R, rheostat; B, dry cell; C, camera; F, film.

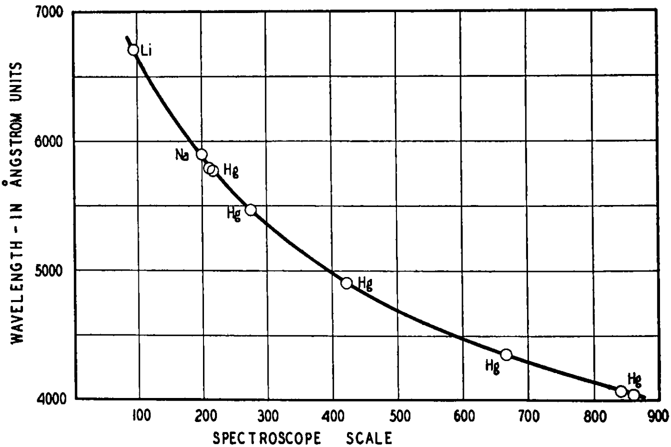

FIG. 2. Calibration curve for spectroscope: Abscissae, arbitrary units of spectroscope scale; ordinates, Ångstrom units. Calibration standards were the lithium and sodium flames, and the mercury arc.

the visible spectrum of the mercury arc (plate 1, fig. 4). The calibration curve is given in text-figure 2.

In measuring spectra all operations were conducted in total darkness. The procedures were as follows: The spectroscope scale was checked against the sodium flame, as described, and the width of the slit adjusted to 0.1 mm. The specimen to be examined was then attached by its dorsal surface to the ball of the index finger with rubber cement, and brought into position (text-figure 1, "X") in front of the slit so that the light from the light organ (ventral in the *Lampyridae*) was directed into the tube. Under such conditions the insects in their struggles ordinarily continued to flash at regular intervals for some time. For visual examination the spectrum was then viewed through the eyepiece (text-figure 1, "E") and the brightness of the scale adjusted (by means of the shielded ("Sh") flashlight lamp ("L") in series with a rheostat ("R") and dry cell ("B")) until it was too dim to interfere with observation, but bright enough to show the limits of the spectrum clearly. For photography a camera ("C") of 7.5 cm. focal length, loaded with Eastman Supersensitive Panchromatic film ("F") was attached to the eyepiece, the shutter was opened, and the firefly allowed to flash for some minutes after which the lamp was turned on for a few seconds to register the scale on the same negative with the spectrum. Where possible only one specimen was used for one spectrograph, and several individuals of each species were examined.

TABLE 2.

Spectrometric Data on the Light Emitted by 13 Jamaican Species

Those spectrographs marked with an asterisk are considered particularly reliable because of superior negative density

Species	Extent of spectra in Å: Photograph	Fig. No. Plate 1	Extent of spectra in Å: Visual	Maximum Å
Photinus xanthophotis catherinae ♂ ...	6400–5350	7	6550–5200	5850
" " " ♀ ...				5800
Photinus pallens ♂	6425–5150*	5	6650–5150	5775
" " ♀	6450–5200*	6	6550–5125	5775
Photinus synchronans ♂	6450–5150*	11	6550–5200	5850
Photinus variabilis ♂	6600–5200*	8	6650–5225	5800
Photinus flavilimbatus ♂			6200–5275	
Photinus ceratus ♂			6200–5350	
Photinus evanescens evanescens ♂ ...			6550–5350	
Photinus gracilobus ♂			6550–5075	
Diphotus unicus			6450–5050	
Diphotus montani			6200–5150	
Diphotus semifuscus			6550–5125	
Photuris jamaicensis ♂	ca. 1275[4]	10		
" " ♀			6550–5225	
Pyrophorus plagiophthalamus (Th.) .	6500–5050*	2	6550–4975	5850
" " (Abd.)	6450–5400	3	6550–5150	5950
Phengodes sp.[5]			5900–5100	

[4] Scale accidentally omitted from spectrograph, so that only the extent can be given.
[5] Specimen collected by Professor E. N. Harvey at Tuxedo, N. Y.

RESULTS AND DISCUSSION

The results obtained are presented in table 2 and in plate 1.

As is often true in spectrography, the determination of the extreme limits of the spectra described was somewhat arbitrary. Their extents depend upon the intensity of the light (visual) or duration of exposure (photography), upon the width of the slit, upon the sensitivity of the eye or of the film, upon the dispersion of the spectroscope, etc. Add to these the difficulties of determining visually the exact extent of the spectrum of a flash of light of short duration (ca. 0.2 sec.), even if repeated many times, and of calipering small spectrographs on coarse-grained film accurately, and it will be appreciated that the limits given in table 2 define only the approximate minimal extents of the spectra. That this is true also for the investigations listed in table 1 is made plain by the work of Coblentz (1912) in which even the most careful densitometer measurements did not permit the specification of the exact limits of the spectra studied. Coblentz's measurements do show, however, as do his figures and the spectrographs given in plate 1 of this paper, that the spectra of firefly light are characterized by an extraordinarily abrupt diminution in intensity near their limits. It was noted in the present study, for example, that above a certain minimal negative density the extent of a spectrograph underwent little increase with increased exposure. It is accordingly believed that the photographic measurements recorded in table 2 are probably not in error by more than ± 25 Å, particularly in the cases where dense negatives were obtained (marked with asterisks). The visual measurements, on the other hand, in nearly every instance somewhat exceeded the extents of the spectrographs of the same species. This may possibly be a spurious effect due to subjective error in measurement, but is more probably due to the superior sensitivity of the eye to low intensities (as compared with that of the film) and would disappear if the film were exposed sufficiently long. In instances where the comparative extents of two spectra are rendered questionable by reason of unequal negative densities, a more reliable index of comparison is perhaps offered by the regions of maximum emission. Coblentz, for example, has shown by densitometric means that there are sharply defined differences in the emission maxima of three American species of firefly. The "emission maxima" listed in table 2 represent only the regions of maximum density in the negatives (obtained by visual inspection) but are adequate for comparative purposes since the sensitivity of the film used is fairly uniform throughout the region studied.

With due regard to the above-mentioned limitations, the following general conclusions may be drawn from the data presented:

Comparative spectra of the light emitted by male and female of the same species.—Possible differences in the color of the light emitted by

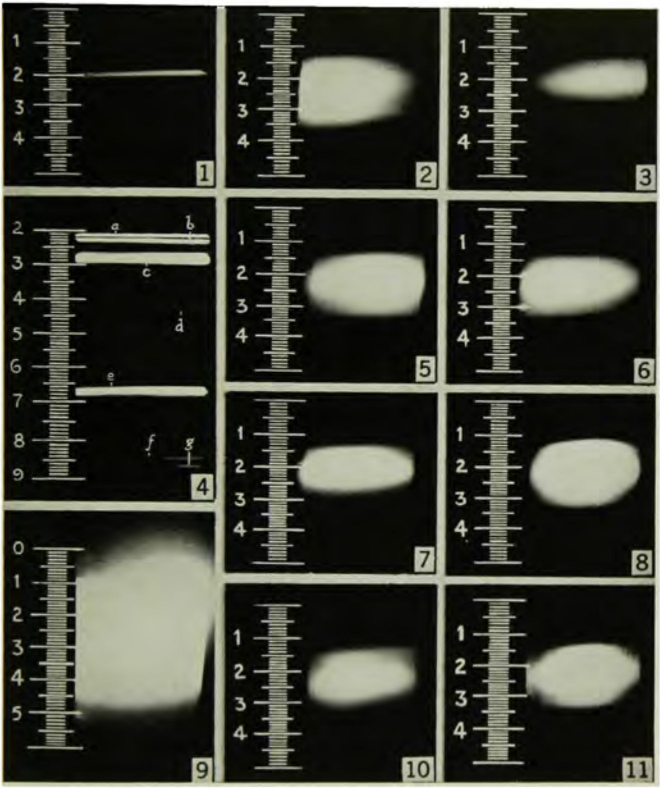

PLATE 1. Spectrophotographs of the light emitted by several species of Jamaican fireflies, and by standard comparison sources. The firefly spectra are probably very slightly less extensive than in the original negatives, due to loss in reproduction. In the original negatives the length of the scale from 0 to 4 is 1 cm. Fig. 1, sodium "D" line, used as the calibration standard. Fig. 2, thoracic organ of *Pyrophorus plagiophthalamus*. Fig. 3, abdominal organ of *Pyrophorus plagiophthalamus*. Fig. 4, spectrum of mercury arc used in calibration: a and b—the yellow doublets at 5791 and 5770 Å; c—the strong green line at 5461 Å; d—faint blue 4916 Å; e—blue at 4358Å; f and g—the violet lines at 4078 and 4046Å. Fig. 5, *Photinus pallens*, male. Fig. 6, *Photinus pallens*, female. Fig. 7, *Photinus xanthophotis catherinae*, male. Fig. 8, *Photinus variabilis*, male. Fig. 9, tungsten filament lamp. Fig. 10, *Photuris jamaicensis*, male; see footnotes 4 and 6. Fig. 11, *Photinus synchronans*, male. The scales in all the figures, and the lines in fig. 4 are slightly retouched to reduce the blurring effects of halation from over-exposure.

the two sexes of a given species have been suggested as factors in the system of mating signals, but no actual measurements have been recorded previously on this point. It was shown, however (Buck 1937a), that such possible differences are not factors in the mating signals of *Photinus pyralis*.

In the present investigation, good spectrographs were obtained from both male and female of *Photinus pallens,* and as will be seen in figs. 5 and 6, plate 1, and in table 2, they do not differ in extent by more than the experimental error, and the maxima appear to correspond exactly. In *P. xanthophotis catherinae* the spectrograph of the light of the female was somewhat lighter than that of the male, so that only maxima can be justifiably compared: these again are seen to be fairly close. In *Photuris jamaicensis,* as previously mentioned, the scale unfortunately was omitted from the spectrograph of the male[6] so that only the extent of the spectrum can be compared with that observed visually in the female: these however appear to be nearly equal.

In summary, then, it can be concluded that the light emitted by the two sexes of a given species is very similar, if not identical, in spectral characteristics.

Comparative spectra of the light emitted by different species.—The results presented in table 2 and plate 1 show the following: (1) As found also by previous workers, the light emitted by fireflies consists of a continuous band lying within the limits 5000 Å to 6600 Å. (2) Certain species, for example *Photinus xanthophotis catherinae, P. synchronans, Diphotus semifuscus and Photuris jamaicensis,* emit light of very nearly the same spectral extent. (3) Certain other species, for example *Photinus variabilis* and *Diphotus montani* emit light of markedly different spectra. The measurements confirm in this instance the striking observational difference between the rich yellowish light of *P. variabilis* and the distinct green of *D. montani.* (4) The light of some species, for example *Photinus pallens,* is comparatively wide in spectral extent, while other fireflies, for example *P. ceratus,* have a considerably smaller range. (5) There seem to be no characteristic differences in the spectra of the four genera examined, although histological work now in progress demonstrates that the structure of the light organs in the different genera does differ characteristically, and to an extraordinary degree. The fact that the light emitted by all the species studied appears to lie in the same general region of the spectrum appears to point to the same fundamental chemical reaction underlying the light production. However, the fact that there are distinct, though minor, differences in the light emitted by

[6] The scale in fig. 10, plate 1, is fitted by comparison with the spectrum of the female, and is included only to allow a rough comparison between the genera *Photuris* and *Photinus.*

different species, or even from different regions of the same individual (see below) indicates that there may be involved several types of luciferin and luciferase, the light producing substances (Harvey, 1920, 1940), much as there are many individual types of hemoglobin. Harvey (1917) has in fact demonstrated that in *in vitro* mixtures of luciferase and luciferin from different species of fireflies the color of the luminescence resulting is determined by that of the species furnishing the luciferase.

Comparative spectra of the light emitted by thoracic and abdominal organs of Pyrophorus plagiophthalamus.—The tropical elaterid beetle *Pyrophorus* is unique among fireflies in possessing a pair of circular light organs on the dorsal surface of the thorax (which emit light continuously while the insect is at rest or is walking, and are extinguished during flight), and a single larger rectangular organ on the anterior surface of the first abdominal segment (which is only alight during flight, when the abdomen is flexed so as to open the cleft between the thorax and the abdomen). It was early reported that the thoracic light organs emit "green" and the abdominal "red" light, and Langley and Very (1890) confirmed this difference by visual spectrometry (table 1), but so far as the writer is aware no photographic record of the spectra has been obtained previously. Figures 2 and 3, plate 1, show the striking difference in spectral extent between the light emitted by the thoracic and abdominal organs of *Pyrophorus plagiophthalamus*. Curiously enough, in this species the spectrum of the thoracic organ (6500 to 5050 Å)[7] extends if anything a little farther toward the red than that of the abdominal organ (6450 to 5400 Å) so that the much greener color of the former is due mainly to its greater extent toward the blue, and also to its different emission maximum. In *Pyrophorus noctiluca,* according to Langley and Very (table 1), the spectrum of the (greener) thoracic organ does not extend as far toward the red as that of the abdominal organ, and they are about equal at the blue end.

SUMMARY

Spectrometric data for the light emitted by 13 species of Jamaican firefly are presented. It is shown that each of these emits light consisting of a continuous band of greater or less extent within the limits 5000 to 6600 Å. There is no indication that the light emitted by males and females of the same species differs significantly in spectral characteristics. Some species have nearly identical spectra, some have quite different ones; some have relatively broad spectra, some narrow. The thoracic and abdominal organs of *Pyrophorus plagiophthalamus* have spectra of strikingly different extents and emission maxima, corresponding to their re-

[7] A re-measurement of the films changed the limits slightly from those contained in the preliminary report (Buck 1937b).

ported "green" and "red" colors. No consistent difference in spectral quality of the light of the four genera investigated was detected.

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THE SELECTIVE EFFECT OF CLIMATE ON THE FLOWERING BEHAVIOR OF SOLIDAGO SEMPERVIRENS L.[1]

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In the past few years biologists have been focusing their attention on the problem of micro-evolution or the study of speciation in its various aspects (Huxley, et al., 1940). The development of many experimental methods has contributed greatly towards an analysis of this obscure problem. The experimental garden has been used very effectively in Sweden by Turesson (1925, 1930, 1931) as a standard environment in which to establish genetic differences between various strains within a species. Extensive investigations of a similar nature have been carried out more recently in North America by Evans (1939) and Clausen, Keck and Hiesey (1940) in which plantings at different latitudes and at different altitudes have been employed. It has now been demonstrated by such methods that genetic differences in flowering time occur within the members of a number of species such as *Solidago virgaurea* L., *Bupleurum longifolium* L., and *Polygonum bistorta* L. in Europe (Turesson, 1931) and *Potentilla drummondii* Lehm. (Clausen, Keck and Hiesey, 1940) in North America. Individuals belonging to these species collected from northern stations or at high altitudes, where the growing season is short, flower earlier than specimens with more southerly distributions or from lower altitudes. In this paper is described a similar case of climatic differentiation of a species into a series of strains distinguishable on the basis of their flowering behavior.

Solidago sempervirens L. (plate 1C) is a species of golden-rod inhabiting salt marshes along the Atlantic Coast from Newfoundland to Mexico. In the north it appears only as the typical species, but between Massachusetts and Virginia it passes into *S. sempervirens* L. var. *mexicana* (L.) Fernald (plate 1A), and further south probably only the southern variety is found. Fernald (1935) distinguishes the variety primarily by its narrower, somewhat ciliolate leaves and smaller heads. It also grows somewhat taller than the species. Fernald states that in the overlapping ranges the variety tends to inhabit the more sheltered brackish localities, whereas the typical species grows characteristically on the saline outer beaches.

[1] Received for publication February 15, 1941.

This wide north-south range (from 25° to 50° north latitude) makes *S. sempervirens* and its southern variety very favorable material with which to study the selective effect of latitude on flowering time. Owing to its strictly maritime distribution, herbarium material can be readily used without having to consider complicating effects due to altitude. Data as to the flowering seasons in different portions of the range have been obtained from the dates of collection of all of the good flowering specimens available in the Gray Herbarium, the United States National Herbarium, the Herbarium of the New York Botanical Garden and the private collections of Dr. W. S. Phillips and of the writer. The data are presented graphically in figure 1, in which the range has been split up by states into convenient north-south sections. The species (solid black) and its southern variety (white) have been distinguished wherever possible. The shift in flowering dates—the median indicated by an arrow in each case—as one passes from north to south can be clearly seen. North of 45° north latitude, in Canada, plants are flowering about August 18, whereas south of 36½° north latitude, from the Carolinas southward, they are blooming about October 10. It will be noticed that south of 31° north latitude, in Georgia, Florida and Texas, there are two blooming seasons, one in October and the other in April. This is due to the mild winters which permit growth to occur throughout the year.

The classical paper of Garner and Allard (1920) demonstrating photoperiodic behavior in plants started research in a new field, the physiology of floral initiation. It has now been established that many species will flower only under a long photoperiod (long-day plants) whereas others will flower only under short photoperiods (short-day plants). Allard (1932) has pointed out that certain species of plants are limited in their northerly or southerly distribution by their photoperiodic requirements. Short-day plants may have insufficient time to complete their reproductive cycle in the short northern fall while long-day plants may never obtain a sufficiently long photoperiod in the south to initiate floral primordia.

In *Solidago* floral initiation takes place from four to six weeks prior to flowering time. From figure 1 floral initiation in *S. sempervirens* would be expected to take place in Florida in September and March when the photoperiod is approximately twelve hours in length. In Canada, on the other hand, this process must take place in early July during a photoperiod of about 16 hours. It is clear that the photoperiod at which the flowering phase is initiated is very different at the north and south extremes of the range of this species.

The question arises, could these different flowering dates at various latitudes be explained on the basis of genetic similarity of all the individuals of the species with respect to flowering behavior, the differences in dates being due to responses to different environments. This question

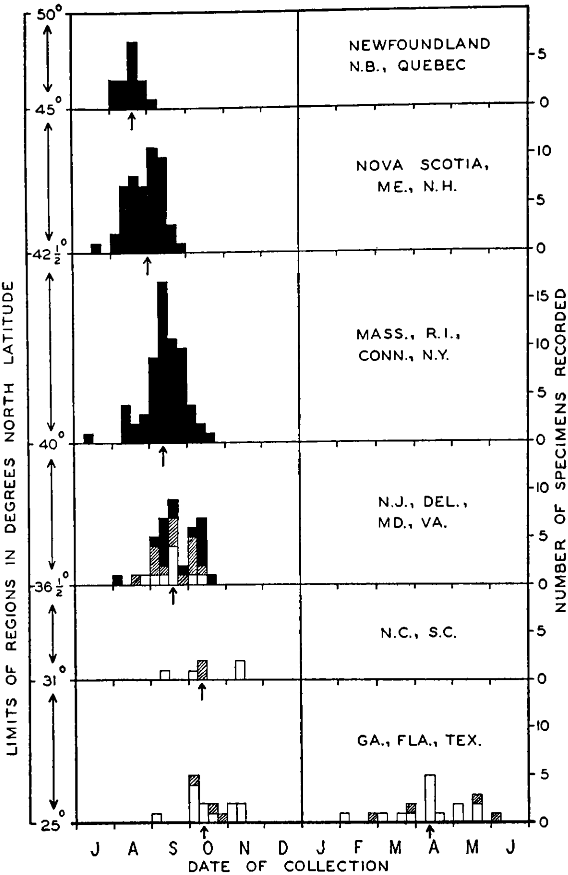

FIG. 1. Graphical representation of the collection dates of all the good flowering specimens of *S. sempervirens* and its southern variety in the Gray Herbarium, the United States National Herbarium, the Herbarium of the New York Botanical Garden, and in the private collections of Dr. W. S. Phillips and of the writer. The range has been split up by states into suitable sections, the north and south limits of which are given at the left. *S. sempervirens*—solid black; *S. sempervirens* var. *mexicana*—white; varietal determinations uncertain—cross-hatched.

may be answered by growing plants from various latitudes under the same environmental conditions.

TABLE 1.

Flowering dates of Solidago sempervirens L. and S. sempervirens L. var. mexicana (L.) Fernald at Rochester, N. Y. in 1940.

Place of Original Collection	Specimen	Anthesis of First Flowers	Plants in Full Bloom	Remarks
Ipswich, Mass.	a	Sept. 18	Oct. 3	See plate 1C.
Ocean City and Point Lookout, Md. ...	b, c	Oct. 4	Oct. 12	See plate 1F, G.
Ft. Myers, Fla.	d	Nov. 16	Nov. 26	See plate 1A, D. Plant brought into greenhouse on Oct. 16.

a Plants grown from seed obtained by cross pollinating two specimens of *S. sempervirens* collected on the sand dunes at Ipswich, Mass. in 1934.

b Plants of *S. sempervirens* var. *mexicana* transplanted from a sandy, vacant lot behind the beach at Ocean City, Md. in 1934.

c Plants of *S. sempervirens* var. *mexicana* grown from seed collected by Mr. O. M. Freeman from Point Lookout, Md. in 1934.

d Plants of *S. sempervirens* var. *mexicana* grown from seed collected by Mr. W. M. Buswell at Ft. Myers, Fla. in 1934.

In the course of a cytogenetic investigation of two species of goldenrods (Goodwin, 1937) casual mention was made of the fact that plants of *S. sempervirens* var. *mexicana* from Florida were physiologically distinct from plants of the same variety collected in Maryland. It was observed that the Florida material flowered at least a month later than the Maryland and grew almost twice as tall (8 to 10 ft.), when cultivated in the greenhouse at Cambridge, Mass. These observations have been confirmed over a period of five years. Table 1 gives the dates of anthesis of the first flowers and approximate dates of full bloom for plants from Ipswich, Mass., Ocean City and Point Lookout, Md., and Ft. Myers, Fla. under cultivation outdoors at Rochester, N. Y. in 1940. The dates are somewhat later than the median for these plants in their original habitats. The differences in flowering dates between specimens collected in these various localities show clearly, however, that these plants differ genetically from one another in their flowering behavior under the same environmental conditions.

The plants from Maryland (plate 1F, G) and Florida (plate 1A, D, E) both belong to the southern variety and are morphologically identical, with the exception that the Florida material in the north usually grows taller than the Maryland. This may be due at least in part to the longer growing period. Turesson (1930, 1931) reports similar differences in height in races of *Solidago virgaurea* and of other species. In addition, it should be noted that specimens from Florida probably cannot complete their reproductive cycle outdoors at the latitude of Rochester. Plants from Miami, Florida (plate 1E), which were at exactly the same stage as the Ft. Myers material on October 16 and which were left outdoors, were killed by frost on October 21. This "lack of hardiness" of the southern material should be attributed to a delay in reproductive activity resulting in the presence of tender, actively-growing meristems at the time of the early frosts. Here is a case in which the northward extension of a southern, short-day strain would be limited by two climatic factors, photoperiod and early frost.

Successful crosses have been made between *S. sempervirens* from Ipswich, Mass. (plate 1C) and *S. sempervirens* var. *mexicana* from Ocean City, Md. (plate 1G). The progeny from such crosses (plate 1B) are very similar in appearance, height and flowering time to *S. sempervirens* from Ipswich. The number of these plants under observation has been too small to draw any conclusions as to the inheritance of flowering behavior but the results indicate that no serious genetic barriers occur between the species and its southern variety.

SUMMARY

An analysis of the flowering dates of *Solidago sempervirens* L. at various latitudes along the Atlantic Coast shows that this species flowers progressively later in the season as one passes from north to south. When plants from different portions of the range are grown at the same latitude under similar conditions these plants still flower at different times, those from the north flowering earlier than those from the south. This has been interpreted as evidence for the existence within the species of a graded series of strains genetically distinguished from one another by their physiological requirements for floral initiation.

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Plate 1. Strains of *Solidago sempervirens* L. all photographed on October 9, 1940 at Rochester, N. Y. A. and D.—*S. sempervirens* var. *mexicana* from Ft. Myers, Fla., in early bud. B.—A cross between *S. sempervirens* ♀ from Ipswich, Mass., and *S. sempervirens* var. *mexicana* ♂ from Ocean City, Md. past full bloom. C.—*S. sempervirens* from Ipswich, Mass., past full bloom. E.—*S. sempervirens* var. *mexicana* from Miami, Fla., in early bud. F.—*S. sempervirens* var. *mexicana* from Point Lookout, Md., nearly in full bloom. G.—*S. sempervirens* var. *mexicana* from Ocean City, Md., nearly in full bloom.


A
B
C
D
E
F
G

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A RESPIRATORY STUDY OF BARLEY GRAIN AND SEEDLINGS [1]

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INTRODUCTION

Though many papers have appeared on the respiration of seeds and seedlings practically no information is available on the nature of the oxidases catalyzing this respiration. Nor has any attention been paid to the problem of whether the oxidases functional in embryos and early seedlings are of the same nature as those functional in the older plant. Allen and Goddard (1938) observed that the respiration of mature wheat leaves is not inhibited by sodium azide or HCN though they had some unpublished observations which indicated that the respiration of immature leaves was inhibited by these poisons. Further, Ross (1938) has shown that the respiration of wheat seeds is partially inhibited by HCN. Marsh and Goddard (1939a) had shown that a large fraction of the respiration of mature carrot roots and immature leaves was inhibited by HCN, NaN_3, and CO with light reversal, while the respiration of mature carrot leaves was not so inhibited. In view of the results of Warburg (1928) and of Keilin (1929, 1936), Marsh and Goddard interpreted their results to mean that the respiration of carrot roots and immature leaves is catalyzed by cytochrome oxidase while the respiration of mature leaves is mediated by some other oxidase. It seemed worth while to investigate more carefully this shift from one oxidase system to another in the course of differentiation of the seedling.

This paper will present results obtained with barley by the use of respiratory inhibitors (HCN, NaN_3, and CO) on intact grain, isolated embryos, endosperm, young seedlings, and on roots and leaves at two stages of development. These results indicate a qualitative differentiation of respiratory mechanisms accompanying morphological differentiation of the shoot. Also, results will be presented indicating the existence of aerobic fermentation in the early stages of germination and the existence of a Pasteur mechanism in grain, embryos, and seedlings. Though much data exists in the literature on the growth of the respiratory rate with germination, we felt it necessary to present some similar data as an introduction to the experiments mentioned above.

[1] Received for publication March 12, 1941.

[2] This work was carried out during the tenure of the Emma J. Cole Fellowship in Botany of the University of Michigan.

The literature on the respiration of seeds is vast and no attempt to review it will be presented here. The reader is referred to Stiles and Leach (1932, 1933) and Stiles (1935). The pertinent newer papers will be referred to in the discussion of our results.

MATERIALS AND METHODS

The grain used was *Hordeum vulgare* strain alpha, obtained from the College of Agriculture, Cornell University. The grain was stored in a desiccator over saturated $CaCl_2.2H_2O$ and solid crystals of $CaCl_2.2H_2O$. This mixture maintains a relative humidity of 32 per cent in the gas phase. Grain that has been stored in this manner reaches, in a few days, a constant moisture content, in this case of 8.32 ± 0.24 per cent. This method of storage was adopted after it was found that air dry grain soaked in water for 12 hours gave variable respiratory results. This variation was markedly reduced by the storage method given above.

The broken and discolored grain was discarded. The grains were individually weighed and only those between the limits 40 to 50 mg. were used. When individual seedlings were run, they were from grains which weighed between 44 to 46 mg. The grain was soaked in water for 12 hours, unless otherwise stated. If not used immediately after 12 hours in water it was transferred to moist filter paper in Petri dishes. For the experiments with "stripped seeds" the lemma, palea, ovary wall, and seed coat were removed as completely as possible, and the grain was always stripped just before use.

The usual procedure was to use 5 or 10 grains, embryos, or endosperm in each respirometer vessel. All vessels were set up duplicate. Except where noted, in the experiments with grains, embryos or endosperms, the bottom of the respirometer vessels were lined with No. 40 Whatman filter paper and moistened with 0.1 ml. of dilute Shive's solution. (KH_2PO_4 0.490 gm./1; $Ca(NO_3)/2.4H_2O$, 0.254 gm./1; $MgSO_4.7H_2O$, 0.739 gm./1; $FePO_4$ 0.00088 gm./1). Dry grain was placed in the vessels with 0.6 ml. of Shive's solution, and leaves and roots in 2.0 ml. of Shive's solution, and with roots 2 per cent sucrose were included in the solution. The Fenn (1928) micro-respirometers used had a sensitivity of 0.6 $mm.^3$ per mm. of scale deflection. The bath temperature was either 22° or 25°C. ± 0.01 and is indicated for each experiment. All results are expressed as values of dry gas at 0° C. and 760 mm. Hg. In O_2 consumption measurements CO_2 was absorbed by 5 per cent KOH in the insets. The aerobic CO_2 was determined by Warburg's (See Dixon, 1934) two-vessel direct method. Anaerobic CO_2 was measured in an atmosphere of tank nitrogen freed of oxygen by passage over freshly reduced hot copper. CO was generated by H_2SO_4 dehydration of formic acid, washed through KOH, and mixed with O_2 in burette bottles. Krebs (1936) KCN/KOH mixtures were used in the insets in the HCN experiments.

The apparatus was shaken 120 times a minute through an arc whose chord is 2.5 cm. This was sufficient to prevent gas diffusion from the atmosphere into liquid being a limiting factor, except where grain was submerged in 2.0 ml. of liquid. No data are reported where gas diffusion to suspending liquid is limiting.

In the cyanide and azide experiments the grains, seed parts, or seedlings were soaked for $\frac{1}{2}$ hour in the poison and then transferred to the respirometer vessels, in which the filter paper was moistened with the same concentration of poison solution. The KCN solutions were neutralized and made to volume in Shive's solution.

The respiration of green tissues and seedlings was measured in a photographic dark room, with a very weak light used only during the period of reading of the apparatus. For light reversal of CO inhibition 100 watt lamps 10–12 cm. from the bottom of the vessels were used.

EXPERIMENTAL RESULTS

Germination and Respiratory Metabolism. Prior to a study of the nature of the oxidases catalyzing respiration, some experiments were undertaken to determine the growth of the respiration with time. Though these results duplicate, in part, some results in the literature, features of our experiments are worth reporting. Further, it is impossible to determine the percentage inhibition by respiratory poisons if gas diffusion is limiting the respiratory rate. Therefore, we examined the relations between oxygen diffusion and respiratory rate.

All results are expressed as $mm._3$ of dry gas at 0° C. and 760 mm. of Hg. Results given as dry weight are calculated on a basis of the weight of grain of 8.32 per cent moisture, and are therefore not strictly dry weight. The dry weight of soaked grain and seedlings is the dry weight, as above, of the grain and not of the seedlings. Wet weights are weights of grain or seedlings that had imbibed water.

One frequently sees the statement that air dry seeds do not respire. White (1909) has reported that several dry seeds have no respiration. However, a careful reading of her paper indicates that she would not have detected the low rates which occur. Some preliminary experiments showed two difficulties in determining the respiration of dry barley grain by the mannometric technique. First, absorption of water from the KOH of the insets causes the seeds to swell and the volume changes interfere with the mannometer readings. Second, preformed CO_2 is released when the tension of atmospheric CO_2 is reduced to zero. Though both effects are small, they are larger than the gas consumption measured. These difficulties may be overcome by the technique outlined below.

Barley grain was equilibrated for several days over $CaCl_2.2H_2O$ as outlined above. After the moisture content was constant the grain was transferred to a second desiccator over a solution containing 80 gm. KOH to 100 ml. of solution. This solution has the same vapor pressure as the Ca Cl_2 mixture. After 48 hours the grain had lost all preformed CO_2. To each of the two respirometer vessels were transferred 4.40 gm. of this grain, and to the inset and control vessel was added KOH from the desiccator. Control respirometers were set up in a similar fashion but without grain. After an equilibration period of 4 hours with the vessels closed, readings were commenced and continued for 48 hours. The experimental vessels showed a low oxygen consumption of 0.044 and 0.024 $mm.^3$ 0_2/gm. dry wt./hr. for the first 24 hour period and 0.048 and 0.027 for the second 24 hour period. These values are below the dependable limit of the apparatus. The control respirometers showed a negative drift (positive pressure) of 0.03 cm./hr.; if such a drift occurred in the experimental vessels, the O_2 consumption would be 0.027 $mm.^3$/hr. too low. The average value, corrected for control drift, is 0.062 $mm.^3$/gm. dry wt./hr. or 0.0028 $mm.^3$ O_2/seed/hr. No great reliance may be placed on this figure, but we may reasonably accept 0.1 $mm.^3$/gm. dry wt./hr. as the upper limit of the oxygen consumption of this barley grain of 8.32 per cent moisture.

TABLE 1.

Oxygen consumption or CO_2 production of dry seeds.

Material	Gas measured and units	$mm.^3$/gm. dry wt./hr	$mm.^3$/ seed/hr.	Reference
Barley 8.32% H_2O 25°C.	O_2	0.062	0.0028	This paper
Barley 10–11% H_2O ?°C.	CO_2 0.33–1.5 mg./kgm./24 hr.	0.007–0.031	....	Kolkwitz (1901)
Barley dry seed 22°C.	CO_2 0.43 mg./80 grain/3 hr.	....	0.912	James and James (1940)
Wheat 12.5% H_2O 25°C.	CO_2 0.45 mg./100 gm./24 hr.	0.095	....	Bailey and Gurjar (1918)
Oat 14.31% H_2O 25°C.	O_2	0.31	....	Bakke and Noecker (1933)
Oat 9.16% H_2O ?°C.	CO_2 59 mg./kgm./5 day	0.25	....	Quann (1904)

Reference to table 1 will show the results obtained in comparison with those obtained by several other investigators. The divergence of results, with one exception, is not greater than is to be expected, considering the different conditions, materials, and methods. The value of James and

James is completely out of line, and is due to the fact that their value was not measured, but determined by extrapolation from the rate six hours after addition of water. Reference to figure 1 of this paper shows that this extrapolation is unjustified and may lead to a value more than 100 times too high!

When dry grain was allowed to imbide water in the respirometer a marked increase in respiratory rate occured with time, as is shown in table 2 and figure 1. For the experiments of more than 12 hours duration the grain was soaked in water for 12 hours at 25° C. and then transferred to moist filter paper in Petri dishes and maintained at 25° C, until just before the measurements were made. On seedlings of 24 hours or older, single seedlings were used in each vessel and the data in figure 1 represent averages of 4 seedlings for O_2 consumption and 4 similar seedlings for CO_2 production.

An inspection of figure 1 shows three clearly marked phases of respiration. An initial rapid increase in rate of O_2 consumption from 0–3 hours; a second phase of lower and variable acceleration from 3–12 hours, and a third phase beginning at 12–14 hours and continuing until 72 hours. The initial phase, and very likely the second phase, is associated largely with the imbibition of water. At 22° C. 1.0 gm. of dry grain imbibed 217 mgs. H_2O during the first 3 hours and 93, 53, and 30 mgs. of water in successive 3 hour periods. Though little data exist in the literature which shows the respiratory rate of seeds during the early hours of soaking, there are considerable data on the relation between increase of respiratory rate with increasing moisture. Particular attention may be called to the papers of Bailey and Gurjar (1918) and Bailey (1921). Recently, Shirk and Appleman (1940) have shown that when dry wheat grain imbibes water there is a rapid increase in freezable water and respiratory rate. If the grain is removed from the water and allowed to stand for several hours, there is a decrease in freezable water and respiratory rate, while the total water content remains practically constant. Their results indicate a striking correlation between freezable (free) water content and respiratory rate. The third phase, beginning at 12–14 hours is probably associated with the marked morphological development. At 12–14 hours the coleorhiza ruptures the seed coats. This rupture of the seed coats and the increase in surface probably mean a much increased oxygen diffusion. No particular significance should be attached to the linear curve from 12–72 hours in figure 1, the line is arbitrarily drawn.

If the data in figure 1 for O_2 consumption or CO_2 production are plotted as log rate against time, the curve is linear from 24–60 hours in agreement with the results of James and James (1940). During the first 2 hours the curve is so steep that extrapolation to zero time is unwarranted. The three phases recognized by James and James may be seen

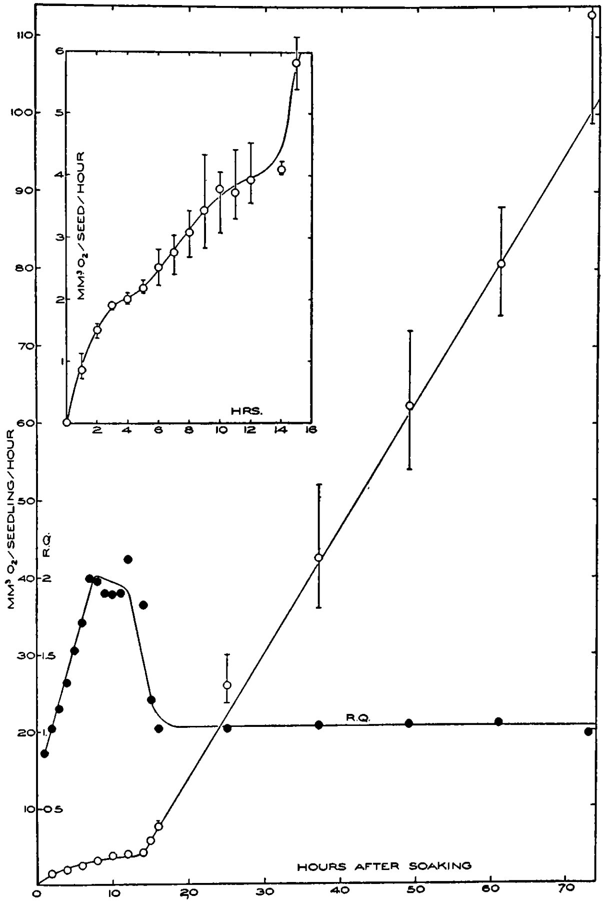

FIGURE 1. Open circles represent the rate of oxygen consumption per seed or seedling at 25° C. in relation to the number of hours after the first addition of water. Each point represents the average of 4 separate experimental vessels and the vertical lines represent the maximum deviation from the mean. The enclosed graph shows the first 12 hours on enlarged scale. Closed circles show the corresponding R.Q.

in our data, if put on a semi-log plot, except that we have insufficient points to establish the phase from 12–24 hours. However, between 0–12 hours our data splits into 3 phases, of dubious validity, except the much greater acceleration from 0–3 hours than 3–12 hours.

Since the rate of liberation of CO_2 increased more rapidly than the rate of O_2 consumption the respiratory quotient (R.Q.=CO_2/O_2) rose above unity (figure 1, tables 2 and 3) and between 12–16 hours returned to unity or slightly below. The decrease in R.Q. corresponded with the rupture of the seed coat and the emergence of the coleorhiza. The marked oscillations of R.Q. obtained by James and James (1940) were not found in our data, including several experiments at 22° C. not reported here.

TABLE 2.

Relation between time of soaking of barley seeds and gaseous metabolism.. Ten dry seeds placed in 0.6 *ml.* H_2O *in respirameter vessels unless otherwise noted. Each figure is the average of* 2 *vessels run simultaneously.*

Hours After Soaking			mm.[3] gas/gm. dry wt./hr. 25°C				
	O_2	Aerobic CO_2	R. Q.	Anaerobic CO_2	Meyerhof Quotient	Anaerobic CO_2	M.Q.
			Seeds started Dry				
1	22.1	16.4	0.74	13.9	0.63	...	...
2	34.4	36.4	1.06	24.0	0.64	...	...
3	40.4	47.8	1.18	31.8	0.60	...	...
4	45.7	61.7	1.35	38.4	0.49	...	...
5	49.7	74.3	1.48	46.1	0.42	...	...
						Seeds soaked[1] 6 hrs. in air	
6	57.8	100	1.70	51.0	0.17		
7	61.5	127	2.06	56.5	...	96.0	0.50
8	68.8	143	2.08	60.9	...	104	0.44
9	72.7	147	2.02	63.6	...	115	0.56
10	89.0	157	1.71	64.5	...	122	0.61
11	82.0	143	1.79	81.0	0.24	125	0.90
12	87.0	146	1.68	82.5	0.26	139	0.92
			Seeds soaked 12 hrs. in air[2]				
14	91.3	166	1.80	105	0.67	...	...
15	130	156	1.15	115	0.68	...	...
16	173	176	1.02	104	0.58	...	...
26	395[3]	390	0.99	231	0.59	...	...

[1] Run at the same time as the seeds started dry left hand columns. In this and the following tables seed was used for grain.
[2] 0.1 ml. of H_2O + filter paper in each vessel.
[3] Seeds from first run above removed, placed on moist filter paper and ½ of the seeds (5) returned to the respirometers at 25 hrs. and measurements continued.

The high R.Q. during early phases of germination has been found by several other authors, including James and James (1940) for barley, Fernandes (1923) and Frietinger (1927) for *Pisum sativum*, and *Genevois* (1927) for *Lathyrus*. That the high R.Q. is associated with a limitation of oxygen diffusion has been pointed out before. That the high R.Q. was really due to a limitation of oxygen diffusion is seen from the data in table 3. Increasing the oxygen tension caused a marked stimulation of the oxygen consumption of whole grain and a fall of the R.Q., but the R.Q. was still above unity. Removal of grain coats caused a greater stimulation of oxygen consumption with the R.Q. distinctly below unity. That this respiration was sufficient to suppress all fermentation is apparent. "Stripped seeds" in 100 per cent O_2 had a higher rate of O_2 consumption than "stripped seeds" in air; however, this increase was not associated with an additional lowering of the R. Q.

TABLE 3.

The effect of oxygen diffusion on the respiration of seeds.

Hours After Soaking	mm.³/gm. dry wt/hr. Whole seeds air O_2	R.Q.	100% O_2 O_2	R.Q.	25° C. Stripped seeds air O_2	R.Q.	100% O_2 O_2	R.Q.
7	52	2.08	131	0.98	171	0.79	274	0.66
8	61	2.02	168	1.08	209	0.67	345	0.59
9	94	1.63	200	1.17	271	0.75	416	0.72
10	144	1.36	220	1.26	303	0.78	458	0.75
11	190	1.31	268	1.20	371	0.82	495	0.78
12	216	1.17	309	1.09	384	0.80	580	0.81
13	252	1.06	342	1.06	447	0.83	617	0.84
14	279	1.06	385	1.03	470	0.83	670	0.88

The high R.Q. is best interpreted as due to aerobic fermentation. Aerobic fermentation is found, normally, only when the rate of respiration is insufficient to fully inhibit the fermentation mechanism. The inhibition of fermentation by oxygen is known as the Pasteur effect. Warburg (1926) and Meyerhof (1925) have interpreted the oxygen effect as an inhibition of fermentation by respiration. (See Turner, 1937; Dixon, 1937; and Burk, 1938, 1939; for reviews of the Pasteur effect.) Meyerhof (1925) has given a convenient expression for evaluating the Pasteur effect; this expression is now known as the Meyerhof Quotient.

$$M.Q. = \frac{\text{mols of } CO_2 \text{ of fermentation in } N_2 \text{—mols of } CO_2 \text{ fermentation in air}}{\text{mols of } O_2 \text{ consumed in respiration}}$$

The CO_2 of fermentation in air is zero when the R.Q. is equal to or less than 1.0; when the R.Q. is greater than 1.0 aerobic fermentation is assumed. The CO_2 of aerobic fermentation=total CO_2 minus respiratory CO_2, assuming respiratory $CO_2 = O_2$. When the M.Q. is equal to or less than $\frac{1}{3}$, no Pasteur effect need be assumed, for respiration is rapid enough to oxidize the products of fermentation. When the M.Q. is greater than $\frac{1}{3}$ a Pasteur effect is demonstrated, if the fermentation equation is:

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$$

since the rate of respiration is not great enough to remove the products of fermentation, and the only way to account for the decreased CO_2 of fermentation is an aerobic inhibition (though it may be partial) of fermentation.

Assuming the equation of alcoholic fermentation to hold for barley, the data in table 2 clearly demonstrates a Pasteur mechanism in barley grain. The fall of the M.Q. with time, which appears in table 2, is open to three interpretations: (1) The Pasteur mechanism has failed. (2) The end products of fermentation in the anaerobic experiments have partially inhibited the fermentation. (3) The development of enzyme mechanisms including the fermentation mechanism, is slower in nitrogen than in air. That the first interpretation is not correct is shown by the data in the two right hand columns of table 2. This grain, started at the same time as those in the left hand columns was soaked for 6 hours in air, and then made anaerobic. The fermentation rate in nitrogen was higher than that continuously in nitrogen and the M.Q. was greater than $\frac{1}{3}$ showing the Pasteur mechanism was in operation. No decision can be made between the two later interpretations on the basis of data at hand.

These experiments not only show the rapid rise of oxygen consumption during germination, an increase of 200–300 times during the first hour, but also demonstrate that during the early phases of germination in air fermentation plays an important role. If the fermentation is of the alcohol type, when the R.Q.=2.0, three fourths of the sugar metabolized is fermented and one fourth is respired. Further, it should be pointed out that if respiration was measured only by CO_2 liberation, as is common in plant physiology, during the early phases of germination an error in determining respiratory gas exchange of 100 per cent would occur, or in case of carbohydrate oxidized, an error of 400 per cent!

The Respiration of Embryo and Endosperm.—There is no tissue connection between the embryo and the endosperm of barley. In soaked seeds from which the lemma, palea, and seed coats have been removed, the embryo may be lifted off without apparent damage. Brown and Morris (1890) showed that such embryos may be grown to mature plants. When 5 or 10 such embryos were placed in our respirometers a good uptake of O_2 occurred and though the embryos have but 1/10 the weight of the whole grain they conusmed half as much O_2. The data are shown in tables 4 and 5 and similar data for the isolated endosperms of the same grain. It may readily be seen that the O_2 consumption per unit weight is about 10 times as great in the embryos as in the endosperm. That little injury has resulted is probable since the sum of O_2 uptake of embryo and endosperm equals that of the intact grain. In our experiments of short duration we found no effect of 2 per cent sucrose on the respiratory rate of the embryos.

TABLE 4.

Comparison of the respiration of embryo, endosperm and seeds at 22° C.

	mm.$^3O_2$/hr.[1]				mm.$^3O_2$/gm. wet wt./hr.			
Hours After Soaking	embryo	endo-sperm	Σ embryo endo-sperm	whole stripped seed	embryo	endo-sperm	Σ embryo endo-sperm	whole stripped seeds
15	3.20	3.90	7.10	6.21	715	76.5	127	113
16	4.08	3.66	7.74	7.43	910	71.8	139	135
17	4.82	4.12	8.94	7.55	1075	81.0	160	137
18	5.52	4.42	9.94	8.54	1230	86.8	178	155
wet wt.[2] in mgs.	4.58	51.0	55.6	55.0				

[1] Values given per unit calculated from average of 2 vessels each containing 5 embryos, endosperms, or seeds.
[2] Average weight from 10 used above.

Recalculating the data of James and James (1940) to the units we use, they find that 12 hour embryos with sucrose form 4.13 mm.^{3} CO_2/embryo/hr. while we find for 15 hour embryos an O_2 consumption of 3.2–4.4 mm.^{3}/embryo/hr. These rates are in good agreement with those obtained by Stoward (1908). No direct comparison of the values obtained here can be made with those obtained by Barnell (1937) on isolated barley endosperm and embryos, because of differences of age.

One striking difference between the respiration of embryo and endosperm is in the R.Q. as may be seen in table 4. The R.Q. of the embryo is that expected for the metabolism of carbohydrates, while the very low endosperm value is below that of the complete combustion of fats. Such low values may be due to incomplete oxidation as in succulent plants (1932) or due to the conversion of fats to carbohydrates. Murlin and co-workers (1933) have shown that the low R.Q. of *Ricinus* seeds is due to a conversion of fat to carbohydrate. James and James (1940) have shown that barley grains contain about two per cent of fat. It is possible that the low R.Q. of barley endosperm is due to the conversion of fat to carbohydrate. James and James have found a low R.Q. of barley embryos in contrast to our findings. No explanation for this discrepancy is apparent. However, Stoward (1908) found an R.Q. for isolated barley embryos of 0.98 at 19° C. and 1.09 at 25° C.

Marsh and Goddard (1939b) have shown that 10^{-3}M NaN_3 and HCN poison the oxygen consumption but not the anaerobic fermentation of carrot root. When such poisons are added to a tissue in air whose respiration is cyanide sensitive and potentially able to ferment, the O_2 consumption may be expected to fall, while the CO_2 production may decrease less, not at all, or may even increase. This is in fact the easiest way to demonstrate the Pasteur effect, for on poisoning with cyanide or azide the R.Q. should rise markedly. James and Hora (1940) failed to demonstrate a

TABLE 5.

The effect of azide and cyanide on the respiration of seeds, embryos and endosperm.

Hours After Soaking	mm.^{3} O_2/hr. 10 embryos	10 endosperm	10 stripped seeds	mm.^{3} CO_2/hr. 10 embryos	10 endosperm	10 stripped seeds	R.Q. embryos	endosperm
				Controls for NaN_3				
15	44.4	51.5	95.1	46.2	15.8	...	1.04	0.31
16	59.2	52.0	110.8	59.2	16.5	...	1.00	0.32
17	69.0	55.0	126.0	69.4	23.9	...	1.01	0.44
				In 10^{-3} M NaN_3				
15	9.6(78)[1]	7.4(86)	23.8(75)	59.5	40.0	...	6.2	5.9
16	9.9(84)	8.1(84)	22.6(80)	52.9	36.8	...	5.3	4.5
17	9.6(86)	8.5(85)	22.3(82)	47.3	33.8	...	4.9	4.0
				Controls for HCN				
15	30.9	28.1	...					
16	40.6	29.2	94.5					
17	45.4	29.2	117.4					
				In 10^{-3} M HCN				
15	5.6(82)	6.1(79)	...					
16	4.6(89)	5.7(80)	10.0(88)					
17	5.3(88)	6.0(80)	11.8(90)					

[1] Figures in brackets indicate per cent inhibition.

Pasteur effect in barley embryos with M/250 HCN though they were able to demonstrate it in seedlings. Using NaN_3 we have been able to demonstrate clearly a Pasteur effect in barley embryos, endosperm, and seedlings. See the rise in R.Q. and the failure to markedly inhibit CO_2 production in tables 4 and 6.

Nature of the Oxidases.—Since the classical work of Warburg (1928, 1930), the inhibition of respiration by HCN and by CO with light reversal of the CO inhibition has been interpreted as a strong indication that the respiration is mediated by an iron porphyrin enzyme known as the phaeohemin oxidase. Keilin (1936) has shown that NaN_3 also inhibits this enzyme and has renamed (1938) the enzyme cytochrome oxidase. That other oxidases occur is well recognized. Polyphenol oxidases have been isolated by Kubowitz (1937, 1938) and Keilin and Mann (1938) and are copper proteins, inhibited by HCN and CO but the later inhibition is not reversed by light. Cyanide resistant respiration is widespread, particularly in the shoots of higher plants. The oxidases catalyzing this respiration are unknown, though on insufficient evidence this respiration is frequently ascribed to the flavine enzymes.

The experiments of Marsh and Goddard (1939) show that a shift in oxidases occurs during the development of carrot leaves. Similar experiments were undertaken with barley. The effect of cyanide and azide on barley seeds, embryos and endosperms is shown in table 5. It is observed that 80 to 90 per cent of the respiration is inhibited by 10^{-3} M HCN or NaN_3. The CO_2 production is not so inhibited and may even increase. It must be emphasized that if oxygen diffusion is limiting the rate of O_2 uptake, smaller inhibitions will be obtained, since the cyanide resistant respiration in barley seeds appears from our experiments to be less sensitive to O_2 pressure than the cyanide sensitive respiration. (See also DuBuy and Olson, 1940.)

TABLE 6.

Inhibition of respiration of embryos and endosperm by carbon monoxide and light reversal of the inhibition. Embryos and endosperm from grain soaked 12 hours.

Gas Mixture	mm.^{3} O_2/embryo or endosperm/hr. Dark	Light	25° C. Dark
	Embryos		
95% CO/5% O_2	1.53	4.32	1.39
	1.46	4.96	1.52
95% N_2/5% O_2	5.08	6.10	58.4
	6.64	7.32	8.80
	Endosperm		
95% CO/5% O_2	1.10	3.40	1.21
	1.30	3.54	...
95% N_2/5% O_2	3.08	4.04	3.66
	2.38	3.48	3.80

TABLE 7.

The effect of sodium azide on the gaseous metabolism of seedlings.

Hours After Soaking	mm.^{3}/gm. dry wt./hr. Control O_2	Control CO_2	R.Q.	25° C. 1.0×10^{-3} M NaN_3 O_2	CO_2	R.Q.
28	545	495	0.91	...	...	...
30	...	...	...	201 (63)[1]	558	2.62
51	740	700	0.95	...	...	...
54	...	...	...	261 (65)	585	2.22
77	788	788	1.00	...	...	...
78	...	...	...	360 (54)	708	1.97

[1] Figures in brackets indicate percentage inhibition calculated on the O_2 consumption of the period immediately preceding.

That the enzyme system inhibited by HCN and NaN_3 is probably cytochrome oxidase is made clearer from the results with CO reported in table 6. It is apparent that the O_2 uptake is inhibited by CO and that this inhibition is light sensitive. We have further observed that barley embryos are strongly and rapidly stained by the Nadi reagent (0.01 M α napthol + 0.01 M dimethylparaphenylenediamine), but not in the presence of HCN. Brown and Goddard (1941) have recently prepared active enzyme extracts from wheat embryos which catalyze the oxidation of hydroquinone only in the presence of cytochrome c. Therefore, there is a strong probability that a large fraction of the respiration of the barley embryo and endosperm is mediated by cytochrome oxidase.

When barley seedlings were poisoned with NaN_3 a respiratory inhibition was obtained which was smaller than that found in seeds. (table 7.) It seemed worth while to determine, separately, the effect of cytochrome oxidase inhibitors on roots and leaves. Table 8 shows that the respiration of primary roots from 4 day old seedlings was strongly inhibited. Adventious roots (14–20 days old) from 25 day old plants raised in Shive's mineral solution were also used. The inhibition is smaller than in the young roots but still appreciable. For leaf material, the first leaf from 7 day old and 14 day old seedlings was used. As may be seen from table 8 the younger leaf has a large fraction (70 per cent) of its respiration inhibited by NaN_3 while in the mature leaf (14 days) a stimulation rather than an inhibition was obtained. This stimulation was surprising, since though previous experience in this laboratory had often indicated that HCN may cause respiratory stimulation, this is the first time stimulation has been obtained with NaN_3

TABLE 8.

Respiratory inhibition of sodium azide on roots and leaves.

Material	mm.[3] O_2/gm. wet wt./hr. Control	NaN_3 10^{-4}M	% inhibition	25° C. NaN_3 10^{-3}	% inhibition
Primary Roots from 7 day seedlings	1275	410	68	162	87
Adventitious Roots [1] from 25 day plants	755	...	..	238	66
First Leaf from 7 day seedlings	539	324	40	185	66
" "	584	315	51	191	70
First Leaf from 14 day seedlings	216	...	..	364	–70

[1] Plants raised in liquid culture, roots 14–20 days old.

James and Hora (1940) have found that 0.005 M HCN inhibits the respiration of 10 day old barley leaves about 66 per cent. With 13 day old leaves inhibitions were found at 0.01 M and 0.02 M but the inhibitions at the two later concentrations were not shown to be reversible. In fact, results obtained with such high cyanide concentrations, and particularly with experiments of long duration, are of no value as an indication of the nature of the oxidases involved.

Considerable difficulty was obtained in demonstrating carbon monoxide inhibition of the respiration of the first leaf from 7 day plants. In three out of four separate experiments at 25° C. with 95 per cent CO + 5 per cent O_2 the rate in CO was slightly less than in the N_2+O_2 controls. The difference was hardly greater than the experimental error. In the fourth experiment significantly higher rates were obtained in CO than in the N_2+O_2 controls. One of the difficulties is that in immature barley leaves the respiratory rate is markedly lower in 5 per cent oxygen than in air. A second difficulty is the decreasing rate with time. Experiments were then run at 15° C. and at 10° C. with the results shown in table 9. Two vessels were run throughout with the gas space containing air. Two others had N_2+O_2 for the first period and then $CO+O_2$ for the second period. While in two other vessels the experiment was started in $CO+O_2$ and shifted for the second period to N_2+O_2. The results are not as clean-cut as could be desired, but they do indicate a respiratory inhibition due to CO. Light reversal was not attempted because of the difficulty imposed by photosynthesis.

TABLE 9.

The inhibition of respiration of the first leaf tissue from 7 day seedlings by carbon monoxide. Gas mixtures 95% CO/5% O_2 *and* 95% N_2/5% O_2.

Gas Mixture	Period 0–2 hrs.	2–4 hrs.	% Change 0–2 hrs. to 2–4 hrs.
	15° C.		
Air	180	155	—13.9
N_2/O_2	141.5	...	
	141.0	...	
CO/O_2	...	108	—23.6
	...	108.3	
CO/O_2	83.3	...	
	95.0	...	
N_2/O_2	...	105.5	+25
	...	119.0	
	10° C.		
Air	129.5	110.4	—16.3
	124.7	103.0	
N_2/O_2	120.6	...	
	126.5	...	
CO/O_2	...	64.8	—47.8
	...	63.9	
CO/O_2	110.0	...	
	104.0	...	
N_2/O_2	...	100.3	—8.5
	...	95.5	

DISCUSSION

The results presented in this paper show that dry barley grain has an extremely low respiration of the order of magnitude of 0.05–0.10 $mm.^3$/gm./hr. During the first hour after the addition of water, to such grain, the respiratory rate increases 200 to 300 times. A rapid acceleration continues during the first twelve hours after addition of water, but at a lower rate than during the first hour. Between 12–14 hours after addition of water the rate of increase rises and the acceleration remains practically constant until the seedlings are 60 hours old.

During the first few hours the rate of increase of CO_2 production rises more rapidly than the increase in oxygen consumption and the R.Q. becomes high (about 2). This high R.Q. is almost certainly due to aerobic fermentation. A Pasteur mechanism has been demonstrated in the grain, and the aerobic fermentation is due to a limitation of the respiratory rate by oxygen diffusion. The frequent practice of plant physiologists of evaluating respiration only in terms of CO_2 production should be avoided when dealing with germinating seeds or other structures where aerobic fermentation may occur. It is to be particularly emphasized that measurements of CO_2 production may frequently fail to show marked inhibitions of respiration by poisons like HCN, NaN_3 or CO. In the case of the endosperm, if the respiratory effect of NaN_3 was calculated on the basis of CO_2 production, a stimulation of 153 per cent would have been demonstrated (due to fermentation), while on an O_2 basis, an inhibition of 86 per cent was found.

Nearly 90 per cent of the respiration of the intact seed, embryo, or endosperm is mediated by an enzyme sensitive to HCN, NaN_3 and CO, with light reversal of the CO inhibition. It is probable that the enzyme is cytochrome oxidase. As the embryo differentiates and grows into a seedling the fraction of the respiration catalyzed by an azide sensitive enzyme decreases. This is largely due to the disappearance of an active cytochrome oxidase from the developing shoot and to some decrease in the percentage of the root respiration mediated by cytochrome oxidase.

At least in barley, the cytochrome oxidase system appears to be the embryonic respiratory oxidase, while in mature leaf tissue some unidentified azide resistant oxidase develops. However, during the early stages of germination (0–18 hours) there is a marked increase in the azide sensitive respiration, and it is only in the later stages that the decrease pointed out above occurs. It is interesting to note that the roots retain the "embryonic" oxidase system even in maturity while it is lost in the leaves. There appears to be a differentiation of enzyme systems in development accompanying the differentiation of tissues and organs.

SUMMARY

The respiration of dry barley grain is of the order of 0.1 $mm.^3$ O_2/gm./hr. Within the first hour of soaking such grain, the respiratory rate increases 200 to 300 times. The rate continues to increase for the next 72 hours, but the rate of increase is less than during the first hour. Dur-

ing the first 12 hours of germination the rate of oxygen diffusion limits the rate of oxygen consumption with a resulting aerobic fermentation. A Pasteur effect may be demonstrated in embryos, endosperm, and seedlings.

The respiration of the embryo accounts for about one half of the total grain respiration. Its rate per unit weight is about ten fold that of the endosperm.

The respiration of the grain, embryo, and endosperm is inhibited by HCN, NaN_3, and CO, with light reversal of the CO inhibition. This is interpreted as respiration catalyzed by cytochrome oxidase. The respiration of young and mature root and young leaf tissue is mediated largely by cytochrome oxidase, while no evidence of the function of this oxidase is found in mature leaves. An apparent differentiation of oxidase mechanisms occurs in the development of the shoot.

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NEWS AND NOTES

THE PROCEEDINGS

Volume 7 was completed with the paper of Stewart and Merrell. This number constitutes the first number of volume 8. With the new volume some minor changes have been made in typography and some changes in publication policy. It is the intention of the publication committee to have each volume consist of six numbers and to publish approximately three numbers each year. There has been added a new section, known as *News and Notes* to record the activities of the Academy and its members. This section will be reprinted and distributed to all members of the Academy. Members having information for the *News and Notes* are requested to submit the information to the Secretary or to the Section Recorders.

D. R. G.

THE NEW LIBRARIAN

The Council of the Academy takes pleasure in announcing the election of John Richmond Russell as Librarian to the Academy. Mr. Russell came to Rochester on April 1, 1940 as Librarian to the University. A graduate of the University of Chicago he was later a graduate student at the University of Michigan. After four years at the New York Public Library, Mr. Russell studied in Europe on a General Education Board Fellowship. From 1935–1940 he was Chief, Division of Cataloging at the National Archives, Washington.

Mr. Russell is much interested in the Academy and is taking an active part in the editorial work of its Publications. The Academy is fortunate to have him for its Librarian.

D. R. G.

GENERAL MEETINGS

October 24, 1940.—Mr. Robert Simpson, of the Department of Geology, University of Rochester, gave an address on *Mountains and Men.* He reviewed the distribution of mountain masses in the various continents, showed their effects as natural boundaries and discussed the limitations which they impose on the inhabitants of the various areas. His conclusion was that the peoples of mountainous areas should not compete with the plains, but should exploit the advantages of their areas for recreation, hydroelectric power and specialized manufacturing.

November 11, 1940.—Dr. William C. Senning, of the New York State Conservation Department gave an address on *Conservation and Research in the Bureau of Fisheries.* Dr. Senning outlined the progress which has been made in an inventory of the fish inhabiting the rivers and lakes of New York State. He described some of the problems faced in Conservation work and outlined the plans for the future. An office of the State Conservation Department, known as the West Central District has been established at the Prince Street Campus of the University of Rochester, with Dr. Senning in charge.

November 22, 1940.—A joint meeting with the Optical Society. Mr. Russel W. Porter of the California Institute of Technology gave a lecture on *The Building of the Two Hundred Inch Telescope of Mt. Palomar.*

December 9, 1940.—Mr. Earl Hilfiker of the Rochester Museum of Arts and Sciences presented an illustrated lecture on *Life at the Beaver Ponds.*

January 13, 1941 with the Research Section, see below.

January 23, 1941.—Joint meeting with the Optical Society and the Astronomy Club. Address by Dr. Lawrence M. Gould, second in command of the First Byrd Antarctic

Expedition. The Academy was fortunate to have had Dr. Gould and greatly enjoyed his fine lecture and movies.

February 24, 1941.—Joint meeting with the Rochester Section, American Chemical Society. Dr. Cyril J. Stand of Eastman Kodak Co. presented an illustrated lecture on a recent trip to Hawaii.

March 24, 1941.—Dr. Edwin Jelley of the Eastman Kodak Research Laboratory addressed the Academy on the subject *Color Phenomena of Crystals.* His lecture was illustrated with Kodachrome slides showing, in particular, the effect of polarized light on various crystals.

April 28, 1941.—Meeting sponsored by the Botanical Section.

M. N. S.

BOTANICAL SECTION

The Botanical Section of the Rochester Academy of Science meets the first and third Monday nights of every month at the Eastman Building on the Prince Street campus of the University of Rochester from 8–9:30 P. M. In addition, occasional meetings are held in the Herbarium Rooms at the River Campus of the University. At this meeting the members study herbarium specimens upon any subject they are especially interested in.

The following program for the year 1940–41 has been or will be followed.

During September, October and November 1940 the study period was confined largely to the *Gramineae* and *Compositae.* In September *Solidago*—Goldenrods—were gathered, analyzed and identified, together with autumn grasses. In October and November Asters were studied and identified. A number of the more difficult *Solidago* and Asters were collected by several members and sent to well recognized authorities in these difficult genera. These aided us in reclassifying some specimens.

The Section is responsible for collecting and mounting specimens for the Burroughs-Audubon Nature Club for its herbarium at its Conservation Station at Railroad Mills and some of these were identified.

The December program was appropriate to the season and the Section studied *Lycopodiaceae* (Club Moss Family) from the Academy Herbarium augmented by specimens from the herbaria of individual members. These, with local conifers, made two interesting programs.

January, February, March and April have been devoted to a study of winter characteristics of trees using Brown's *Trees of Northeastern United States;* studies were made of the genus *Panicum* of the *Gramineae* family and of some of the *Juncaceae* (Rush family). Different members of the Section who are especially interested in these plants have acted as leaders.

During the last four months of the year, May, June, July, and August fresh specimens, perhaps species new to the area or old species from new stations, will be brought in for critical analysis and identification.

On April 13, 1941, the sixtieth anniversary of the founding of the Botanical Section occurred. The members celebrated this date with a field trip. These field trips are held during the summer season either in small groups or by the entire section.

The regular Academy meeting on April 28, 1941, will also note this sixteenth anniversary in its program. We expect to have as our speaker Dr. Josiah L. Lowe of the New York State College of Forestry who will talk on *Lichens* illustrated by Kodachrome slides.

G. A. B. C.

MINERALOGY SECTION

The Mineralogy Section of the Rochester Academy of Science meets once each month, from October through May inclusive, on the second Thursday of each month. The indoor meetings are held at Ward's Natural Science Establishment. In addition to the indoor meetings, several field trips are taken each year for the purpose of collecting specimens of minerals, rocks, and fossils, and to study the geology of the region visited.

The indoor meetings of the 1940–41 season have consisted of the following:

October 10.—Members exhibited specimens collected during the past summer, and told of their collecting experiences.

November 14.—Mr. Everett G. Beine and Mr. Charles E. Francis talked on the *Minerals Used in the Chemical Industries.*

December 12.—Mr. John Dowe, Jr., lectured on the *Varieties of Quartz.*

January 9.—Mr. Charles W. Foster demonstrated and explained fluorescence.

February 13.—Mr. Edwin G. Foster spoke on the *Strategic Minerals.*

March 13.—Miss Alice S. Richardson told of her experiences in the collecting of mineral specimens in Vermont, New Hampshire, and Maine.

April 10.—Mr. Walter H. Wright reported on *The Minerals of North Carolina.*

May 8.—Miss Marguerite Smith will lecture on *The Minerals of Monroe County.*

Field Trips

June 22–23, 1940.—A two-day trip was taken to St. Lawrence and Lewis Counties. The Carbola Chemical Company talc mine near Natural Bridge was visited. Specimens of talc, serpentine, pyrite, chlorite, etc., were collected. A marble quarry near Gouverneur was visited. From here good crystals of tourmaline and calcite were collected. The lead mines near Rossie and the Loomis talc mine near Fowler were also visited.

Other field trips included the LeRoy limestone quarries, the region around Alfred, Deep Run, and Niagara Falls. The latter trip was at the invitation of and in conjunction with the Buffalo Society of Natural History.

The Section has in progress a permanent record of mineral localities of Monroe County. This work is being carried on under the direction of Mr. Edwin G. Foster. A map, mounted and donated by Mr. Foster, has recorded on it the mineral localities. The geology is expertly done on the map by Miss Marguerite Smith.

Officers of the Mineral Section—1941

Robert C. Vance	Chairman
David E. Jensen	Recorder
George R. Costich	Treasurer
Edwin G. Foster	Chairman of the Committee for Recording Mineral Localities of Monroe County
John Dowe, Jr.	Chairman of Field Trip Committee

R. C. V.

RESEARCH SECTION

This is a new section of the Academy which has been meeting regularly since January of this year. It had its inception in a report to the Council by a special Committee consisting of Dr. S. C. Bishop and W. S. Cornwell. The Council appointed a larger committee consisting of Dr. D. L. Gamble (Chairman), W. S. Cornwell (Secretary), and Professors Bishop and Fairbanks. Later Drs. Goddard and Roudabush were added. As a result of the report of this committee the new Section was formed.

The purpose of the Research Section is to provide for monthly meetings for the professional Scientists of the Rochester area, for the presentation of original research, and to aid in the publication of the *Proceedings*. It is particularly hoped that it shall provide a common meeting ground for the industrial, academic, and medical scientists. All persons interested should apply to the Recorder of the Section.

The dues of the Section are $3.00 a year in addition to the regular Academy dues of $2.00. All of the section dues are used for publication of the *Proceedings*.

Meetings are held the first Tuesday of each month from October through May at the Dewey Building, River Campus. All members of the Academy and their guests are welcome to the meetings of this Section.

The following meetings have been held:

November 26, 1940.—Organizational meeting.

January 13, 1941.—Mr. Karl Schmidt, Field Museum of Natural History, Chicago, on the subject: *Desert and Highland in Peru.*

February 4, 1941.—Drs. S. C. Bishop and R. H. Goodwin of the University of Rochester, *What Is a Species?*

March 4, 1941.—Mr. William A. Ritchie of the Rochester Museum of Arts and Sciences gave an illustrated lecture entitled *The Recent Excavation of an Ancient Site on Frontenac Island.*

April 1, 1941.—Drs. R. L. Roudabush, O. R. McCoy, F. S. Bond, and E. P. Offutt participated in a *Symposium on Malaria.*

W. S. C.

MILTON S. BAXTER

The Academy, and particularly the Botanical Section, lost one of its most valued members in the death of Milton S. Baxter on October 15, 1938. Mr. Baxter had been a member of the Academy for a great many years, was leader of the Botanical Section and Curator of the Academy Herbarium. He was widely known for his extensive botanical collections. A forthcoming issue of these Proceedings will carry a biographical article on Mr. Baxter.

DONALD BEAN GILCHRIST

The Academy regrets to announce the death of its former Librarian, Donald Bean Gilchrist on August 4, 1939 at Meredith, New Hampshire. Donald Gilchrist was born at Franklin, New Hampshire in 1896. Mr. Gilchrist came to Rochester as Librarian of the University of Rochester in 1919, a position which he held until his death. From 1931 till his death he was also Librarian to the Academy. Mr. Gilchrist was a graduate of Dartmouth College (A.B. 1913) and of the New York State Library School (B.L.S. 1915). Mr. Gilchrist served in the New York State Library and University of Minnesota Library before coming to Rochester.

Mr. Gilchrist was widely known among American librarians, particularly for his work in their associations and for his numerous articles in professional journals.

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
VOL. 8, NOS. 2 & 3 APRIL 20, 1942

STUDIES IN THE GEOGRAPHY OF POPULATION CHANGE, CANANDAIGUA LAKE REGION, NEW YORK[1]

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CONTENTS

[1] Received for publication, July 25, 1941.

I. INTRODUCTION

Every cultural pattern is related to a populational pattern. The distribution of crops on an Iowa farm, of transportation routes in Siberia, or of religions in Africa, can be explained adequately only with direct reference to the distribution of inhabitants. The field of sociology is frequently divided into two parts, one rural, the other urban, largely because of the differences in social phenomena between areas of sparse and of dense population. In the economist's triumvirate of land, labor, and capital, each element is based upon population density. Historians regard population density as important in matters of national policy and international friction, and in the migration of ideas and of people. Tax rates, civil improvements, and economic planning involve the use of populational data.

Ontario County, New York, is interested in surfacing more roads. Which shall be surfaced? Not necessarily those which are most densely populated today, nor even those in which the present trend is towards increasing population, for such trends may be short-lived. The roads which will best repay the cost of improvement are those which will be used by an increasing population during the next few decades. Detailed studies are essential for such predictions. Similar analyses of relationships would facilitate the location of electric power lines, railroads, and in fact all forms of capital investment.

A good beginning has been made in studies of population. The interest of geographers has been growing since about 1930,[2] and since 1933 a quarterly bibliography of all types of demographic research has been published.[3] It may well be that, as the number of students working in the field increases, those phases dealing with the effects of human distribution upon human problems should be left to the sociologist, the aspects centering upon the relationship between population density and environment should be interpreted by the geographer, and the broader statistical problems should be left to the demographer. It is inevitable, but certainly not unfortunate, that the borders occasionally would be crossed by the more adventuresome students in each field.

Fully a third of the geographic studies have dealt with entire countries. In almost every one, regardless of area covered, the smallest populational unit has been the township (or commune, or "administrative unit") and the source of data the government census (for examples, see Kendall, 1939; Glendinning, 1934).

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[2]Analysis of American, British, and French periodicals of the last two decades reveals that populational studies occupy only a small place in geographic research (one article in 26 in America; one in 35 in Europe) but that during the last decade American journals have carried about twice as many such articles as they did during the preceding ten-year period.

[3] The Populational Index, published by the Princeton University School of Public Affairs with the cooperation of the Population Association of America.

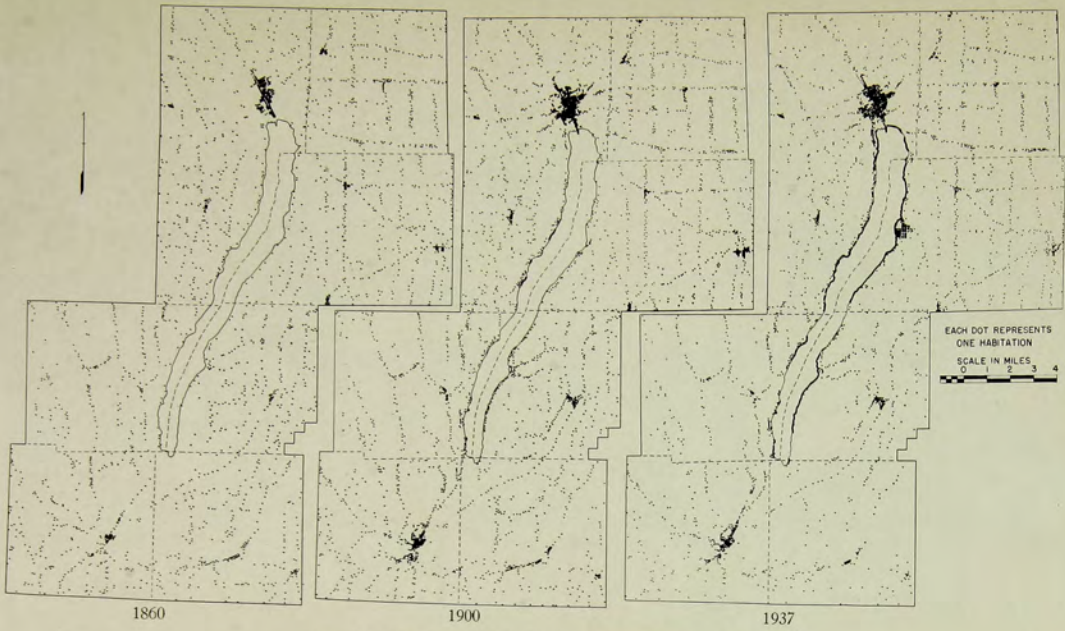

FIG. 13. Distribution of habitations, Canandaigua region.

It is obvious, however, that many variations in population distribution cannot be measured by such large units. Therefore, in this study the fundamental unit is the individual habitation instead of the township. Only by the synthesis of such small elements can previously-existing generalizations be evaluated, and new ones discovered; only in this way can accurate populational boundaries be drawn, and large-scale studies broken down for practical use of regional planning organizations.

The two objectives of this investigation are, first, an evaluation of the possibility of studying changes in population by mapping individual habitations, and second, an inquiry into the geographic relationships of the changing distribution of people in a specific area in the Finger Lakes district of New York. The studies were originally submitted, in earlier and larger form, to the School of Geography, Clark University, in partial fulfillment of the Ph. D. requirements. The criticisms and suggestions of Dr. Clarence F. Jones and Dr. W. Elmer Ekblaw of Clark, and of Dr. Harold L. Alling and Dr. Sterling A. Callisen of the University of Rochester are gratefully acknowledged. Other quantitative studies of New York State population shifts are Brigham (1916) and New York State Planning Board (1935).

The area selected comprises seven townships, as shown in figure 1. It totals 338 square miles, being 26 miles long and 13 miles wide. In the center of the region, and axial to it, lies Canandaigua Lake, the attenuated form of which aptly qualifies it as a "finger" lake. The areal boundaries, although political, correspond quite closely to the drainage divides of the lake itself. Like the other Finger Lake basins, Canandaigua is something of a geographic unit because of the tendency for commerce to follow drainage lines, and for major towns to develop in the bottoms of major valleys. The area is, then a hydrographic, a political, and something of a geographic unit.

Other factors favored the selection of this locality. Tumble-down old barns, cellar holes with scattered foundation stones and rotting timbers, indicate that this is a region of rural maladjustment, and leads one to the suspicion that, since population changes seldom keep pace with the stresses which cause them, the area will continue to lose population. On the other hand, hundreds of attractive new summer cottages indicate at least a seasonal return flow of population. A further striking contrast is noted between the relatively level, accessible, populous Lake Ontario Lowland and the rugged, relatively isolated, sparsely inhabited Allegheny Plateau.

The hundred-and-fifty-year period since the area was settled has been the subject of several scholarly and semi-scholarly volumes. Topographic, geologic, pedologic, highway, and railroad maps are available, and it was found possible to construct accurate habitation maps for 1937, 1900, and approximately 1860 (see maps following page 50), in addition to a generalized map for 1820, thus giving distributional data at approximately 40-year intervals back to the time when the Indians occupied the area. Archeological treatises have supplied some data regarding aboriginal population shifts.

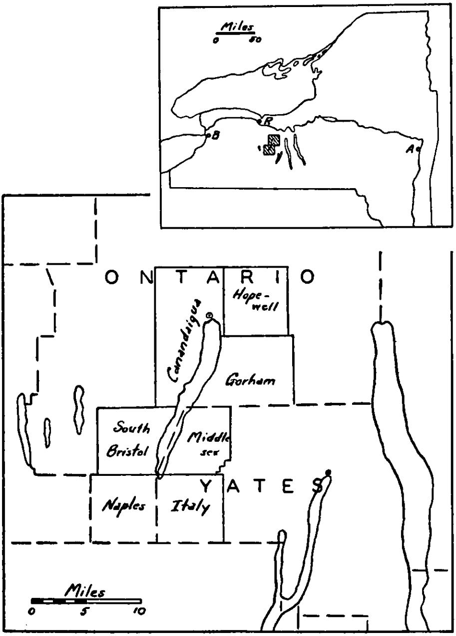

FIG. 1. Orientation diagrams. The position of the Canandaigua region in New York State and of its component townships with respect to the western Finger Lakes, is shown.

The dwelling maps with their 40-year intervals supply abundant areal detail, while the census data for the seven townships, gross in areal information, provide considerable chronological detail.

Disadvantages in the selection of the Canandaigua basin include the fact that choice of region with such variety of physical conditions and populational responses eliminates simplicity and uniformity. Also, the fact that the soils of one-fifth of the region were mapped several years later than those of the remainder has necessitated a translation of the later, more detailed, classification into terms of the earlier, more generalized map.

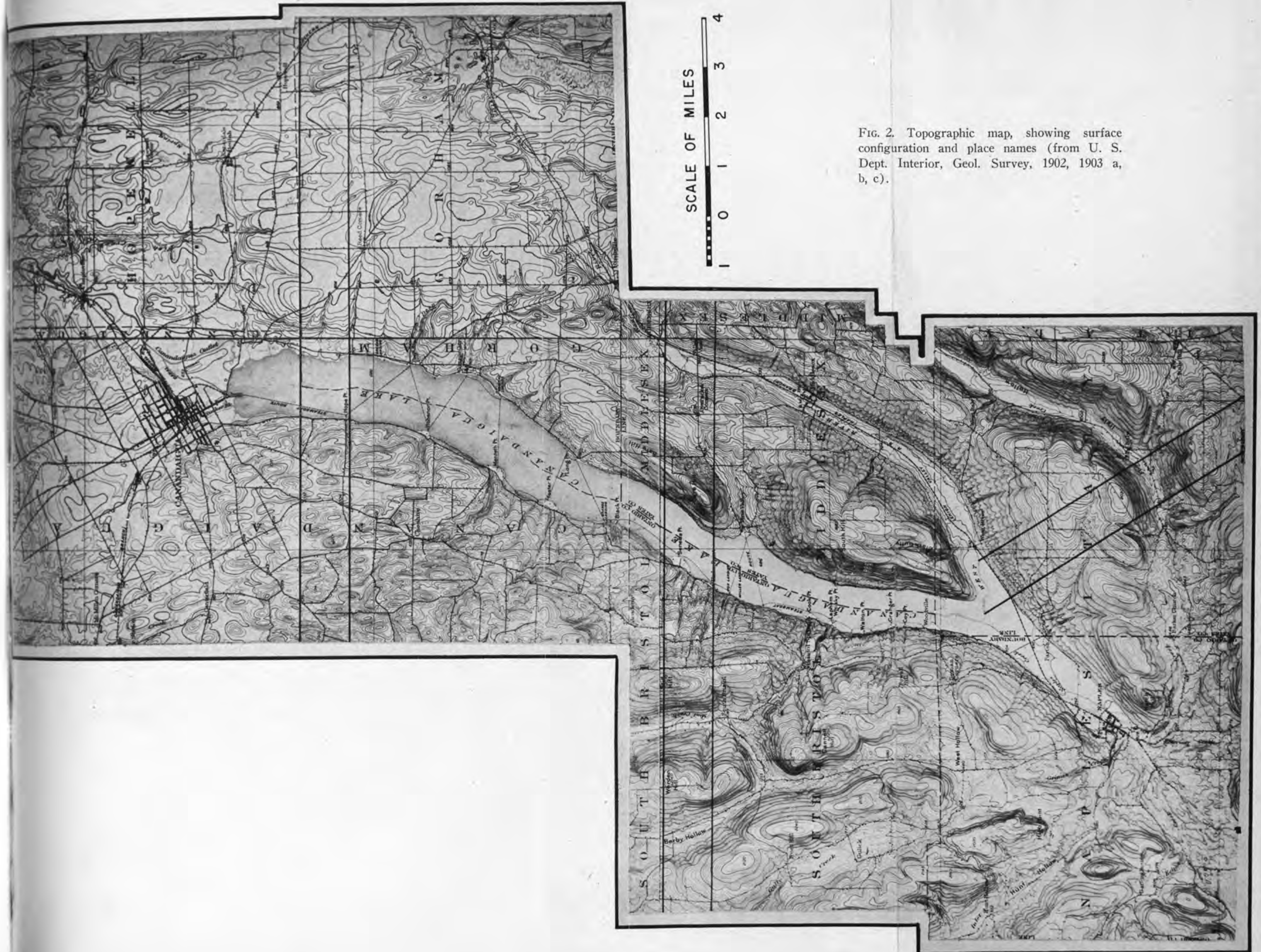

FIG. 2. Topographic map, showing surface configuration and place names (from U. S. Dept. Interior, Geol. Survey, 1902, 1903 a, b, c).

The study does not attempt to investigate all factors which may have influenced regional differentiation of population shift, for some of the elements could be approached better through land utilization studies, and others through cultural analysis of the various immigrant groups (for an example of such study in Tennessee see Kollmorgen, 1940). But the study does purport to analyze the most important physical and locational factors.

II. THE REGION: ITS PHYSICAL SETTING

The Canandaigua area is a rather compact unit in north-central New York. About twice as long as it is broad, it lies athwart the boundary between the Ontario Plain and the Allegheny Plateau. Canandaigua Lake lies along most of the longitudinal axis of the area, and towards it most of the land slopes (fig. 2). These flanking slopes rise for six or eight miles away from the lake both to the east and to the west, and culminate, on either side, in a broad divide which overlooks the basin of the next finger lake. Along each of these two areas of water parting are the town lines which bound the area on the east and west.

A 45-minute drive southeast from Rochester over a three-lane concrete highway which winds across the rolling, park-like Ontario Plain (plate 1A; all plates reproduced in this paper are gathered opposite page 54) and for some distance parallels the Barge Canal, brings one into the pleasant little town of Canandaigua (for this and all other place-names see fig. 2). The broad main street is flanked by spacious houses, impressive behind their classical columns. Highway markers inform the visitor who cares to read them that this is historic country, the route of General Sullivan's expedition which, at the close of the Revolution, drove the Seneca Indians from the territory and opened it to white settlement. One senses in the aristocratic air of the houses that the city is proud of its history—proud of the day when Canandaigua was the largest city west of Albany, while Buffalo and Rochester were still small frontier villages.

The mile-long main street runs through the business district and continues into the residential section beyond. There the street bends and beyond it lies Canandaigua Lake, flanked in the foreground by undulating slopes, each of which is a patchwork of fields rising gradually towards the skyline. Off in the distance, towards the head of the lake, the flanking slopes rise more steeply, and the horizon, high above the lake, can just be distinguished through the bluish haze (for a view of the southern half of the lake, see plate 3D). The land inclines not only from the lake shores to the inter-lake divides, but also from the foot of the lake towards the head, which lies invisible in the distance. The solid agricultural pattern of the nearer slopes gives way to much unbroken green in the distance.

A drive through this region which stretches away to the south begins with a run through a gauntlet of hot-dog stands and amusement booths—

crude reminders that geographic ecesis may not always be gracious. Once clear of the city, however, the concrete highway, which leads to Syracuse and Albany, is left behind and East Lake Road is followed—a macadam strip flanked by farm buildings rather typical of the Ontario Plain, buildings neither neat nor dilapidated, but testifying by the preponderance of classical architecture (plates 1C, 4C) over the jigsaw Gothic (plate 4D) to a period of heaviest settlement during the early years of the last century.

Swinging a mile or so away from the lake and continuing southward the road begins to climb, and soon enters a region where broad expanses of almost flat uplands give way rather suddenly to great open valleys, their floors in some cases lying almost a thousand feet below the upland (plates 1B, 3A). On the high flats abandoned buildings (plate 1D) are numerous, in apparent contrast to the flourishing activity of the valleys below. But a swing down into one of these valleys shows even more evidences of decadence in the bottoms than were visible on the hilltops.

Near the southern end of the area, some 20 miles from the starting point and down in a precipitous-walled valley flanked by acres of steeply-pitching vineyards, lies the village of Naples with its wineries. From it the road turns northwards and returns to Canandaigua along the west side

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PLATE 1. Contrasted landscapes and dwellings. A.—Ground moraine of the Ontario Plain, smoothed by prolonged glacial lake activity and planted to beans and buckwheat. B.—An Allegheny Plateau landscape in the Bristol Hills. Here are found the regional maximum of configuration and relief. Few fields remain on the upland flats. C.—This "Greek revival" farmhouse on the Ontario Plain reflects in its architecture the population history of the region. The main section dates from the 1840's, near the end of the first period of expansion, while the rear wing, added just prior to 1870, suggests the second and latest period of population increase. D.—Relic of over-enthusiastic expansion. Although surrounded on three sides by broad, level acres, the people who occupied this farmhouse finally quit trying to wrest a living from a thin, acid soil, and to market their crops over a road which dropped a thousand feet in two miles.

PLATE 2. Some reasons for populational contrasts. A.—Decadent road, Italy Township. This was formerly one of the important upland roads shown in figure 9, but as family after family emigrated it became a private driveway and finally a field road. B.—Drumloidal landscape, Canandaigua Township. Here the Pleistocene ice-sheet left scattered, elongated hills which break the monotony of the lowland landscape but also hasten the abandonment of farms. C.—Early morning cloud banner along Canandaigua Lake. Fortunate evidence of important micro-climatic variations, this cumulus cloud banner is the result of comparatively warm temperatures over the lake on a cool autumn morning. D.—Detail of coarse loam soil, South Bristol Township. This view of Ontario gravelly loam in a cultivated field near the hamlet of Bristol Springs shows a soil that is above average in coarseness, drainability, and alkalinity as a result of its formation from a parent material of moderately thick glacial gravels.


A
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of the lake, passing through a series of landscapes more or less the reverse of those encountered on the southward trip.

Obviously this is not a region which can be treated by a few generalizations, and its problems of geographic adjustment are in a general way the epitome of the problems of upper New York State. Why has Canandaigua village changed from the jumping-off place for pioneer settlement into a thriving western metropolis and then into a pleasant but almost static little agricultural and resort town? Why have families left the region, after a generation or more of the hardest kind of labor? Were they the victims of changing conditions beyond their control, or had their fathers attempted to farm the unfarmable? Whence come the summer resorters, with their carpenters and their paint cans, and how many more of them can the land support? These questions—and many more—must be answered before the Canandaigua region can understand its past, and even begin to plan for its future.

Geology

The region lies in two physiographic provinces, the Eastern Lake section of the Central Lowlands, and the Glaciated Allegheny Plateau section of the Appalachian Plateaus (Fenneman, 1938). The boundary between the two approximates in a general way the boundary between the northern and southern halves of the area as can be inferred from figure 2. Thus Canandaigua, Hopewell, and Gorham Townships are situated

Plate 3. Plateau landscapes. A.—Looking up Middlesex Valley, Middlesex Township. Here is plateau farming country at its best, for the valley bottom is broad, open, and rather well-drained. B.—Looking across Italy Valley, Italy Township. View southeastwards from Italy Hill, showing a relief of almost a thousand feet. C.—Swell-and-swale configuration on the Naples recessional moraine. One mile south of Naples village, looking southwestward. D.—View of southern end of Canandaigua Lake. Such panoramas as this, photographed from the kitchen window of a summer cottage, help to explain the still-increasing summer-time popularity of the Canandaigua basin.

Plate 4. Summer cottages and a pioneer home. A.—First summer cottage on Canandaigua Lake. Built about 1876 by the Chesebroughs of "Vaseline" fame, this well-built cottage was often visited by Secretary-of-State William Seward. It was reached by steamboat. B.—Modern summer cottage on artificially-made site. A picturesque setting, a good deltaic beach, and complete isolation in spite of proximity to a paved highway, combined to make this location so attractive that the shale banks were blasted away to provide a level site for the cottage. C.—A pioneer home, Italy Township. The dwelling is testimony, not only to the careful work of the pioneer stonemasons, but also to their ability to use local materials. The walls are built of West River sandstone chinked with glacial clay. D.—Evidence of early cottage construction, South Bristol Township. The running scrollwork beneath the eaves dates the construction of the cottage as of the decade prior to 1880.

on the plain whereas South Bristol, Naples, Middlesex, and Italy Townships lie on the plateau.[4]

Bedrock geology of the area is simple (Clarke and Luther, 1904; stratigraphic terminology modernized in Goldring, 1931; and Cradwick, 1935). Both provinces are underlain by sedimentary rocks, the strike of which is in general east-west and the dip southward at the rate of approximately 40 feet to the mile. Thus in travelling from north to south through the area the outcrops of successively younger and higher formations are encountered. Since this series of formations increases in sandiness upwards, the plateau owes its origin to the presence of resistant sandstones and flagstones, whereas the plain, situated upon less resistant formations which are mostly shales, has been eroded to a much lower level.

Canandaigua Lake, lying at an elevation of 686 feet above sea level, can be considered for most purposes the lowest part of the region (Fig. 2). The northern plain, flattish to drumloidal in character, lies in general from 100 to 500 feet above it, and the level hilltops of the plateau to the south, lying at an elevation of more than 2200 feet above sea level, in many cases rise almost 1000 feet above their neighboring valley bottoms.

These accordant flat-topped summits are assumed to be remnants of the Schooley peneplain, dissected to late youth or sub-maturity while the Ontario Plain was being eroded to late maturity or old age on the weaker shales to the north. The geomorphic story of this prolonged period of erosion has been discussed by Herman L. Fairchild in a number of papers (see especially Fairchild, 1925), although field evidences suggest a few changes in his maps. Interesting variations in plateau configuration, important enough to strongly influence population distribution, exist. For example, unreduced upland surfaces in South Bristol and Naples Townships are limited to patches averaging only one square mile in area, whereas those of Middlesex and Italy each include several square miles. Furthermore, various patterns of valley systems are found, such as the crudely radial one of Naples Township and the "linked chain" arrangement of South Bristol.

Pleistocene glaciation provided the latest important changes in physiography, for the entire region was covered by continental ice. During its northward retreat the ice-front paused long enough just south of the southern end of Canandaigua Lake to deposit an admirable recessional moraine (plate 3C), part of the important Valley Heads Moraine of New York State. This heterogeneous deposit can be recognized easily on the topographic map (fig. 2) by the crenulated character of the contours, and on the soil map (fig. 5) by the presence of Canadea soils. It not only

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[4] Specifically, Fenneman designates the outcrop of the Tully limestone as boundary across west-central New York. In the Canandaigua region the Hatch formation, some 43 feet higher stratigraphically and six or eight miles south geographically would make a more accurate boundary horizon.

caused Canandaigua Lake to reverse its direction and drain northwards, but also influenced markedly the ensuing population history of the plateau.

Temporary glacial lakes, hemmed in between the ice-front on the north and the high land to the south, accompanied each stage of the northward retreat of the ice (Fairchild, 1909) (fig. 3). At first they were limited to

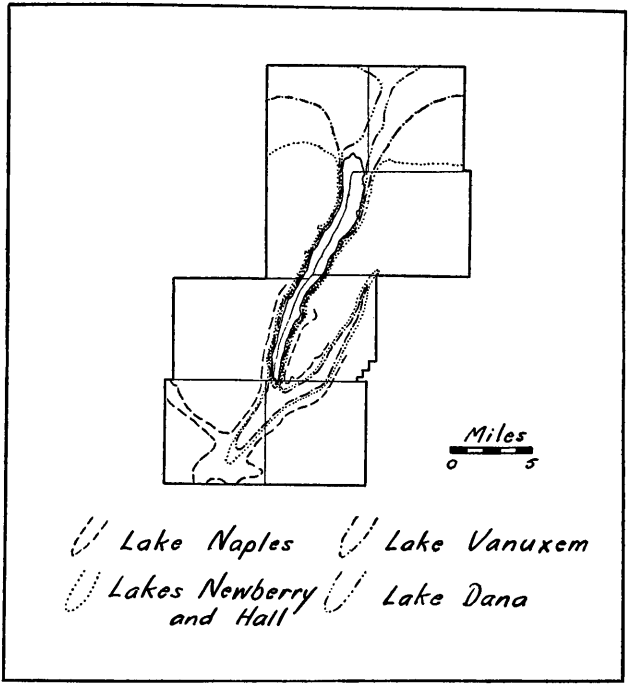

FIG. 3. Location and extent of former glacial lakes (after Fairchild, 1909).

the high-level valleys of the southern townships,[5] but later, as the ice-front retreated to the northern edge of the area, they occupied Canandiagua and Middlesex Valleys, and still later spread over a large part of the nothern plain. Thus glacial lake influence was brief in the southern valleys, more prolonged in Middlesex Valley, Canandaigua Valley and

[5] More or less casual observations suggest that high-level lakes occupied a greater number of the valleys than Fairchild realized.

much of the northern plain, and most prolonged in a triangular area north of Canandaigua city (compare plates 1B, 3A, 1A). Long-continued glacial lake deposition has resulted in decreased surface configuration and increased clay content of the soil.

Another type of glacial phenomenon which has influenced population change is that of the elongated, rounded, drumloidal[6] hills (plate 2B), numerous in the southern half of Canandaigua Township, but absent from the comparable area on the opposite side of the lake.

Ground moraine in the region varies from a few inches to many feet in thickness, being very thin on most of the southern hills. Plowshares on many of the plateau farms strike bedrock on each circuit of the field. In contrast, the plateau valleys in some cases have received several feet of glacial material, and such is also the case throughout the northern plain, although here much of the drift is buried beneath glacial lake sediments.

Many of the sedimentary formations of the region had local economic importance during the early periods, having been used for building stone, quicklime, and the like (Clarke and Luther, 1904), but as better materials have come within competing distance the use of local products has declined, until today only sand and gravel are exploited, and even these are consumed within a few miles of their place of origin.

Climate[7]

Variability, both with time and with place, is the keynote of the Canandaigua climate. Precipitation falls in a definite seasonal rhythm, temperatures exhibit marked continentality, and the characteristics of both temperature and precipitation differ greatly from place to place within the area. Although the climatic records show the Köppen classification (Köppen and Geiger, 1932) to be Cfb, there are both Cfa and Dfb stations within the Finger Lakes district, and a close network within the Canandaigua area would undoubtedly reveal examples of at least the Dfb type.

Although no Weather Bureau stations exist within the area, one is situated only a mile north of the northern border, at Shortsville, and another is located only two miles south of the southern border, at Atlanta (fig. 4),[8] in the bottom of a broad preglacial river valley more than 500 feet deep. The elevation at Shortsville is 660 feet and that at Atlanta 1300 feet.

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[6] Fairchild (1929) maps most of these as true drumlins.
[7] Data from Mordoff (1934), supplemented by Martin (1931).
[8] At Atlanta records of precipitation cover 18 years, those of other elements 7 or 8 years. Conclusions drawn from data of this station have been checked against those of other stations on similar sites. Records for Shortsville cover a period of 31 years.

Temperature. Normal lapse rates could well account for the differences in temperature between plain and plateau. Shortsville is 1½° warmer than Atlanta (46.6°F. instead of 45.2°F.). Similarly, Shortsville has recorded an all-time maximum of 102° and a minimum of –17°, while Atlanta records a maximum of 96° and a minimum of –35°.

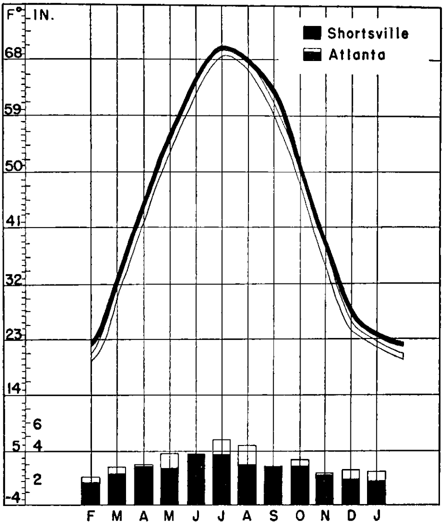

FIG. 4. Temperature and rainfall regimes, Shortsville and Atlanta (data from Mordoff, 1934).

Precipitation. The Finger Lakes district is one of the drier parts of New York State. Striking differences are found between plain and plateau, however, for 30 inches fall annually at Shortsville, on the plain, whereas 37 inches fall at Atlanta, on the plateau. The regime is one of little-modified continentality at both places, the precipitation of the wettest month being twice that of the driest month. But at Shortsville the maximum is in June, the minimum in January; at Atlanta the maximum is in July, the minimum in February.

Average variability is not unusually large at either place; not as large, in fact, as that of Rochester, which has a somewhat heavier annual rainfall and is situated on Lake Ontario. A system for computing extreme variability has been devised,[9] and at Shortsville the annual figure is ±20 percent, that of the growing season being ±50 percent. At Atlanta the annual variation is ±30 per cent, but during the growing season is similar to that of Shortsville. A 50 percent extreme variability during the growing season means that at Shortsville the farmer expects 15½ inches of rain during his productive season, but has received as little as 10 inches and as much as 22 inches during the 31 years covered by the observations. As to sunshine, the region does not experience much of the cloudiness of the Lake Ontario fringe, although the percentage of possible sunshine (49 percent annually, 61 percent during the growing season) is considerably lower than that of the United States as a whole. Atlanta is slightly more sunny than Shortsville.

Growing Season. A striking difference in length of growing season exists between Shortsville and Atlanta, the result of differences in elevation and configuration, rather than of distance from Lake Ontario or Lake Canandaigua (see isoplethic map of average length of growing season, Mordoff, 1934, p. 36). Five and one-half months (161 days) are frost-free at Shortsville, and only four and one-half months (130 days) at Atlanta. The probabilities are that frost will not occur after May 8 around Shortsville, while it can be expected until nine days later at Atlanta. In the fall, danger is great after September 24 in the south, not until three weeks later in the north. Here is a very practical effect of air drainage, for Atlanta is located in a broad open valley flanked by high hills, whereas Shortsville, thirty miles farther north, is on an open plain where concentration of local cold air is all but impossible.

Turning to statistical probabilities, a crop which needs five months to mature would be nipped only two times out of ten in the north and more than eight times out of ten in the south. A four-month crop would be killed one year in four if planted near Atlanta, but probably never would be affected at Shortsville. If the short growing season of the south is considered in conjunction with the fact that many of the soils there are poorly drained, it becomes apparent that the southern farmer, in comparison with one in the north, will not be able to get onto his land until two weeks later in the spring, and must complete most of his harvest three weeks earlier in the fall.

These data show the magnitude of climatic differences between two points thirty miles apart, and can be accepted as indicative of the general differences between plain and plateau.

[9] Extreme variability:

½[(precipitation of wettest year—mean annual precipitation)+(mean annual precipitation—precipitation of driest year)]/mean annual precipitation.

Growing season variability: same formula, but covering only May 1—September 30.

Micro-Climatic Observations. To fully analyze climate as a factor in population change, micro-climatic data should be gathered to indicate the differences in growing season between farms only a mile or two apart horizontally, but several hundred feet apart vertically; and between farms subject to the tempering influence of Canandaigua Lake as opposed to those less favorably situated. Such a complete study has not been made, but micro-climatic observations were taken on five different mornings, the last of which brought the first general frost of the autumn of 1937 to the region. On one of these mornings the visual evidence of micro-climatic variations shown in plate 2C, was observed.

The area selected for study was Stid Hill, on the west side of the lake in South Bristol Township (fig. 2). Observations began at the shore of Canandaigua Lake and extended 2½ miles inland, up the two-mile lakeward slope of Stid Hill ridge to its crest, which is 1384 feet above the lake, then down the steeply-pitching interior slope to its base in Mud Creek Valley, only 314 feet above the lake but 2½ miles distant from it. Land utilization mapping revealed that vineyards and orchards were present only on the lakeward slope, and these only to a height of about 700 feet above the lake. The five sets of data afford highly suggestive evidence of the micro-climate of the plateau.

First, there were definite temperature differences within the region on these fall mornings, as a result of 1384 feet of surface relief, but they were less than might have been expected. There never was more than 12°F. difference on any one morning, and the average was 7°.

Second, Mud Creek Valley was, on each morning, slightly colder than the lake shore, and was usually colder than any part of the slope leading down to the lake. Hence the lake did moderate the temperature of the slope leading down to it.

Third, the warm lake did not keep inversions from developing on the lake slope, although it probably modified them considerably. Data suitable to this purpose were gathered on three mornings. Inversions were present on two of them, in both cases extending to a height of about 600 feet above the lake. The upper limit of fruit cultivation ends approximately where temperature, on fall mornings, ceases to increase with elevation.

Natural Vegetation [10]

Reminiscent of the arrangement of troops in the Battle of Gettysburg, where the Confederate army advanced from the north and the Union forces lay to the south, is the vegetative pattern of upper New York State. Favored by the beneficent climatic effects of Lake Ontario, the Southern Hardwoods have spread northwards from the Appalachians of

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[10] Data taken from Recknagel (1923), but especially from Bray (1930), as reproduced in New York State Planning Board (1935).

Tennessee and Kentucky, and occupy the lowland plain, whereas coniferous representatives of the Northern Mixed Forest lie on the plateau to the south. Although plant ecologists draw an arbitrary boundary between Southern Hardwoods and Northern Mixed Forest along the northern end of the Canandaigua region, study of settlement records (McIntosh, 1876; Cleveland, 1873; Doty, 1925, vol. 1; Turner, 1852) show that the entire region was part of a zone of vegetative transition.[11]

At present, judging from census records for Ontario and Yates Counties, only 15 percent of the region is in forest. Even during the time of occupance by the Iroquois the original vegetative pattern had been altered, for the Indians cleared away forest, not only for the growing of crops, but also to induce a heavy cover of tall grass which would attract deer.

Soils [12]

Although soil maps exist for the entire Canandaigua region, one part consisting of five townships was surveyed in 1910, the other part not until 1916.[13] In the interim considerable refinement and reorganization of pedologic classification had taken place. As a result, it was necessary in this study to translate the data for the later, more detailed survey into terms of the earlier, more generalized one.[14]

Although the details of soil variation throughout the region are complex, the general scheme is relatively simple. Only six series have areal importance (more than one square mile of total area) and the major pedologic differences are closely related to variations in physiography (compare fig. 5 with fig. 2). A brief summary of each of the six series follows.

In northern New York prolonged deposition in glacial lakes has usually resulted in the formation of a group of clayey soils known as the Dunkirk (see fig. 5 for the distribution of this and other soil series). In the Canandaigua region the Dunkirk occupies a crudely triangular area, with its apex at Canandaigua city, where all of the later glacial lakes deposited

[11] The Chestnut-Chestnut Oak-Yellow Poplar association seems to have dominated the physiographically transitional area occupied by Gorham Township and the southern half of Canandaigua, and to have extended along the shores of Canandaigua Lake at least two-thirds of the distance to the southern end. In addition, the south-facing slopes of such large plateau valleys as that of West River were covered with ash and hickory. Similarly there were a few patches of fir, spruce, and tamarack, representatives of the Northern Mixed Forest, in the poorly-drained swales of the Ontario Lowland.

[12] The two primary references are Carr and others (1912), and Maxon (1918).

[13] 1910: the Ontario County townships of Canandaigua, Gorham, Hopewell, South Bristol and Naples.
1916: the Yates County townships of Middlesex and Italy.

[14] Some indication of the difficulties involved in translation can be gained from the fact that along the boundary between the two surveys, twice as many types were found on one side as on the other; and that a single soil type on one side of the line, the Volusia loam, is represented by parts of six soil types on the opposite side of the line.

debris. It is a heavy but somewhat calcareous soil with moderately efficient to moderately poor drainage, and is represented by two important types, namely silty clay loam and clay. The A horizon is seven or eight inches thick, somewhat greater than the average for the region.

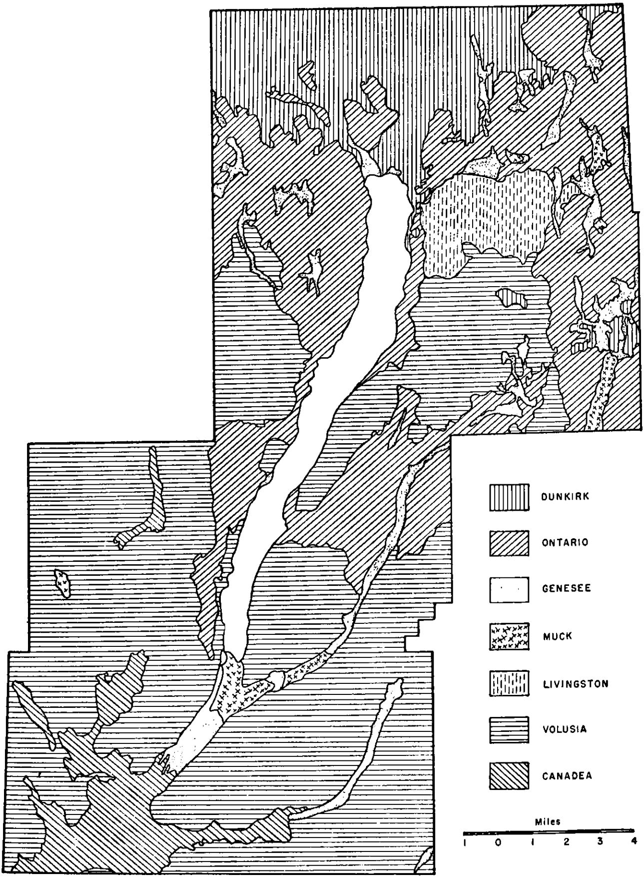

FIG. 5. Major soil series of the Canandaigua region (generalized somewhat from Maxon, 1918, and Carr and others, 1912).

The Ontario series of soils occupies the middle and higher parts of the plain and extends onto the forepart of the plateau for a distance of several miles, especially along the open, lakeward slopes. It is probably the best soil in the region as regards a combination of alkalinity, thickness, and drainage. It has developed from moderately thick ground-moraine, and owes its somewhat calcareous nature to the presence of limestone, derived largely from the Onondaga formation which outcrops along the northern edge of the area. Its texture is lighter and its drainage is better than those of the soils of most of the rest of the region. The commonest widespread textural type is simple loam, although fine sandy loam has significant areal extent, and other types are present (plate 2D). The A horizon of the Ontario varies from eight to twelve inches in thickness.

The typical group of soils of the plateau is Volusia. Derived by way of thin till from the underlying shales and sandstones, it is acid at all horizons. Drainage is far from perfect. On the flat uplands the presence of an indurated layer just below the B horizon frequently causes water to remain at the surface for days, and on the steep slopes the thinness of the soil is a handicap. Brown mottlings are common in the subsoil regardless of slope. Thickness of A horizon varies from an average of ten inches in the loam (moderate slopes) to only four or six inches in the shale loam (steep slopes). Textures commonly range from shale loam to silt loam, although more extreme types are present.

As a transitional soil between the Ontario series of the plain and the Volusia series of the plateau is the Livingston, which occurs in a single area on the eastern side of the lake. Here, on level to undulating topography, glacial and glacio-lacustrine processes have produced a light topsoil, but the underlying shales have created an imperfectly drained subsoil. Only one texture, a silty clay loam, is recognized. The thickness of the A horizon averages ten inches.

The most nearly normal soils of the plateau are those which have developed on the recessional moraine of the southwest. They belong to the Canadea series, and contrast strongly with the neighboring Volusia, for they have a slightly calcareous subsoil and good drainage characteristics. Both of these qualities result from the great depth of porous and permeable parent material, and from the steeply rolling surface configuration. Two textures, a gravelly loam and a silt loam, are recognized, the difference in amount of fine material being the result of differences in deposition on the floor of a short-lived, high-level glacial lake or lakes.

The Genesee soils are typical of the floodplains along the bottoms of the broadest valleys of the plateau, but they are also found in scattered, low-lying patches in every part of the area. In spite of a tendency towards seasonal flooding, drainage of representatives of this soil series is fairly good. The A and B horizons are invariably acid, but subsoil is frequently alkaline. Four textures, all loamy, are found.

The only other soil having an area of more than one square mile is Muck, which, being composed largely of plant remains, is actually a pseudo-soil. It occupies the lowest part of the broad valley-bottoms within two or three miles of the southern end of the lake, in addition to small, scattered depressions in both plain and plateau.

Representatives of the Honeoye and Clyde series are found in the region, but their total areal extent is insignificant.

In summary, in spite of great variations from place to place, it can be said that the dominant textural types are the loams and silt loams; that, although many areas are adequately drained, most of the region has soil-water problems; and that, in spite of large areas having a tendency towards moderate alkalinity, an acid chemical reaction is the rule. Marbut (1935) classifies the entire region as "Grey-Brown Podzolic."

This brief treatment of soils will be supplemented, where necessary, in the discussion of population changes in later chapters.

III. THE ABORIGINAL POPULATION, AND CENSUS STUDY OF WHITE OCCUPANCE

Aboriginal Population

On the stage setting outlined in the preceding chapters, the drama of settlement and depopulation has been played. The period of occupancy by white men constitutes only the latest act in the epic, and a few program notes regarding the earlier phases of the drama will not be amiss.

The first human occupance for which any distributional data are available is that of the Algonkian Indians,[15] the immediate predecessors of the Iroquois. These people seem to have lived rather gregariously, usually in unfortified villages on lowland sites near streams. The Algonkians finally gave way to the Iroquois, of which the Seneca tribe occupied western New York. With the arrival of the Seneca, the population centers shifted from valley-bottom to hill-top, thus taking advantage, for purposes of defense, of steep slopes with running water at their bases. Italy Hill, South Hill and several of the "Bristol Hills"[16] show evidence of such occupation.

Just as the coming of the Iroquois changed the population pattern of the region, so Iroquois history itself reveals a major gradational change in distribution. The later Seneca villages occupied poorer and poorer

[15] Prior to the Algonkians were the Mound Builders, and before them an earlier culture, possibly Eskimoid, dominated the region, according to Parker (Doty, 1925, chaps. 3–5), and conversation with Charles Wray, Rochester Museum of Arts and Sciences.

[16] The term "Bristol Hills" will be used frequently in this paper to refer to the interior hills of South Bristol township.

military sites and better and better agricultural lands, probably because the population, and hence the food needs, increased. Almost all the later Seneca villages lay along the southern edge of the Ontario Plain, on the great east-west trail which connected the domain of the Six Nations. The villages in some cases included several hundred or even a thousand people, who lived gregariously in "long houses." Some of the individual dwellings sheltered as many as 50 people, and thus furnish a striking parallel to crowded modern living. From three or four to more than a hundred houses characterized each village.

Perhaps half the food which sustained the people in these agglomerations came from their own communal gardens and orchards,[17] and most of the remainder came from the native animal life.[18] Although there were no domesticated meat animals, deer were attracted to relatively accessible areas by clearing the forest and allowing grass to grow in its place. Hunting camps of more or less permanency were scattered throughout the forest, attesting the need for the hunters to range far afield to supply the village meat requirements.

The towns were kept from developing any real permanency, however, by several factors. Much of the game in the vicinity was soon killed off, and the rest retreated to a considerable distance. The soil lost whatever fertility it originally possessed, because of constant cultivation, and in spite of some crop rotation (corn and beans, in alternate years). The surrounding forest became cleared of the litter that was so necessary for firewood and construction material, the need for the latter being especially important because insects inevitably attacked the bark houses. Also it may be that disease was a factor, for certainly sanitary precautions were few. Hence every few years, perhaps ten on the average (Milliken, 1876, based upon Irving W. Coates), the villages were moved, providing very frequent minor changes in population distribution within the longer periods of evolutionary change.

The most recent short-term moves of the centers of Seneca population have been described by archaeologists, especially Parker (1922, vol. 2, pp. 650–664 and 716–717). From their data a map of village migration in the Canandaigua region has been compiled. Although not reproduced in this paper, the map shows that the village, which towards the close of the Indian period occupied the site of the present city of Canandaigua, had moved at least twice during the preceding century. It should be remembered that these changes represent minor ones towards

[17] Apple seeds were probably introduced by Jesuit missionaries, according to Doty (1925).

[18] Deer, the dominant game animals, were especially abundant. Elk and moose were not unknown, and buffalo were occasionally seen. The most numerous predatory animals were wolves, bear, and cougar. There were dozens of species of small fur-bearers and of game birds. Speckled trout swam in most of the streams, and salmon frequently came up Canandaigua Outlet as far the northern end of the region (Turner, 1852; Doty, 1925, vol. 1; Cleveland, 1873).

the end of the Seneca occupance, following a long evolutionary change from the fortified plateau sites to the accessible farming land of the plain.

A careful appraisal and interpretation of available data[19] had made possible some estimate of the total number of Indians in the Canandaigua region. Immediately preceding 1687, when a French expedition headed by de Nonville entered upper New York, there were probably five hundred Indians in the area under discussion, and between 1687 and 1779, when they were scattered by Major General Sullivan, there were as many as a thousand of them, mostly in the single village of Kanadarque (or Canadarq or Canandaigua).[20] In September, 1779, Sullivan found the village to consist of 23 unusually well-built houses. His men burned every house to the ground, destroyed the crops and orchards, and obliterated every means of subsistence possible, thus carrying out General Washington's order to force the Seneca from central New York. Ten years later, when white settlers began to swarm in from New England, the Indians were no problem whatsoever. And fifteen years later, in 1794, at their former castle of Canadarq, the Seneca nation assembled for the last time to sign what were virtually its own exclusion papers.[21]

Thus with the end of Iroquois occupance in 1779 closed the next-to-the-latest period in Canandaigua populational history. The Seneca, the Algonkians, and their predecessors were gone, and the stage was set for the European whites.

White Population History as Revealed by the Census[22]

The major part of this study of the Canandaigua region deals with the results of a study of habitation maps, supplemented in places by township census data, representing a century and a half of white man's occupance.

[19] Donaldson (1892), Milliken (1911, vol. 1, based on Greenaugh, Kirtland, and Johnson), Parker (in Doty, 1935, vol. 1, chap. 5), and McIntosh (1876).

[20] The very large increase is the result of a movement of Seneca villages into the area. Meanwhile the total Iroquois population dropped to one-half, then regained its former total (Donaldson, 1892).

[21] The last mention of Indian occupance is that of a wigwam which stood near Bristol Springs, in South Bristol Township, until 1815; a wigwam which was sporadically occupied by hunting parties. Indians at that time used to straggle past the neighboring farms in groups of two or three to twenty, sending the squaws into the farm houses to beg for loaves of bread.

[22] Federal census records are available at 10-year intervals from 1790 through 1930. State census records, taken in the middle of each federal intercensal period, give additional data, of questionable accuracy, from 1814 through 1875. Between 1790 and 1840 many new townships were split off from pre-existing ones. Hence it has been necessary to extrapolate the population of the offspring townships from the figure given for parent and offspring.

Example: Hopewell split off from Gorham in 1822. Prior to that, data for "Gorham Township" are actually the data for Gorham and Hopewell. The share of the total which belonged to Hopewell was computed by assigning it the same proportion of the total as it had on the three censuses following the split. Inaccuracy is minimized because parent and offspring were invariably similar environmentally.

It has already been suggested that the availability of maps for individual dwellings necessitates breaking the time-span into quarters: 1780–1820, 1820–1860, 1860–1900, and 1900–1940. An examination of the census record (fig. 6), on the other hand, shows that the population history of the region actually falls into three "natural," rather than arbitrary, periods: a period of growth from 1790 to 1840 (50 years), one of instability from 1840 to 1880 (40 years), and finally one of decline, from 1880 to 1930 (50 years).

By sheer good fortune the habitation maps reveal the distribution of population at approximately the mid-point of each natural period. It has seemed advisable to summarize the population changes of these natural periods before proceeding to a detailed study of the more arbitrary. Such a summary will not only familiarize the reader with the general trends in the region, but also with the limitations of a census study, although it is not to be inferred that all the possibilities of a census study have been explored here.

The Period of Growth, 1790–1840. The opening period, 1790–1840, is marked by rapid and continuous growth, from 464 persons in 1790 to 17,200 in 1840, an average increase of some 334 persons each year (fig. 6). This was the settlement period, when in common with the rest of upper New York and, later, with much of the Midwest, immigration was pouring in from New England, Pennsylvania and the Middle At-

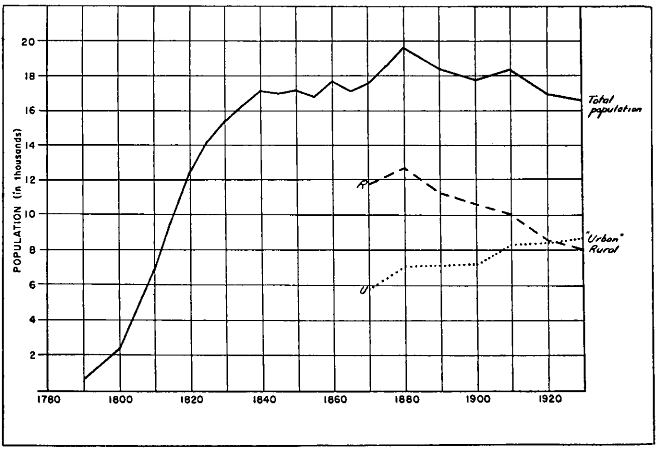

FIG. 6. Population history of the region. The "urban" figures are those of Canandaigua city and Naples village.

lantic states. The curve can be divided into halves, the first characterized by accelerating increase, the second by slight deceleration but nevertheless strong growth.

The first half of the period, was the time when the western Iroquois still gathered annually at Canandaigua to receive their land payments. It was the time when upper New York was the goal of westward moving settlers, when the Great Trail of the Iroquois, although widened to permit the passage of wagons, was still the main route of travel, and Canandaigua was on that route. It was the boom time for the Finger Lakes district.

Towards the end of the first half of the period of growth the War of 1812 was fought, taking much of the avilable man-power from Canandaigua farms but giving in return a flourishing market for cash crops among the army units which were strung out along Lake Ontario. Toward the end of the period construction of the Erie Canal began.

The Canal was completed soon after the close of the first half of this period of growth, bringing subtle but powerful changes in the location of the region. The main transportation route moved northwards from the old Iroquois trail of the plateau fringe onto the more level topography of the plain itself. Very gradually the Canandaigua region felt the effect of this shift, for although the Canal was completed in 1825, it was not until 1840 that the population curve of the region as a whole began to fluctuate uncertainly. The success of the waterway was not recognized immediately and even after its future was assured there was a possibility of a feeder line to connect Canandaigua Lake with the main canal.[23] Meanwhile, the markets of the east moved closer, for what had originally been a month-long journey to Albany was now only a five-day trip, a growing cash-crop market seemed assured, "Genesee wheat" was acquiring a reputation, and the lands continued to populate. With the coming of the Erie Canal the death-knell for Finger Lake agriculture had been sounded, though it was mistaken for another kind of music and growth continued at only a slightly decreasing rate.

The 50-year period of expansion did not affect all parts of the Canandaigua region equally, as the census curves for the individual townships (fig. 7) show. Every township experienced marked growth, but there the similarity ceases. Canandaigua outstripped all the others from the very beginning, and at almost every date during the period had twice as many people as any other township. Gorham and Hopewell reached their peaks in 1830, ten years before it was reached for the area as a whole, and Naples continued to populate even during the period which we have designated for the region as a whole as one of instability.

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[23] The branch canal (McIntosh, 1876) was to have been 19½ miles long, dropping 225 feet by means of 23 locks. The expense proved prohibitive.

Some of the factors contributing to the township variations are not difficult to determine. The unique growth of Canandaigua Township is due almost solely to the growth of the village, a fact which can be inferred, even without specific figures, from the behavior of similarly-located but non-urban Hopewell Township. Gorham and Hopewell, both of which grew rapidly during the first half of the period, reached their peaks early, probably accompanied by rural Canandaigua, for two reasons. First, they were populated more rapidly, and hence became saturated sooner, and second, there was a larger cash-crop element in their economy, which made them first to feel the competition of the more accessible plain to the north, and more easily-farmed lands of the Midwest.

South Bristol, Middlesex and Italy, all plateau townships, were populated more slowly, and hence drew settlers after the plains had ceased to attract them. Their comparative inaccessibility engendered a subsistence economy which enabled them to withstand agricultural competition for a longer period of time.

Naples Township, very much like the other plateau units in many ways, nevertheless contained a metropolis which in the days of slow transportation was entrepôt for a large section of the plateau. This local commercial pre-eminence was not threatened until much later, when good roads and rapid transportation brought the region within the economic sphere of Canandaigua city. Hence Naples was the last township to show a net decline in population.

The date 1840, which closes the period, is the most significant one in all Canandaigua's history, for it marks the end of an era of growth which had been continuous ever since the region was opened, and the beginning of an era of uncertainty, which was to be followed by a period of decline, not yet ended in 1941.

The Period of Instability, 1840–1880. In marked contrast to the continuous increase in population during the early period is the tendency towards alternate increase and decrease of the middle period, 1840–1880 (fig. 6). During this 40-year interval the population curve oscillated downward, then upward, three times, but resulted finally in a net increase of 14 percent. The period concluded with the largest population ever concentrated in the Canandaigua region, 19,705 people, an average density of 66 people per square mile. At present, even in summertime when several thousand transients move into the area, the total figure would not exceed that of 1880.

If the last half of the preceding period was the Canal period, this was the railroad period, for the first train crossed Hopewell and Canandaigua Townships in 1840. The line ran from Syracuse to Rochester, taking a considerable southward detour in order to pass through Canandaigua village. It touched only the northern part of the area, entering along Canandaigua Outlet channel, and leaving by way of Padelford (fig. 2). In 1851 another line was laid, from Canandaigua village southeast across Hopewell Township and the northeastern corner of Gorham to Penn Yan and Elmira in the southern part of the state. Two years later, in 1853, this line was extended westwards from Canandaigua to Niagara Falls. It was only the northern townships which received any direct benefits, however, and the railroad isolation of the four plateau townships continued well into the next period.

An era of plank, and later of gravel, road building accompanied the expansion of the railroad, improving considerably upon the turnpikes of the Canal era. The resultant speeding of transportation was paralleled by a quickening of industry. Both changes were important in the Canandaigua region, but were considerably more important farther north where accessibility was even greater; hence the wavering oscillations of the population curve.

A considerable part of this fluctuation may be more imaginary than real, for the state census invariably shows a smaller population than does the federal compilation (fig. 7). The magnitude of this discrepancy is not uniform, either from decade to decade or from township to township. Hence a correction factor could not be applied, and the state figures have been disregarded in the discussion which follows. Even without them, enough oscillation exists to justify calling this a period of uncertainty.

The first two decades (1840–1860) may be thought of as a time of rural decline and slight urban gain, for all the townships lost population except Canandaigua and, for a brief period, Naples. The last two decades were an era of both rural and urban gains, initiated in the eastern townships, regardless of urbanity, by the stimulus of the Canandaigua-Elmira Railroad, and involving every township by 1880 regardless of urban tendencies or transportation facilities.

The 1880 peak is secondary in importance to the peak of 1840, even though greater in magnitude, for it represents only a brief reversal of downward trend in every township except Canandaigua. The powerful depopulating forces which preceded and followed this date were only temporarily neutralized by a brief rush of immigration. Perhaps half the local gains were experienced in Canandaigua village, the remainder being concentrated largely in the plateau where the rapid rise of viticulture attracted many farmers of German extraction.

Summarizing the unstable middle period, it was a time of slight decline, then rise, culminating in an all-time population peak for the region. Several other tendencies appeared among the individual townships, but they differed from one another not only in intensity but also in kind, mak-

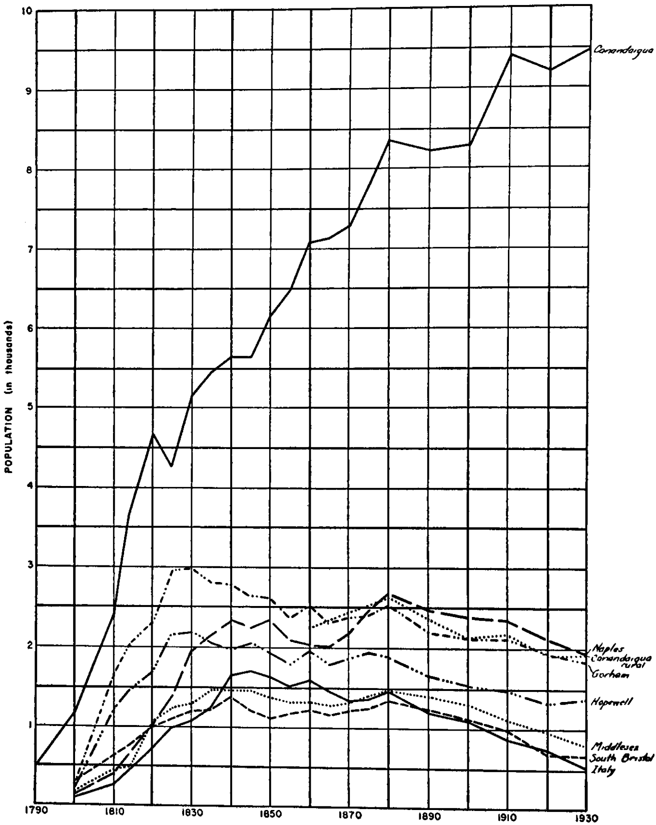

FIG. 7. Population history of individual townships.

ing the graph of township population curves a tangle of crossing and re-crossing lines which tend to cancel each other. The only important local exception is Canandaigua Township, which grew continuously, although at varying rates, throughout the entire period, because of increasingly important urban functions.

The Period of Decline, 1880–1930. So far as the census records show, the uncertain days of Canandaigua population ended in 1880, even as the palmy days had ended in 1840. From 1880 to the present, depopulation has been continuous excepting only Canandaigua city (see curves for Canandaigua Township and "Canandaigua rural," fig. 7).

Even at the opening of the period of decline the original pioneer enthusiasm had long since disappeared. Indeed, if it was present in any one of the region's residents it led to his moving westward, for by 1880 upper New York was far removed from the pioneer scene. Viticulture, together with its associated wine-manufacture, may have slowed the decline somewhat, but was powerless to check it. The small, scattered factories which had used local water-power were gone, and no large power sites were available to take their places. By 1911 the only power development was a small hydroelectric station on the Canandaigua Outlet. Except for the wineries of Naples, the Lisk enamelware factory and the McKechnie Brewing Company were the only significant manufacturing industries soon after the beginning of the present century.[24]

Seasonal occupance of the lakeshore by summer cottagers began just prior to the opening of this period, but did not become important until the arrival of the macadam road and the automobile, shortly after 1900. The beneficial influence of lake resorts on the census curve even today is largely limited to a stimulation of growth of Canandaigua village, which is the center for the carpentering and construction trades and also for the purchase of household supplies.

All of these influences: growing resort business, increased manufacturing, and improved transportation, were powerless to neutralize the effect of wholesale farm abandonment on the population curve. In many ways these elements actually hastened the rural decline, for certainly the rise of rapid transportation, the lure of new manufacturing plants, and the ability to sell a run-down farm to a city worker for a summer cottage helped to draw off the less successful and the more ambitious farmers. Depletion of small amounts of soil fertility, loss of considerable topsoil through erosion, and competition with Midwestern farms were also important factors.

During the period of decline the census figures reveal population changes not only by townships, but also by rural and urban categories (fig. 6). Thus at present 48 percent of the population is rural and 52 percent "urban,"[25] the two curves having crossed in 1920.

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[24] Among the manufacturing plants which came and went prior to 1911 were a chilled-plow works, a sash-balance factory, a general iron works, a brick-making plant, and a paper pail manufacturing company. Since 1911 the McKechnie Brewing Company also has closed its doors, but the Roper Knitting Company, manufacturing swimming suits, sweaters, and related recreational clothing, has been established since that date.

[25] The term urban, as used here, includes both Canandaigua and Naples villages, in spite of the fact that the latter has never had a population of 2500. If Canandaigua alone were so classified, 45 percent instead of 52 percent would be urban.

Canandaigua city grew continuously during the 50-year period. Naples village, smaller and less accessible, by no means fared so well, its curve resembling that of the rural townships more closely than that of Canandaigua city. Like the rural areas, its 1880 peak was its last one, for since that time it has remained static. Evidently the region can only support one metropolis, Canandaigua.

Rural population has been decreasing continuously in every township except two.[26] Losses have been exceptionally high in the plateau, where Middlesex, South Bristol, and Italy have lost 43 percent, 50 percent, and 65 percent of their population respectively.

The magnitude of the 65 percent decline can be suggested best by stating that Italy Township, which contained 1444 persons in 1880, had only 510 persons in 1930. In spite of macadam roads, which brought the township within a half hour of Canandaigua, within three-quarters of an hour of the main line of the New York Central Railroad, and within an hour of a transcontinental airport, Italy has returned to a population smaller than it had when Canandaigua was a hard day's drive away, when the Erie Canal was still a draftsman's plan, and when Rochester was little more than a cross-roads settlement. In short, Italy has returned to the population it had about 1815.

Assimilating all of the material contained in this study of census records, it is seen that they yield a clear picture of fluctations in population of the region from decade to decade, and suggest several broad inferences regarding the way external and internal forces have influenced township units. Some generalizations regarding the comparative behavior of plain and plateau, village and rural area, can be made. For this study, however, the census figures supply a relatively fine-mesh chronological framework on which the detailed areal pattern of population changes will be woven.

IV. HABITATION MAP ANALYSES: SETTLEMENT OF THE REGION AND SOME LATER SHIFTS

Creation of the Basic Population Pattern, 1788–1820

For nine years after the Senecas were scattered by General Sullivan's army, that is, from 1779 to 1788, the Canandaigua area stood virtually unoccupied. It was by no means forgotten, however. The soldiers of the expeditionary force, returning to their New England homes, gave enthusiastic reports on the fertility and beauty of the Lake Ontario coun-

[26] The two exceptions are Naples Township, where the rural component increased between 1890 and 1900 because railroad connections finally reached the village in 1892 by way of Middlesex; and Canandaigua Township, where the rural population increased between 1900 and 1910 in response to an upward surge in Canandaigua city.

try, and before long a business venture unprecedented in American history was initiated,[27] with the objective of opening this new land to settlement. Led by Oliver Phelps, a financier of Windsor, Connecticut, and his partner Nathanial Gorham, a group of interested persons purchased from the State of Massachusetts all the land in New York between the meridian of Seneca Lake and the Genesee River.[28]

The Period 1788–1800

Phelps himself came into the area in 1788, selected Canandaigua as the site of his headquarters, put up a storehouse, cut a sleigh road along the Great Trail of the Iroquois eastwards from Canandaigua towards Geneva, and cleared a wagon road to the head of navigation on Canandaigua Outlet, about six miles northeast of the present site of the city. These things accomplished, he returned to New England. The following spring (1789), vigorous settlement began. By autumn of that year "the place was full of people; residents, surveyors, explorers, adventurers; houses were going up. It was a busy, thriving place" (Turner, 1852).

All the early settlers were from New England, the home of most of Sullivan's men, and of Phelps and Gorham. Furthermore, although a month was required to negotiate the difficult all-water passage into the region from Schenectady,[29] it was the only feasible route at that time, and because New England lay just beyond its eastern end it tended to draw men from that region. Usually the settlers came in groups, consisting of several families which had been neighbors in the Berkshires or the Western Upland of New England. Later, with the opening of a wagon road along the valley bottoms of the Allegheny Plateau, some people from the Middle Atlantic States joined the inflow.

Expansion from Points of First Settlement. The relationships between points of first settlement and the general impopulation of each

[27] Here the county-township-range system of land subdivision was used for the first time in America, and the first regular land office opened. "Each township was sold by selection, accompanied by another chosen by lot, both at the same price" (Corbett, 1898).

[28] For this 4000-square-mile tract the Phelps and Gorham firm paid the State of Massachusetts $100,000 and the resident Indians $5,000, with the promise of an additional $500 annuity "forever." The last of the "forever" payments probably was made about 1815. The Indians were to have hunting and camping privileges in the region for 20 years—until about 1810. But few remained after the settlers arrived.

[29] Flat-bottomed batteaux were built at Schenectady, and poled up the Mohawk to its headwaters at Rome. There boats and food were portaged a mile to the headwaters of Wood Creek, down which they drifted into Oneida Lake; thence across Oneida Lake, down its outlet to the Oswego River, up against the current of the Oswego, the Seneca, the Clyde, and Canandaigua Outlet to Manchester, from which a ten-mile wagon road led to Canandaigua village. Other portages were necessary at Little Falls and Seneca Falls. The trip from Schenectady to Canandaigua took a full month.

township merits discussion. The sites settled first in each political unit may be termed township nuclei, or secondary nuclei, to distinguish them from the major regional, or primary nucleus, of Canandaigua village. After the establishment of the primary nucleus in 1788, the secondary nuclei were formed, in regular southward progression: those of Gorham, South Bristol, and Middlesex during the next year (1789), that of Italy two years later (1790), and of Naples three years later (1791) (fig. 8).

From each of these township nuclei, and from the primary nucleus as well, the peopling of the countryside took place, by two different methods. Where regional relationship formed a strong focus upon a single site,

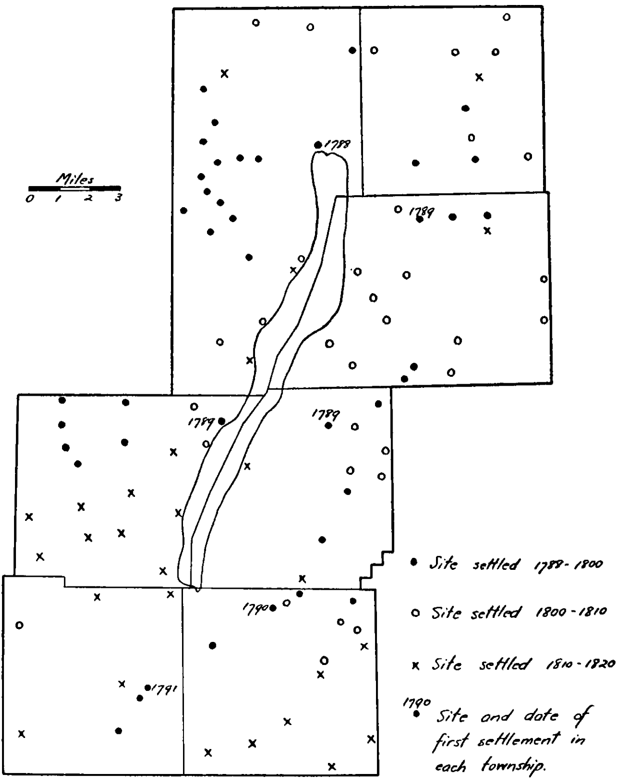

FIG. 8. Populating of the region, 1788 to 1820.

settlement tended to take the form of expansion around the original point, whereas in the regions of less striking focality newcomers tended to break from the township nuclei into remoter regions, starting centers of a third order. So it was in South Bristol, where Seneca Point, the township nucleus, did not expand until after considerable growth had occurred in the more remote tertiary centers of the back country. Similarly, in Italy Township, three new tertiary nuclei developed before the original settlement had expanded at all. In Middlesex Township, although the original nucleus was probably at Overacker Corners, subsequent settlement was at scattered points along Middlesex Valley.

In contrast to such scattered expansion is the contiguous system, shown in Canandaigua, Hopewell, and Naples. Here the strategic importance of the initial site was so great that incoming settlers built up the contiguous area to a considerable population before scattering over the adjacent countryside. This category includes both the townships of the plains, and in addition hub-and-spokes Naples Township at the southern end of the lake. In Gorham Township, where the topography is transitional between plain and plateau, both settlement types appear, for contiguous expansion occurred in the north while a scattered pattern developed along the southern boundary.

Points of Original Settlement as Present-Day Strategic Sites. Because all of the seven townships except Hopewell were settled as independent units, the question as to whether the sites of initial settlement had permanent strategic value is cogent. The answer lies in whether or not these six sites still dominate their respective townships. In the case of two of them the answer is definitely affirmative, in two more the answer is only partially affirmative, and in another it is negative.

The point where Phelps and Gorham began their first settlement and opened their land office is today not only the commercial nucleus for Canandaigua and Hopewell Townships, but still remains entrepôt for the entire region. Strategic factors will be amplified later in a discussion of urban areas, but location at the foot of Canandaigua Lake, on the well-travelled Ontario Lowland, is obviously of paramount significance. Similarly, the locale of initial settlement in Naples Township, now Naples village, has continued to be regionally important. In South Bristol Township, Seneca Point was commercially important for several decades, but was finally eclipsed by the inland valley site of Bristol Springs, and in Middlesex Township, Overacker Corners, an upland site, enjoyed only a brief period of township supremacy before it was overshadowed by the valley-site of Middlesex village. In Italy Township, West River probably never even enjoyed the local prestige of a gristmill.

From the foregoing discussion of development within the townships, it can be seen that physical differences produced important differences in settlement history, and that gradually the individual strategic sites in each township have either increased or decreased in importance depending upon their relative strategic value in terms of the entire Canandaigua basin. Additional evidence of the relative unimportance of the township boundaries is at hand.

Of the 24 plateau settlements shown on the map to have been made prior to 1800, 19 were in the valley bottoms, 4 on the upland, and 1 on the lake shore. With regard to the plain, data are lacking for the area close to Canandaigua village, but of the 20 settlements which are mapped 18 lie in the land above the area of former glacial lake action, on moderately high, rolling, well-drained land. Thus, within each of the two regions of similar environment, the same tendencies were present, regardless of political boundaries.

The best single example of physiographic influence is found in the long line of scattered settlements along the bottom of the continuous Naples-West River Valley, stretching for 15 miles through the four townships of Naples, Italy, Middlesex and Gorham, by the year 1800. Because the valley was settled from four different township nuclei it was so to speak, discovered independently from each of the four centers.

The Decades 1800 to 1810 and 1810 to 1820

During the decade 1800 to 1810 the plain continued to populate faster than the plateau (fig. 8). On the lowland most of the expansion was contiguous, but it tended to push people onto less well-drained land, and farther from the village, for the better areas had already been occupied. On the plateau, although immigration was much lighter, gaps along the valley floors began to fill in, very few settlers going elsewhere. The most important demographic event of the decade, however, was the occupance of the well-drained but only moderately sloping lands of the transitional area between plain and plateau, in central Gorham and southern Canandaigua Townships.[30]

The period 1810 to 1820 finds the southern townships receiving for the first time the dominant percentage of the incoming agriculturalists. By the end of the decade the major part of the floodplains had been settled, at least thinly, and many a moderately-steep slope in each township had received its first plowing; but few people had yet occupied the uplands. In general these stand out as the great unsettled areas at the close of the first quarter of white populational history.

[30] This paper makes no attempt to analyze the quality of the people in relation to the quality of the land. In describing the populating of the southern half of Canandaigua Township, however, McIntosh (1876) characterizes the region around Cheshire as "poor land, with poor settlers."

The settling of the Canandaigua region was now well advanced, its 12,500 people representing more than half the total number of inhabitants and probably more than three-quarters of the rural population which the area was to contain at its most populous period, that is, about 1880. The War of 1812 with its increased cash-crop market had come and gone, the Erie Canal was under construction, and the pioneer period was closing.

A Settlement Detail: Italy Hollow

Before leaving the period of settlement a type example of the settlement of a plateau valley should be described. Italy Hollow has been chosen as the model.

The Hollow is one of the deeply-incised pre-glacial valleys in the old Tertiary peneplain (fig. 2). The modern floodplain is about three-quarters of a mile wide and above it rise thousand-foot precipitous slopes of shales and sandstones, originally heavily forested. The valley at one time joined Canandaigua Valley just northeast of Naples, but Pleistocene glaciation half filled the southwestern end with morainal debris, as can be readily seen from the topographic map. Present drainage is by Flint Creek, an underfit stream which rises on the moraine near Barker Church and flows northeast along the valley bottom, receiving a small tributary from the shale hills just before it leaves the northeastern corner of the township. At this point, in 1794, the first two farmers in Italy valley located. The decade from 1800 to 1810 brought four more settlers into the region. Three of them settled just up the valley from the original occupants, making an "extension" of the original nucleus. The fourth went a mile or so further up the valley beyond his neighbors, making an "outlier."[31]

The third decade, 1810–1820, brought 15 or 20 new families, which filled in the gap between the outlier and extended nucleus, and ran their own continuous extension several miles farther up the valley to the edge of the moraine, where the change in topography, soil, and probably in vegetation determined the limit of general advance. One courageous individual, however, went a couple of miles upstream on the moraine and created a new outlier.

In a similar way the other plateau valleys were populated. First a nucleus, in most cases tertiary; then creation of outliers and extension of the nucleus; then filling in of the gaps, further extension, and further outliers, until all of the habitable area was populated.

On the Ontario Plain the sequence was similar, even though started from a single primary nucleus instead of from tertiary nuclei. Here on

[31] Between 1794 and 1800, three additional settlers tried the high flats above Italy Valley, but gave up and moved away almost immediately.

the level plain concentric rings are the corollary of the "extension of nucleus" in Italy Valley. Outliers were formed, and then the rings grew outwards until these were absorbed, but meanwhile new outliers had sprung up.

By some such method of creation of nucleus, then establishment of outliers, followed by an expansion of the nucleus, most pioneer settlement probably progresses.

At the end of the first quarter, by 1820, most of such pioneering in the Canandaigua region was completed, and the basic populational pattern set. Although the total number of people continued to increase for ten years more, the first quarter of white populational history was over.

Some Details of Regional Readjustments, 1860–1940 [32]

The last two quarters of white populational history, from 1860 to 1900, and from 1900 to 1940 have been the subject of careful analysis by a comparison of the habitation maps which begin and close the periods. The details of this analysis are reported elsewhere (Simpson, 1940), and only a few of the more interesting facts will be repeated here. They have been organized by townships in order to preserve regional relationships.

Italy Township. Italy, where in 1860 there were 1605 people and now are only 457, is the most depopulated township in the Canandaigua region. The extreme decadence of one small area is shown in figure 9. This three-and-a-half square miles of upland on the eastern edge of the township contained 19 habitations and 7½ miles of road in 1864, 13 inhabitations and the same amount of road in 1900, and no habitations and only 4 miles of road (plate 2A) in 1937, a change from a density of 28 people per square mile to complete abandonment.

Lured into the region by cheap land which could be purchased on the installment plan,[33] and by gently rolling upland topography which belied its thin, acid soil, the settlers here found themselves as time went on less and less able to compete with more accessible farms having better soils. As pavement and social amenities began to appear on the more

[32] No detailed study of the second quarter, 1820 to 1860, has been made. During that period the population grew by less than half as many people as it had during the preceding quarter (5,253 as compared with 12,493). The increase was largely confined to three areas: the previously unoccupied moraine of Naples Township; the similarly uninhabited hilltops of the entire plateau, but especially those of Italy Township; and finally, Canandaigua village and its environs. Only a few isolated hilltops and the steepest of the valley walls remained unpopulated in 1860, and even on a surprising number of steep walls, homes had been built and fields were being cultivated.

[33] Aldrich (1892) refers to the primitive settlers of Italy Township as "almost all poor." Even at this early time poor farmers, on poor land, migrated frequently, as shown by the fact that there was only one instance in Italy Township (prior to 1892) of the title to a piece of land staying in a family for two generations.

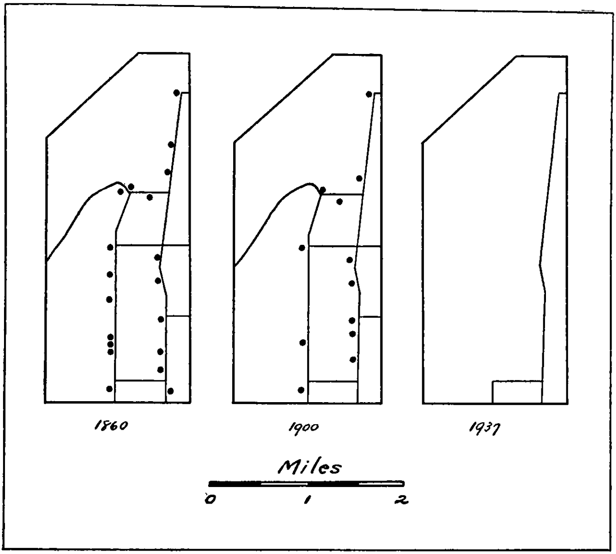

FIG. 9. A decadent area. Part of Italy Hill, Italy Township. Each dot represents one habitation. Lines represent roads.

populous valley bottoms, the upland farmers began to emigrate, making it increasingly difficult to provide public services for those remaining.

An interesting example of the migration of a village is afforded by the hamlet of Italy, which lies in the bottom of steep walled, thousand-foot deep Italy Valley (plate 3B). In 1900 the village lay where two roads dropped precipitously down from the upland on either side to join the main artery along the valley bottom, and not far to the north another road from the upland slanted down into the valley bottom (figs. 2, 10). By 1937 two of the upland roads which had given strategic importance to the site of the village had been abandoned, and the increasing importance of large Naples village, eight miles to the west, was tending to draw the remaining upland traffic westwards in such a way as to by-pass Italy village. So filling-station, garage, and store were built at the point most suitable to tap that traffic, one-half mile west of the old site, leaving only two public-service buildings, both of them churches, behind. The total number of buildings at the former site declined from 13 to 10, and at the new site increased from 15 to 16, during the 37-year interval.

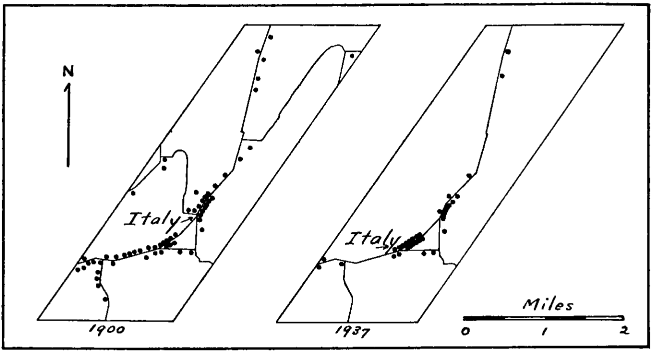

FIG. 10. Migration of Italy hamlet, 1900 to 1937.

Middlesex Township. "Prosperity (can be secured)," wrote Lewis C. Aldrich (1892) to the Yates County farmers "by industrious economy and sobriety." If this were entirely true we might not have to look further to explain the fact that Middlesex Township has suffered somewhat less depopulation than has Italy. But, in spite of general environmental similarity, there are differences in opportunity which cannot be overlooked. In Middlesex the broad valley of the same name is higher and better-drained than it is in Italy, and characterized by Genesee soils rather than Muck (plate 3A). The gentle upland slopes are mantled with Ontario loam, more fertile than any soil in the neighboring township, and Canandaigua Lake washes one side of the area. Furthermore, the railroad reached Middlesex 40 years earlier than it did Italy. In spite of all these advantages, however, the broad summit of South Hill, where formerly there were twelve houses, today has not a single dwelling.

South Bristol Township. Across the lake from Middlesex is South Bristol Township, characterized by the same types of soil but by a somewhat "finer-mesh" topography and hence by a greater percentage of steep interior slopes (plate 1B). Its lakeward slopes, however, are less steep than those of Middlesex. It is the only township in the region without a railroad (fig. 12), and through almost all of its history it has been the least densely populated township.

An example of the way in which two very similar parallel roads on the same kind of terrain can differ in populational history is shown in figure 11. The two roads not only parallel each other, but also parallel contours along the lakeward flank of Stid Hill (fig. 2). The western-

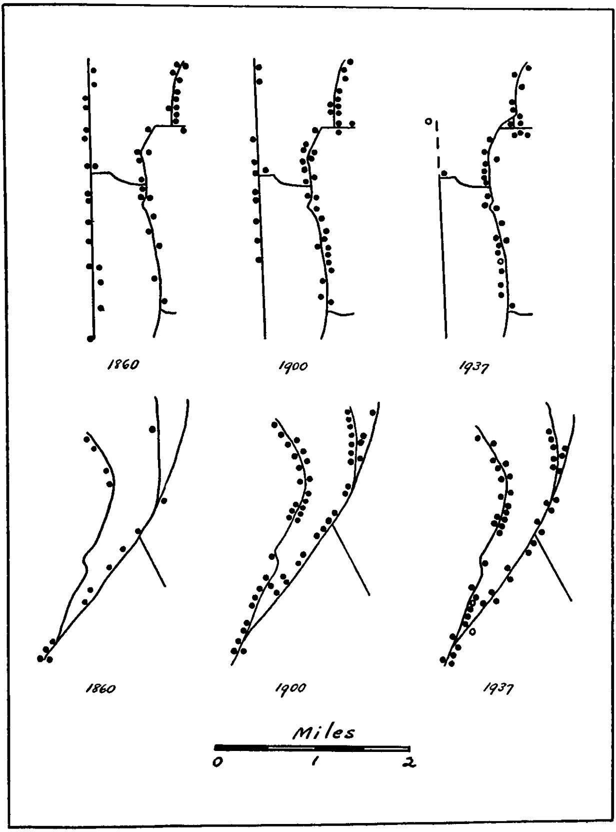

FIG. 11. Contrasting population shifts, 1860 to 1937. Solid dots represent permanently-occupied dwellings; open dots, summer cottages. Upper Series.—Two parallel roads on lakeward slope of Stid Hill, South Bristol Township. Lower Series.—Road fork along western flank of Naples Creek valley, 2½ miles northeast of Naples village.

most road lies between the 1800- and 1900-foot contours, the eastern one runs along the 1300-foot level. Extreme decadence characterizes the upper road in contrast to relative stability on the lower one. Other variables are:

(a) considerable thin, acid Volusia shale loam on the upper road, and a corresponding proportion of relatively thick, calcareous Ontario loam on the other.

(b) the upper road is four or five hundred feet higher above the lake vertically, and a half-mile farther away from it horizontally, than is the lower road.

(c) the upper road is unsurfaced, the lower one macadamized.

(d) the upper road has somewhat less sloping land.

The last-named factor can be eliminated as an influence on population change because areas which have similar slopes along both roads nevertheless have contrasting histories. Factor (c) is shown to be of negligible importance by study of comparable roads on Gannett Hill, three miles further south, where part of the upper road has held considerable population in spite of lack of pavement. Thus pedologic and microclimatic factors are paramount.

The township probably had the first summer cottages on Canandaigua Lake (plate 4A, D). From the windows of the earliest cottages, built in the 1860's but still occupied today, the grandparents of the present generation of cottage folk looked out across the lake to one of its most splendid panoramas: the towering walls of thousand-foot high South Hill and Bare Hill, their lower slopes newly cut into steep flights of vineyard terraces, their middle and upper slopes heavily forested with hardwoods and a sprinkling of evergreen, their summits covered with a patchwork of fields. Between the hills lay the broad gentle slopes of Vine Valley.

Similarly, South Bristol is the first township to have a large number of back-country summer cabins, a result of as great proximity to Rochester as is commensurate with picturesque landscape and people (for stories of the folkways of the district see Carmer, 1936).

Naples Township. Naples is a hybrid township, having some characteristics of the plateau areas,[34] a few characteristics of the plain,[35] and many qualities which are unique.[36] Quite in contrast to the peculiar decline of the small area in South Bristol Township previously referred to, is that of a small bit of Naples Township. Here both roads were thinly populated in 1860, but on each of them densities have increased greatly since that date, as shown in figure 11B. The easternmost road runs

[34] Large areas of Volusia loam, great relief and surface configuration, relatively fine-textured drainage pattern, and heavily declining population.

[35] Total population large, and contiguous rather than scattered expansion of early settlements.

[36] Location astride great Canandaigua Valley, thick deposits of recessional moraine, large areas of Canadea soil, outward-radiating valley system, population peak in 1880 rather than 1840.

along the low, alluvial fill of the Canandaigua Valley, whereas the western road climbs steeply up the slopes to the upland (fig. 2). Thus differences in gradient are not reflected in differences in population shift, the advantages of air drainage on the steep southeast-facing slope, coupled with proximity to Naples village having been important enough to attract population during the viticultural boom of the 1870's, and to hold them since that time.

The village of Naples can be explained only with reference to Canandaigua Lake, to which it owes much of its local pre-eminence. In fact, every important village in the Finger Lake district is located strategically with respect to a lake, being either at the northern or southern end.[87] At these points north-south traffic and east-west traffic converge, and since traffic is heavier at the northern, or lowland, end, the northern cities tend to eclipse the southern ones in size. So Naples, although important, is overshadowed by Canandaigua city.

Canandaigua Township. This township dominates the region, for it has 52 percent more area and five times as many folk as any other township. If, however, the city of Canandaigua is excluded and the figures reduced to an areal basis, Canandaigua is found to rank considerably below Gorham and Hopewell (Canandaigua, 32 people per square mile; Gorham, 37; Hopewell, 38, according to the 1930 census).

Although its population and shifts have been much more evenly distributed than those of townships previously discussed, regional differences are noticeable even here. Thus, the pattern of distribution in the northern part is one of radiating lines along the roads leading out of Canandaigua city whereas the pattern of the southern part is one of rather evenly-spaced distribution. The central part of the township, which corresponds quite closely to the area of Ontario soils, has not suffered appreciable decline since 1900. In contrast, the northern third, largely on the Dunkirk soils of the old lake bottoms, has declined somewhat, and the southern third, rolling, drumloidal, and characterized by Volusia soils, has declined greatly during the fourth quarter.

The city of Canandaigua has grown by periodic surges of immigration, separated by periods of stagnation, as can be inferred from figure 7. Since initial impopulation, there was a rapid increase between 1870 and 1880, and again between 1900 and 1910, the latter caused largely by increasing resort, and possibly factory, population, the former by widespread agricultural immigration.

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87 The following cities stand at the lower ends of the six major Finger Lakes: Canandaigua (Canandaigua Lake), Penn Yan (Keuka Lake), Geneva (Seneca Lake), Seneca Falls (Cayuga), Auburn (Owasco), and Skaneateles (Skaneateles). The southern ends of the lakes, named in the same order, support Naples, Hammondsport, Watkins Glen, Ithaca, Cascade, and Glen Haven.

Of more interest, however, is a comparison between the population declines of two small villages: Cheshire and Centerfield. In spite of similar early history, the two hamlets have taken opposite trends since 1900. Cheshire, situated on the Canandaigua-Naples road, which is now State Highway 21, has suffered abandonment of two grocery stores. Centerfield, in contrast, has enjoyed some commercial expansion because of increasing importance of the old Iroquois footpath, now U. S. Highway 20, over which thousands of cars run daily. The village boasts two more buildings now than it had in 1900, both of them filling stations. Thus it represents an interesting type of modern economic specialization. It is a hamlet without garage, without blacksmith shop, and even without general store. It consists of 13 homes, one church, and three filling stations. Modern high speed automobiles may be bringing Centerfield closer to the wholesale and retail stores of Canandaigua city, but it still takes a quarter of a gallon of gasoline to get there.

Hopewell Township. Hopewell Township has the best situation for farming in the Canandaigua region. It has the least surface configuration consistent with moderately good drainage of its somewhat clayey soils, for most of its streams lie 10 to 30 feet below the general elevations, whereas in Gorham most of them are 40 to 60 feet below it, and in the level parts of Canandaigua they are scarcely below it at all. Hopewell can best be compared topographically with the central third of Canandaigua Township. From the standpoint of agriculture it is the premier township, for its farm population density is greater, its farm lands more valuable, and its farms smaller than those of any other township (U. S. Dept. Commerce, Bur. of Census, 1935).

The township has never developed any agglomerations of more than 100 inhabitants, for Canandaigua city, just beyond its western border, served as settlement nucleus in the early days and has functioned as shopping center ever since. The most definite gridiron population pattern of any township is evident in Hopewell, for here level topography and lack of urban development permitted full use of the township-range system.

Hopewell has had conservative and rather uniform tendencies in population change. Although the best farming township in the area, it has lost population slowly and continuously since 1830. Regional differences are slight, but reflect differing distance from Canandaigua not at all, presence of an important highway somewhat,[38] and soil characteristics to a greater degree.

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[38] The commercial value of highway traffic even to farmers is seen by the fact that of the 50-odd farms along this road, more than 20 percent sell tourist services and goods (overnight rooms, antiques, etc).

Gorham Township. Gorham Township is comparable to Hopewell in many respects, for in approach to optimum surface configuration, in intensity of farm utilization, and in development of gridiron population pattern it ranks second only to its neighbor on the north. In population change, too, it has been very similar to Hopewell.

In Gorham, which is not only near the northern end of the lake, but also is unhampered by steep shoreline bluffs, the density of summer cottages reaches its maximum, an average of one every 127 feet. Not a quarter-mile of lake front remains unpopulated, and back of the shore is an entire village composed only of summer cabins, which house a summertime population of almost 500 people. It is not surprising, then, that the population of this already populous township is doubled on weekends during the resort season.

Having shown in the preceding pages that the kaleidoscopic shifting of population around the basin of Canandaigua Lake is related to other mappable elements, the next chapter will attempt to isolate and evaluate certain of these relationships.

V. SOME RELATIONSHIPS BETWEEN ENVIRONMENTAL FACTORS AND POPULATION CHANGE

Farmers constitute only about 37 percent of the Canandaigua population, but they utilize 85 per cent of the land. Thus they are of great importance in an areal study of population shift. In the following pages the results of a comparison of such shifts with other mappable factors, namely physiography, soil, road type, distance from lake, and distance from village, will be made.

The method used has been as follows. Dot maps showing the actual location of each farm building in approximately 1860,[39] 1900, and 1937 were prepared on transparent drafting cloth. Copies of these three maps, basic to the entire study, are shown as figure 13 following page 50. By superimposing each of the dot maps on a map of soil types, for example, the number of dwellings on each type at each date could be counted, and magnitude of density and shifts computed. A tabular form has been worked out to present the findings of such comparisons, not only for soils, but also for other environmental factors. Such environmental units occupy the left-hand vertical column (for example, see table 4). From left to right, also in vertical columns, are recorded successively the area of each environmental unit, and for each date considered, the following items: number of habitations, percentage change in number of habita-

[39] Specifically in 1859 for the Ontario County townships of Canandaigua, Gorham, Hopewell, and South Bristol, and in 1864 for the Yates County townships of Middlesex and Italy.

tions, density of habitations, an index figure, and a translation of habitation density figures into population density figures.

Two of these elements should be described further. First is the "index figure." It is a number which shows how much of its areal share of the population a given district is carrying. Thus from table 1 it can be computed that Canandaigua township in 1860 had 20 percent of the land area of the entire region, but only 18 percent of the population. So it was carrying eighteen-twentieths or nine-tenths of its chance share of the people and its index figure becomes .9. Similarly, all areas carrying less than their share of the population have an index of less than 1.0 and all districts with more than their areal proportion have an index greater than 1.0.

The second element needing fuller explanation is that of "farm population density." Obviously, the actual number of people living in a given district at any date can be computed by multiplying the number of habitations by the number of persons per dwelling. This calculation would be simple if the latter number were always uniform, but it varies both with time and place. In 1855 there were 5.3 persons per dwelling in the region as a whole, but the number varied from 5.8 in Canandaigua and Hopewell to 4.8 in Gorham, according to the State Census of 1855. This variation is especially striking when one remembers that Hopewell and Gorham are contiguous townships of similar physical and social backgrounds. Likewise, the figure has varied with time, such as from 5.3 for the entire region in 1855, to 4.0 in 1930.[40] Consequently it has been deemed advisable throughout the study to discuss habitation changes rather than population changes, even though actual population figures are given in the last three columns. The population figures are based upon 5.3 persons per habitation in 1860, 4.2 persons in 1900, and 4.0 in 1937. Figures for 1860 and 1937 are accurate to within 10 percent, those for 1900 to within 15 percent.

With the phenomenon of decreasing number of persons per habitation in mind some of the seeming peculiarities of the tables are explained.

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[40] This is the number of people per home in Ontario County in 1930. In 1935 there were 3.9 persons per farm home. Census figures useable in computing the number of persons per farm home differ greatly in type from census to census and are totally lacking for many dates. Some enumerations apply to whole counties, others to individual townships; some were for number of persons per dwelling, others for number of persons per family; some differentiated between rural and urban, others did not. Out of various data the following figures were obtained for number of persons per farm dwelling in the region:

1855	5.3
1865	5.0
1875	4.5
1920	3.9
1930	4.0

They probably are accurate to within five percent for the region as a whole and within 10 percent for any single township.

For example table 4 shows an increase in number of dwellings between 1860 and 1900 on level and gradually-sloping land, but at the same time a definite decrease in population, because the number of persons per farmhouse declined almost twice as fast as did the number of farmers.

That the accuracy of the dot maps can be relied upon has been ascertained in a number of ways. The one for 1937 was made by the author, and checked against a published map of habitations for Ontario County which appeared shortly afterwards (Rural Directories, 1938). That for 1900 is derived from topographic maps of the United States Geological Survey (U. S. Dept. Interior, 1902, 1903a, b, c), and checked in certain critical areas by consultation with long-time residents. The map for 1860 is based upon published wall-maps of the two counties involved (Beers and Beers, 1859, 1865), maps which show evidence of painstaking preparation. A final check of the number of habitations shown on each map has been made by converting the number of dwellings in each township to figures for total number of people, and comparing these with the census reports. Discrepancies were almost all less than 10 percent, the discrepancies probably being a result of census error as much as of dot map error.

Population shifts for the entire region and for the individual townships are summarized in table 1.

It will be seen that in 1937 the Canandaigua region had 1694 farmhouses, an average of 5.68 to a square mile, but that the latter figure varied from 8.5 in Hopewell to only 2.7 in Italy. In terms of actual population, the region averages 22.5 persons per square mile, attaining only 10.8 in Italy but 34.0 in Hopewell. Examination of the index figures reveals that this great variation from township to township was formerly much less, for today Italy is carrying only .5 of its areal share of population and Hopewell carries 1.5 times its share, whereas in 1860 Italy carried .9 and Hopewell 1.2.

Physiography and Farm Habitation Change

Ontario Lowland versus Allegheny Plateau. Since the three northern townships correspond to the Ontario Lowland and the four southern townships to the Allegheny Plateau, it is possible to recapitulate table 1 to show the differences in farm habitation change between the two physiographic provinces. This has been done in table 2.

Similar data for the three western townships in comparison with those of the four eastern ones have also been included (table 3), to show the minimal differences between two arbitrarily selected regions.

It is seen that each physiographic province carried its proportional share of the total in 1860, but the plain has increased its share, period by period from 1.0 to 1.1 to 1.2, while the plateau declined from 1.0 to .9

TABLE 1.

Farm habitation changes by townships.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire region	298	1988	2359	1694	+19	–28	–15	6.68	7.91	5.68	1.0	1.0	1.0	35.5	33.2	22.5
Canandaigua	61	386	485	391	+26	–19	+1	6.3	7.9	6.4	1.0	1.1	1.2	33.4	33.2	25.6
Hopewell	36	282	335	305	+19	–9	+7	7.8	9.3	8.5	1.2	1.2	1.5	41.3	39.1	34.0
Gorham	49	348	401	313	+15	–22	–9	7.1	8.2	6.4	1.1	1.1	1.1	37.6	34.4	25.6
Italy	41	246	255	111	+4	–56	–55	6.0	6.2	2.7	.9	.8	.5	31.8	26.0	10.8
Middlesex	39	233	286	187	+23	–35	–20	6.0	7.3	4.8	.9	.9	.8	31.8	30.7	19.2
Naples	41	258	320	229	+25	–32	–12	6.3	7.8	5.6	.9	.9	1.0	33.4	32.8	22.4
South Bristol	31	235	277	158	+18	–43	–33	7.6	9.0	5.1	1.1	1.1	.8	40.3	37.9	20.4

TABLE 2.

Farm habitation changes, Ontario lowland and Allegheny plateau.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire region	298	1988	2359	1694	+19	–28	–15	6.68	7.91	5.68	1.0	1.0	1.0	35.5	33.2	22.5
Ontario lowland	146	1016	1221	1009	+17	–17	0	6.9	8.4	6.9	1.0	1.1	1.2	36.6	35.3	27.6
Allegheny plateau ...	152	972	1138	685	+17	–39	–29	6.4	7.5	4.5	1.0	.9	.8	33.9	31.5	18.0

TABLE 3.

Farm habitation changes, western and eastern halves of the region.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire region	298	1988	2359	1694	+19	–28	–15	6.68	7.91	5.68	1.0	1.0	1.0	35.5	33.2	22.5
Western half	133	879	1082	778	+23	–27	–6	6.6	8.1	5.9	1.0	1.1	1.1	35.0	36.1	23.6
Eastern half	165	1109	1277	916	+15	–27	–16	6.7	7.7	5.6	1.0	.9	.9	35.5	32.3	22.4

TABLE 4.

Gradient and farm habitation changes

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
All types	29.2	208	252	193	+21	–23	–7	7.1	8.6	6.6	1.0	1.0	1.0	37.6	36.1	26.4
Level land	5.7	60	72	61	+20	–15	+2	10.2	12.6	10.7	1.5	1.5	1.7	55.1	50.0	41.6
Gradual slopes	13.2	102	114	87	+12	–24	–14	7.7	8.6	6.6	1.1	1.0	1.0	40.8	36.1	26.4
Marked slopes	3.7	27	35	25	+30	–28	–7	7.3	9.5	6.7	1.0	1.1	1.0	38.7	39.9	26.8
Steep slopes	6.6	19	31	20	+62	–35	+5	2.9	4.7	3.0	.4	.6	.4	15.4	19.7	12.0

to .8. Farm population density on the plain has decreased by 24 percent since 1860, while on the plateau the decline has been 47 percent.

Gradient and Farm Habitation Change. Slope of farm land influences its population-carrying capacity in several ways, largely by affecting type of land utilization and yield and value of products. Steep gradients mean high production and marketing costs, and low returns per acre. Thus, each slope farmer must utilize more area to support his family, and small population densities result.[41] Because the hillside farmer can produce almost no crops as cheaply as his contemporaries on more level land, every increase of farm acreage on level land cuts into his margin of profit and forces him either to decrease his standards of living or to increase his acreage, or both. Every increase in mechanization of agriculture and every improvement in transportation is apt to favor level land more than sloping land and thus increase the farmer's handicaps (Baker, 1921). Furthermore, steep gradient produces rapid soil erosion[42] and leads to greater acreage of cover crops. Land with a gradient greater than 15 percent should not be planted to crops, and that with more than a 25 per cent slope should be left in forest (Baker, 1926, pp. 461–462). Marked gradients do facilitate drainage, an important asset in areas of hardpan or impervious bedrock such as much of the Canandaigua region, but with increasing slope, soil erosion increases so much faster than drainability that in regions of pronounced gradient the disadvantage outweighs the gain.

Gradients in the Canandaigua region vary greatly (fig. 2). Almost one-third of the area of the northern townships has less than a three percent gradient, as a result of the smoothing action of Pleistocene lakes on a land already relatively level (plate 1A). In contrast, the southern region shows many square miles with gradients ranging from 25 to 50 percent and hence unfit for anything but permanent forest (plates 1B; 3A, B, C, D).

In order to measure correlation between gradient and population shifts, as well as that of other factors to be discussed later, sample strips of land were selected. There are three of these strips, each a mile wide and so selected as to sample each of the various environmental types. The location of them is shown, between the double ruled lines, in figure 2, and their validity as samples is suggested by the following figures:

Area: 9.8% of entire region (29.2 sq. mi.).

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[41] Grapes are an exception to this principle, for they are so valuable that they repay the cost of terracing the slopes, i.e., converting the declivities into a series of narrow flats.

[42] Soil erosion increases in greater than arithmetic progression as the gradient is increased. A 3½ percent slope has been proven steep enough to lose 20 tons of soil per acre per year, and an 8½ percent slope sufficient to lose three times that amount. Experiment cited in Howe and Adams (1936, pp. 14–15).

Population: 10.0% of total in 1860, 10.6% in 1900, 11.4% in 1937.

	Density of farm habitations		
	1860	1900	1937
Sample strips	7.1	8.6	6.6
Entire region	6.6	8.0	5.8
Percentage error of samples	+7.6	+7.5	+13.8

For purposes of gradient analysis the land in the sample strips was classified according to steepness of slope. Four categories were recognized:

(a) level land: slopes less than 100 feet per mile (less than 2%)
(b) gradual slopes: slopes of 100 to 500 feet per mile (2 to 10%)
(c) marked slopes: slopes of 500 to 900 feet per mile (10 to 17%)
(d) steep slopes: slopes of more than 900 feet per mile (more than 17%)

Only level land can be considered free from erosion, although much of the gradually-sloping land has little of it. None of the steep land should be cultivated, according to Baker (1921).

In 1860, after 70 years of farming, unmistakable adjustments to gradient can be seen, density ranking roughly in inverse proportion to gradient, as shown in table 4. Level lands were carrying 1.5 times their areal share of population, whereas steep slopes supported only .4 of their allotted portion.

At the time of the 1860 census, decline in farming population was well under way, and the brief upward surge of 1870 to 1880 had not begun. When expansion did commence, it was not distributed evenly on the different types of slopes. Marked and steep slopes actually gained population while gradual and level categories lost (table 4). In fact, the year 1900 found steep slopes more densely populated than gradual ones. That viticulture was the major cause of such changes can be inferred from preceding discussions, and has been verified positively by comparing the figures for the sample strips of the plains, which have grown almost no grapes, with those for the entire sample area.

Following the influx of grape-growers, however, former tendencies reasserted themselves, and since 1900 areas of great slope have been the heavier losers.

Level Land and Farm Habitation Change. Although the more level land in the Canandaigua region has not always been the most favored type, it has generally been so, and the question arises as to whether such land has been favored regardless of other aspects of its physiography. Have the relatively level but high hilltops of the summit peneplain responded in the same way as the equally flat valley bottoms below them? Because the amount of level upland in the sample strips was too small to give satisfactory results, a different method was used. The two most typical plateau townships, South Bristol and Italy, were divided into three classifications; "upland flats," which are level to gradually sloping; "valley-bottom flats," which are similar; and "valley walls," almost all of which are classed as "steep" or "marked" in gradient. Table 5 shows the population changes on these three types, which together constitute 76 square miles of the Allegheny Plateau.

Even in 1860, when transportation was by horse and wagon, the high flats were so difficult of access and their thin, shaley soils so poorly drained that they carried only .8 of their share of the population of the plateau, while the more-favored valley-bottoms supported 2.1 times their areal quota. The years between 1860 and the present have greatly increased this differential, so that today, the valley-bottom index number is 2.3, and that of the uplands only .4. Although 32 people occupy each level square mile of the valley bottoms, only 6 occupy each similar area of the uplands.

Because two different sizes of high flats are found in the region of study, an attempt was made to determine whether large summit areas fared any differently than small ones. The Italy uplands are two in number, each containing about ten square miles, whereas South Bristol has six of them, each of which contains about one and one-half square miles. The small flats were found to have supported somewhat fewer people per square mile at each date, but more importantly, to have suffered heavy decline at an earlier date than did the large summits (before 1900 rather than after that date; table 6).

The earlier decline of the small areas is apparently related to the fact that fewer people can occupy them. An upland with only four families on it has greater difficulty combating isolation than one with several times as many occupants, and the loss of one or two families is a serious blow.

Combining the foregoing observations regarding the three types of relatively level land in the plateau, it is found that they have ranked in the following order as regards ability to hold population: first, valley-bottom flats; second, large upland flats; third, small upland flats.

Other Relationships between Slope and Farm Habitation Change. Two other problems were considered in connection with the question of gradient and farm habitation change, but really significant results are lacking. One was the matter of relative merit of lake slope as opposed to interior valley slope, and the other was that of north-facing versus south-facing valley walls.

Regarding the latter question, it can be said that neither slope supports a significant number of people and that even where use is made of the sides of valleys, farm buildings are usually located at the bottom. Hence the best approach to the problem would be through studies of land utilization.

The only steep slope which is intensively utilized over a large area is that on the northwest side of Naples village (fig. 2). This valley wall,

TABLE 5.

Farm habitation changes, selected physiographic areas.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire unit	76	480	490	273	+2	–44	–43	6.3	6.5	3.6	1.0	1.0	1.0	33	27	14
Upland flats	30	159	143	42	–10	–70	–74	5.3	4.8	1.4	.8	.7	.4	28	20	6
Valley walls	32	137	151	118	+10	–22	–21	4.3	4.7	3.7	.7	.7	1.0	23	20	15
Valley-bottom flats ..	14	184	196	113	+6	–42	–38	13.1	14.0	8.1	2.1	2.2	2.3	69	59	32

TABLE 6.

Farm habitation changes, large and small upland flats.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
All upland flats	30	159	143	42	–10	–70	–74	5.3	4.8	1.4	1.0	1.0	1.0	28	20	6
Large upland flats (Italy)	20	116	111	32	–4	–71	–72	5.3	5.1	1.6	1.1	1.1	1.1	28	21	6
Small upland flats (S. Bristol)	10	43	32	10	–26	–72	–77	4.3	3.2	1.0	.8	.7	.7	23	13	4

with a 50 percent gradient, faces southeast, and opposite it, on the other side of the village, is a similar slope which faces northwest. No other important differences between the slopes exist. The southeast-facing wall is completely covered with vineyards, rising terrace above terrace in the Italian and German manner, whereas the other slope is in full-grown forest. Probably 50 people per square mile are supported by the one, none by the other.

The other question raised in connection with slopes is that of the relative merit of lake slopes in comparison with those of interior valleys. Unfortunately there are only two good slopes reaching down to the lake, one in Middlesex Township and another opposite it in South Bristol, and the extraneous variables are numerous. The only generalization which can be made with assurance is this: that the interior valley walls have always been sparsely populated, and have declined at about the same rate as the general regions in which they lie, whether that be South Bristol or Middlesex, whereas the lake slopes, depending largely upon steepness of slope and thickness of soil, have either sustained their population well or have never been populated.

Naples Recessional Moraine and Farm Habitation Change. R. H. Whitbeck (1913) made an important study of the Driftless Area of Wisconsin, showing how the glaciation of Wisconsin had favored its agriculture. Opportunity is afforded in the Canandaigua region to study the influence of several glacial types upon habitation changes. Two brief studies have been made, comparing changes on the thick recessional moraine which blocked the southern end of the Canandaigua Valley with those on the very thin ground moraine of the valleys around it, and one comparing depopulation on the drumloidal hills of the plain with that of the more normal ground moraine on the opposite side of the lake.

The Naples recessional moraine (plate 3C) has been assumed to coincide with the area of Canadea soils in Naples Township (fig. 5). The remainder of the rural part of the township, except the low-lying, marshy alluvium at the southern end of Canandaigua Lake, has been used to exemplify thin ground moraine. The hummocky, swell-and-swale configuration of the recessional moraine is characteristic of such features everywhere, but it departs from typicalness in its drainage, which has been rather well integrated by north-flowing streams that drop at the rate of about 200 feet to the mile. The thin-tilled or "non-moraine" area has a similar stream pattern, but is less well-drained because of the West Hill sandy shales which lie just below the surface almost everywhere.

By 1860 the drift-built sector had a decided populational advantage over the "non-moraine," the density being 54.4 per square mile on the latter and only 15.9 on the former (table 7), but during the third quarter this differential was partially overcome by the erection of 41 new

TABLE 7.

The Naples moraine and farm habitation changes.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire unit	36	201	243	175	+21	–28	–13	5.6	6.8	4.9	1.0	1.0	1.0	29.7	36.4	27.2
Recessional moraine	13	133	134	96	+1	–28	–20	10.2	10.3	7.4	1.7	1.5	1.5	54.4	43.3	29.6
Thin-tilled (non-moraine) area	23	68	109	79	+60	–28	+16	3.0	4.7	3.5	.5	.7	.7	15.9	19.7	14.0

TABLE 8.

Glacial deposits of the plain and farm habitation changes.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire unit	39	254	314	285	+24	–9	+12	5.2	8.0	7.3	1.0	1.0	1.0	27.6	33.6	29.2
Drumloidal area	15	77	107	95	+39	–11	+22	4.5	7.1	6.3	.8	.8	.9	23.9	29.8	25.2
Ground moraine	24	177	207	190	+11	–9	+7	7.4	8.6	7.9	1.1	1.1	1.1	39.2	36.1	31.6

buildings on the non-moraine and only one on the moraine.[43] Incoming grape-growers were largely responsible for this change, but mixed farming may have been influential, judging from crop data contained in the state censuses of 1845 and 1855, which show that Naples was the best agricultural township in the plateau region even prior to the great spread of viticulture. Its farmers had almost as many acres of rye planted as did the other three townships together, and the yields per acre were outstanding. Furthermore, Naples topped all other townships in cheese production. Such mixed farming, later combined with grape culture, drew immigrants into many parts of the township; and because the moraine was already rather densely settled, increments were much greater on the thin-soiled non-moraine.

Since 1900, with the influx of new farmers stopped, both moraine and non-moraine have depopulated identically, preserving the proportions of 1900 and showing conclusively that the temporary advantages which the non-moraine enjoyed were the result, not of any differing ability to withstand depopulation, but rather of a variation in ability to attract compensating immigration. Today the moraine has densities slightly greater than the average for the entire Canandaigua region, plain and plateau included, whereas the thin-tilled hills and valleys of Naples are exceedingly sparsely settled.

Drumloidal Area versus Ground Moraine. Generally speaking, soil is the most important physical variable on the plain because physiographic differences are comparatively subtle there. Nevertheless, one striking topographic form is found, the drumloidal hills of central Canandaigua Township (fig. 2, plate 2B). For reasons not clearly understood they are absent across the lake in southern Hopewell and northern Gorham Townships, over which more level ground moraine, somewhat modified by glacial lake action, is spread.

The drumloidal area is a region of considerable surface configuration, like the plateau, but of little relief, like the plain; the ground moraine which was selected for comparison with it has little of either relief or surface configuration. Soils and accessibility of the two areas are comparable, and lake shore has been excluded from the computations for both types.

Differences in habitation density between the two kinds of landforms (table 8) were much smaller than those between the morainal types of Naples Township. Nevertheless the drumloidal area was so much less densely populated in 1860 that it registered large gains during the en-

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[43] Here the advantage of habitation figures over population figures becomes apparent. Although the population of the moraine declined from 54.4 to the square mile in 1860 to 43.3 in 1900, there was one more dwelling on the moraine at the later date.

suing 40 years, increasing 39 percent in contrast to the 11 percent increment on the ground moraine. Before the ice-moulded sector had attained the number of farm dwellings held by the more level area, however, decline set in and both regions depopulated proportionately, with the result that today the densities stand in the same proportions as they did in 1900.

The four glacial types studied compare as follows in habitation density today:

Ground moraine of the plain	7.9	habitations per square mile
Naples recessional moraine	7.4	" " " "
Drumloidal region of the plain	6.3	" " " "
Naples thin-tilled area	3.3	" " " "

As further summary, a final table (table 9) has been compiled showing changes in number of persons in each of the physiographic types studied. The categories are not, of course, mutually exclusive.

Soil and Farming Habitation Change

Three studies were made to learn whether there were any similarities between soil regions and those of farming population changes since 1860. One is a survey of relationships on the sample strips, another is an analysis of Naples Township, and a third examines a part of the Ontario Lowland where soil is the only important physical variable.

Study of the Sample Strips

The soils of the sample strips were grouped in three different ways in order to ascertain what influence, if any, they had on population changes. The first grouping is by soil types or units, the second by textures, and the third by series.

Analysis by Soil Types. Six different types of soil have areas of more than one square mile on the sample strips and hence were judged large enough to warrant separate analysis. Each of the soils was described in chapter III and will be discussed here only in relation to the sample strips. Table 10 shows the habitation and population data for the six important soil types and is followed by table 11, in which soil types have been ranked in descending order of habitation density for each of the three dates. In successive columns to the right are given the habitation density, the thickness of the A horizon, and the texture of the B horizon.

Close correspondence between thickness of A horizon and habitation density existed in 1860. Ontario fine sandy loam, which has not only a favorable A horizon but an unusually porous B horizon, was the only soil to sustain a denser population than its topsoil would lead one to expect. Although figures for total thickness of A, B, and C horizons, that is,

TABLE 9.

Summary of physiography and farm habitation changes.

Physiographic units (In order of decreasing population density, 1860)	Farming population per square mile					
	Number			Comparative rank		
	1860	1900	1937	1860	1900	1937
Valley bottom flats	71.1	60.1	24.4	1	1	9
Lake slopes of S. Bristol township	55.1	50.0	41.6	2	3	2
Level gradient	54.1	53.0	42.8	3	2	1
Naples recessional moraine	47.2	37.4	25.6	4	5	7
Gradual slopes	40.8	36.1	26.4	5	6	6
Ground moraine (most of Gorham and Hopewell townships)	39.2	36.1	31.6	6	7	3
Marked slopes	38.7	39.9	26.8	7	4	5
Ontario Lowland Province	35.5	35.3	27.6	8	8	4
Entire Canandaigua Region	34.7	33.2	22.5	9	9	10
Allegheny Plateau Province	33.9	31.5	18.0	10	10	11
Large upland flats	28.1	21.4	6.4	11	12	15
Upland flats (large and small)	28.1	20.2	5.9	12	13	16
Drumloidal area	23.9	29.8	25.2	13	11	8
Small upland flats	23.9	13.4	4.0	14	17	17
Plateau slopes (of lake and interior valleys)	22.8	19.7	14.8	15	15	12
Steep slopes	15.4	19.7	12.0	16	14	14
Thin-tilled (non-moraine) area (Naples township)	14.8	18.9	13.2	17	16	13

TABLE 10.

Soil type and farm habitation changes.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
All types	29.2	208	252	193	+21	–23	–7	7.1	8.6	6.6	1.0	1.0	1.0	37.6	36.1	26.4
Ontario loam	9.0	82	95	85	+16	–11	+4	9.1	10.6	9.4	1.3	1.2	1.4	48.2	44.5	37.6
Livingston silty clay loam	3.4	25	28	25	+12	–11	0	7.3	8.2	7.3	1.0	.9	1.1	38.7	34.4	29.2
Volusia loam [1]	5.1	22	28	17	+28	–39	–23	4.3	5.5	3.3	.6	.6	.5	22.8	23.1	13.2
Volusia silt loam ...	2.6	12	13	5	+9	–61	–59	4.2	4.6	1.9	.7	.6	.3	22.3	19.3	7.6
Volusia shale loam [2]	4.5	9	12	12	+33	0	+33	2.0	2.7	2.7	.3	.3	.4	10.6	11.3	10.8
Ontario fine sandy loam	1.2	8	12	13	+50	–8	+63	6.7	10.0	10.9	.9	1.0	1.7	35.5	42.0	43.6
Miscellaneous [3]	3.4	50	64	36	+28	–43	–27	14.7	18.8	10.6	2.0	2.1	1.5	77.9	79.0	42.4

[1] Includes Wooster stony silt loam of 1916 survey (Italy and Middlesex townships).
[2] Includes Lordstown stony silt loam of 1910 survey (Italy and Middlesex townships).
[3] Includes all types having an area of less than one square mile.

TABLE 11.

Farm habitation ranking of soil types, 1860–1937.

Soil types	Thickness of A horizon (inches)	Texture rank (B horizon)	Total thickness of A, B, and C horizons	Habitations per square mile					
				Number			Rank		
				1860	1900	1937	1860	1900	1937
Ontario loam	8–12	3½	"many feet"	9.1	10.6	9.4	1	1	2
Livingston silty clay loam	10	6		7.3	8.2	7.3	2	3	3
Ontario fine sandy loam	8–10	2		6.7	10.0	10.9	3	2	1
Volusia loam	10	3½		4.3	5.5	3.3	4	4	4
Volusia silt loam	5–8	5	"more than 3 feet"	4.2	4.6	1.9	5	5	6
Volusia shale loam	4–6	1	"less than 3 feet"	2.0	2.7	2.7	6	6	5

depth to bedrock, are fragmentary, those which are available show a correspondence in rank between thickness of A horizon and thickness of all unconsolidated material (table 11). Hence habitation density is related, not only to thickness of A horizon, but presumably to distance to bedrock as well.

Because the early settlers usually judged the quality of a soil in terms of the size of the trees which it supported (Cleveland, 1873), they settled on the thicker and better drained soils first, thus indirectly establishing a crude relationship between population density and thickness of A horizon. During the eighty years of settlement adjustment prior to 1860 this relationship probably was not altered. Even today it is clear, although somewhat weakened by two changes: the rise of the Ontario fine sandy loam from third rank to second and finally to first by virtue of a unique increase in habitations since 1900; and by the rise of the very poor Volusia shale loam from the bottom of the list to the next higher position. In both of these exceptional cases, good drainage and accessibility seem to have been responsible. In receiving an actual gain in habitation between 1900 and 1937, the Ontario fine sandy loam became unique. No other kind of soil, nor any category of gradient or physiography, shares this distinction.

The other relationship tested in table 11 is that between habitation density and soil texture. No correspondence in rank appears at any period.

Analysis by Soil Texture. Although no similarity between habitation density and soil texture appeared in table 11, it seemed possible that more generalized tabulation might reveal gross relationship, so another grouping was made.

This time all of the 23 soil types found on the sample strips, regardless of area, were put in one of the following texture categories: (a) coarse loams (the sandy, gravelly and shaley textures), (b) fine loams (the silty and clayey textures), (c) simple loams, (d) clays, or (e) muck. After tabulation, the clays and muck were eliminated because they totalled less than one square mile of area. The results are shown in table 12. Even on this generalized basis it will be seen that there was no relationship between rank of texture and rank of habitation density in 1860 or in 1900, but that by 1937 some correspondence was evident. Such relationship is largely a result of important increases on the shale (coarse) loams of the plateau valley walls between 1870 and 1880, followed by relative stability between 1900 and 1937 while the other textural classes declined considerably.

Hence in recent years a faint relationship between texture and population density has developed.

TABLE 12.

Soil texture and farm habitation changes.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
All categories	29.2	208	252	193	+21	–23	–7	7.1	8.6	6.6	1.0	1.0	1.0	37.6	36.1	26.4
Coarse loams [1]	3.5	17	33	31	+94	–5	+84	4.9	9.5	9.0	.7	1.0	1.3	26.0	39.9	36.0
Loams	11.9	98	114	99	+16	–13	+1	8.2	9.6	8.3	1.2	1.1	1.3	43.4	40.3	33.2
Fine loams [2]	13.1	93	110	60	+18	–45	–35	7.1	8.4	4.6	1.0	1.0	.7	37.6	35.2	18.4
Miscellaneous [3]	.7	0	3	3	0	0	0	0	4.3	4.3	0	.4	.5	0	18.1	17.2

[1] Sandy, gravelly and shaly loams.
[2] Silty and clayey loams.
[3] All types having a total area of less than one square mile (specifically, clay and muck).

TABLE 13.

Soil series and farm habitation changes.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
All series	29.2	208	252	193	+21	–23	–7	7.1	8.6	6.6	1.0	1.0	1.0	37.6	36.1	26.4
Ontario	10.4	91	112	98	+23	–13	+8	8.8	10.8	9.4	1.3	1.3	1.5	46.6	45.4	37.6
Livingston	3.4	25	28	25	+12	–11	0	7.3	8.2	7.3	1.0	.9	1.1	38.7	34.4	29.2
Volusia [1]	13.2	59	74	40	+26	–46	–32	4.5	5.6	3.0	.6	.6	.4	23.9	23.5	12.0
Miscellaneous [2]	2.2	33	38	31	+20	–22	–7	15.0	17.3	14.1	2.1	2.0	2.1	79.5	72.7	56.4

[1] Includes Wooster and Lordstown of Italy and Middlesex.
[2] Includes all series having an area of less than one square mile.

Analysis by Soil Series. Discussion in preceding sections has shown that there was strong relationship between population and thickness of A horizon, although this has weakened somewhat in recent decades; also that an almost insignificant association between habitations and texture has become evident in late years.

To round out this study of the sample strips the soils were reorganized for a third time, according to series. Only three of them have areas greater than one square mile. These are shown in table 13, ranked in the descending order of thickness.

At each of the three dates population density ranked the same as soil thickness, and the differential is much greater today than it was in 1860, as shown by the change in indices. Hence the study by series and the study by texture each corroborate the findings of the study based upon soil type or unit.

Study of Naples Township

In an earlier section the recessional moraine of Naples Township was seen to have begun the period under examination with more than three times the population density of the surrounding "non-moraine," an advantage which was reduced by one-third as a result of the late 19th century immigration. Because the recessional moraine is composed of two soil types which have in common great thickness of parent material, but in contrast very different textures, they were analyzed separately, and compared with the neighboring thin-tilled soil types, of which there are three (Volusia loam, shale loam, and silt loam).

The two morainal soil types are the Canadea gravelly loam, with a seven-or-eight-inch A horizon and a B horizon containing considerable interstitial sand; and the Canadea silt loam, with a slightly thicker A horizon (8 to 10 inches) and considerable silty and clayey interstitial material in both A and B horizons. Thus drainage in the silt loam is only fair, and the soil is subject to considerable erosion.

Table 14 shows that there have been great differences in the number of people on the various soil types of Naples Township. Section A shows that here, as on the sample strips, the thicker series has had the denser population. Here, however, the differential has declined somewhat since 1860. The great viticultural immigration to Naples, because it took little cognizance of soil conditions, tended to populate the thin soils more than had been the case on the sample strips.

Section B of the table shows that, as is to be expected, texture and population had little in common, but that there was an increasing tendency towards relationship, as revealed by the following summary.

TABLE 14.

Soil and farm habitation changes, Naples township, 1860–1937.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire unit	36	201	243	175	+20	–27	–12	5.6	6.7	4.9	1.0	1.0	1.0	29.7	28.1	19.6
A.																
Canadea series	13	133	134	96	+1	–28	–20	10.2	10.3	7.4	1.7	1.5	1.5	54.4	43.3	29.6
Volusia series	23	68	109	79	+60	–28	+16	3.0	4.7	3.5	.5	.7	.7	15.9	19.7	14.0
B.																
Gravelly loam	8	93	93	70	0	–25	–25	11.6	11.6	8.8	2.0	1.7	1.8	61.5	48.7	27.2
Shale loam	9	17	53	48	+212	–9	+182	1.9	5.9	4.7	.3	.8	1.1	10.1	24.8	21.2
Loam	8	31	30	18	–3	–40	–42	3.9	3.8	2.3	.7	.6	.5	20.7	16.0	9.2
Silt loam	11	60	67	39	+12	–42	–35	5.5	6.1	3.5	1.0	.9	.7	29.2	25.6	14.0

TABLE 15.

Soil type and farm habitation changes, Ontario plain.

	Area	Thickness of A horizon	Farm habibtations												Farm population density		
			Number			% Change			Density			Index					
	sq. mi.	(inches)	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire unit	40.2	–	257	322	279	+25	–13	+9	6.4	8.0	6.9	1.0	1.0	1.0	33.9	33.6	27.6
Dunkirk clay	9.5	7	49	61	48	+24	–21	–2	5.1	6.4	5.0	.8	.8	.7	27.0	26.9	20.0
Dunkirk silty clay loam	15.0	8	89	110	99	+24	–10	+11	5.9	7.3	6.6	.9	.9	.9	31.3	30.7	26.4
Ontario loam	15.7	8–12	119	151	132	+21	–13	+11	7.6	9.6	8.4	1.2	1.2	1.2	42.3	40.3	33.6

	Textural rank	Habitation density 1860	1900	1937
Gravelly loam	1	1	1	1
Shale loam	2	4	3	2
Loam	3	3	4	4
Silt loam	4	2	2	3

In Naples Township, as on the sample strips, there has been a tendency for change from correlation of population density with thickness of A horizon to one with texture of the same stratum.

In passing, it should be said that Naples Township affords striking illustrations of the many interesting populational details which are apt to go unrevealed in census reports. Thus, this area of forty-one square miles, if studied from census reports, would show population density changes as follows:

1860	30.1 persons per square mile
1900	32.7 " " " "
1937	21.3 " " " "

Actually there were, in clearly defined physical units, densities as different as these:

1860	17.5 to 61.5
1900	18.1 to 48.7
1937	8.8 to 27.2

Study of Part of the Ontario Plain

The extreme northern part of the Canandaigua region is very uniform topographically, and thus the soils become the important physical variable. For this reason, and also because much of the soil belongs to the Dunkirk series, which has not elsewhere been related to changes in the distribution of habitations, Dunkirk soils of the Ontario Plain are analyzed in the following paragraphs.

They consist of two textural types, the Dunkirk clay, derived from fine glacio-lacustrine sediments, and from which water tends to escape only with difficulty; and Dunkirk silty clay loam, which is somewhat better drained in both A and B horizons. To them, for comparative purposes, has been added the Ontario loam, the other important soil type on the Ontario Plain.

A moderate population differential exists between each of the three types (table 15) in spite of the absence of contrasts in topography and accessibility. Because the ranking of both texture and thickness are identical for these soils, habitation densities correspond to both. Differentials have not changed in magnitude importantly since 1860, as shown by the indices.

Accessibility and Farming Habitation Change

The two most important aspects of local accessibility namely, presence of paved roads and proximity to town, have been studied briefly and will be commented upon. In addition, an analysis of the changing distance of farm population from the lake has been included in this section, although it is recognized that not only accessibility, but also micro-climate has been important in influencing the shift.

Quality of Roads as a Factor. The history of road improvement here has been long. By 1860, which was the beginning of the third quarter, the days of turnpikes and plank roads had gone, and gravel was being applied to the main thoroughfares. Shortly after the opening of the fourth quarter the first macadam was applied, and at present concrete pavement is common on through highways. There is today one mile of "surfaced" road (that is macadam or concrete) to each 2.7 square miles of area (fig. 12).

The road pattern at present is essentially the same as it was 80 years ago. Only a few isolated connecting roads in the back country have been abandoned, as a result of depopulation and the speeding-up of transportation.

It is a simple matter to determine population densities along the present-day paved and unpaved (i. e., surfaced and unsurfaced) roads and thus to evaluate road quality as an influence upon contemporary population densities. In order to project this analysis into earlier periods, however, it has been assumed that the routes on the sample strips which are surfaced today have been the best roads ever since 1860. Certainly in very few instances has the relative quality of a thoroughfare changed significantly since that date.

With this assumption as basis, an analysis was made of population changes on the sample strips since 1860 in relation to present-day road condition. Table 16 reveals that in 1937 paved roads supported more than twice as many families as did unpaved roads, and that furthermore, even in 1860, the roads later to be paved had almost as great a populational advantage over those not to be paved as they have today. Evidently the gravel and plank thoroughfares of 1860 were only slightly less superior to their contemporary natural roads than present-day macadam and concrete are to the coexistent gravelled and unimproved roads.

The fact that there was less differential between the two kinds of roads in 1900 than at either of the other two dates reflects greater scattering of the population at that time, when upland flats had not yet been severely depopulated, but steep slopes had already been settled.

Distance from Village as a Factor. In an attempt to answer the question of how far away from a village the population density is affect-

TABLE 16.

Road type and farm habitation changes.

	Length, linear miles	Farm habitations: Number			% Change			Density			Index			Farm population density		
		1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
All types	48.5	208	252	193	+21	–23	–7	4.3	5.2	4.0	1.0	1.0	1.0	22.8	21.8	16.0
Roads paved in 1937	12.5	90	104	95	+16	–9	+6	7.2	8.3	7.6	1.7	1.6	1.9	38.2	34.9	30.4
Roads unpaved in 1937	33.2	115	146	98	+27	–39	–15	3.5	4.4	3.0	.8	.9	.8	18.6	18.5	12.0
Roads abandoned in 1937	2.8	3	2	0	–33	–100	–100	1.1	.7	0	.3	.2	0	5.8	2.9	0

TABLE 17.

Distance from town and farm habitation changes.

	Area sq. mi.	Farm habitations: Number			% Change			Density			Farm population density		
		1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937
Entire unit	48	339	453	376	+32	–17	+10	7.1	9.4	7.8	37.6	39.5	31.2
Land within ½ mile of village ..	10	88	148	126	+68	–15	+43	8.8	14.8	12.6	46.6	62.2	50.4
Land ½ to 1 mile	16	122	151	122	+26	–19	+9	7.0	9.4	7.6	37.1	39.5	30.4
Land 1 to 1½ miles	22	129	154	128	+19	–17	–1	5.9	7.0	5.8	31.3	29.4	23.2
Entire Canandaigua region	298	1988	2359	1694	+19	–28	–15	6.7	7.9	5.7	35.5	33.2	22.5

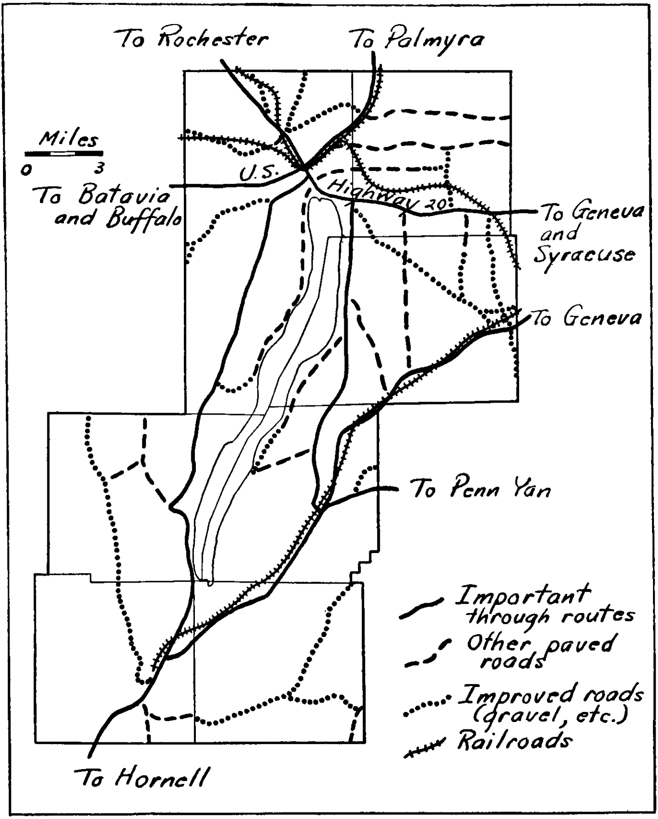

FIG. 12. Transportation map, Canandaigua region.

ed by that village, belts one-half mile wide were drawn around each of the four leading villages and the population at each different period within these one-half mile belts was computed (table 17). By comparing these figures with those of the area as a whole, it was apparent that the half-mile zone had greater than average density, and that the differential has increased at each period.

The second belt plotted around each village included all land between one-half mile and one mile from the edge of town. At this distance differentials were less, but still significant (table 17). Here, too, they increased from 1860 to 1900, and from 1900 to 1937.

Between one mile and 1½ miles from town, urban influence was ineffective until after 1900, but by 1937 a slight response was observed, as shown in table 17. Hence the radius of village influence has increased.

It was also found that only the two largest towns, namely Canandaigua (7,541 people) and Naples (1,070) affected their environs importantly, and that Naples, although the smaller town, had the larger sphere of influence. This is because viticulture is more dependent upon proximity to shipping point or winery than are the general types of agriculture found around Canandaigua.

Distance from Lake as a Factor. Canandaigua Lake influences the farming population of the area in two ways: first, it tempers the climate, thus prolonging growing season and benefiting agriculture; second, its valley has somewhat better roads than does the back country, because of lower elevation and much heavier traffic during the summer season. Hence most people have chosen to dwell rather near the lake, a preponderance which is increasing (table 18). Whereas the median distance of the land in the sample strips is 3.12 miles from the lake, the median distance of population was 2.84 miles in 1860, 2.56 in 1900 and 2.37 in 1937.

Although distance from lake has declined consistently over the area as a whole as shown in table 18, the plains portion of the sample strips has reacted in exactly the opposite direction, as shown in the following analysis of median distance of farms from lake:

	Miles		
	1860	1900	1937
Plains samples (Canandaigua and Gorham)	2.23	2.78	2.62
Plateau samples (South Bristol and Middlesex)	2.22	1.34	1.50

On the plain the surrender of farm land to summer cottagers has helped to swing the center of populational gravity landward, while elsewhere heavy interior depopulation has pushed the median towards the lake shore.

Changing Distribution of the Summer Cottages

Entirely missed by the Federal Census is that great group of transient but important residents of the Canandaigua area, the summer folk. At any time between Memorial Day and Labor Day there are thousands of them, employing laborers, paying taxes, and buying almost everything from food to farms. They double the population of at least one township[44] during "the season," and populate an entire village which ranks

[44] Gorham has approximately 461 permanently-occupied dwellings and 469 summer cottages.

TABLE 18.

Distance from lake and farm habitation changes.

	Area	Farm habitations												Farm population density		
		Number			% Change			Density			Index					
	sq. mi.	1860	1900	1937	1860–1900	1900–1937	1860–1937	1860	1900	1937	1860	1900	1937	1860	1900	1937
Entire unit	29.2	208	252	193	+21	–23	–7	7.1	8.6	6.6	1.0	1.0	1.0	37.6	36.1	26.4
0 to 1 mile	4.0	22	41	38	+86	–7	+73	5.5	10.3	9.5	.7	1.1	1.4	29.2	43.3	38.0
1 to 2 miles	5.0	46	56	44	+22	–21	–4	7.2	11.2	8.8	1.3	1.3	1.4	48.8	47.0	27.2
2 to 3 miles	5.0	43	52	39	+21	–25	+19	8.6	10.4	7.8	1.9	1.2	1.2	45.6	43.7	31.2
3 to 4 miles	5.0	30	33	22	+10	–33	–27	6.0	6.6	4.4	.8	.8	.7	31.8	27.7	17.6
4 to 5 miles	4.0	36	37	24	+3	–35	–33	9.0	9.3	6.0	1.3	1.2	.9	47.7	39.1	24.0
5 to 6 miles	3.0	15	17	15	+13	–12	0	5.0	5.7	5.0	.7	.7	.8	26.5	23.9	20.0
6 to 7 miles	3.0	12	13	10	+8	–23	–17	4.0	4.3	3.3	.6	.5	.5	21.2	18.1	13.2
7 to 8 miles	.2	4	3	1	–25	–67	–75	20.0	15.0	5.0	2.0	1.0	1.0	106.0	63.0	20.0

as the third largest in the area.[45] They increase the entire population of the region by 24 percent, and the rural population by 49 percent, not including the hundreds of people who live in tents, tourist cabins, trailers, and hotels during the summer months.

More factors than the beauty of the clear blue water backed by rolling slopes or rugged hiles (plate 3D) are necessary to explain this great concentration of recreation seekers. The elongated shape of Canandaigua Lake has resulted in a shoreline of 33.7 miles, more than twice the length it would have if the lake were circular. Within a 30-mile radius of the lake are a total of more than 600,000 people (ten different states of the Union have less). Largest of the urban centers is Rochester, only 25 miles from the northern end of the lake, a city of 328,000 people with standards of living somewhat above the national average. A modern concrete highway, four lanes wide in places, as well as a railroad and a bus line, link Canandaigua to Rochester.

In spite of many favorable qualities, the lake is not ideal for the development of great cottage densities, for shale bluffs rise so steeply from the water along some miles of frontage that cabins must either be perched at the top of them or utilize the very small bits of alluvium at their bases. In an attempt to gain isolation and a picturesque setting on the shores of this densely populated lake, a level site for at least one cottage has been blasted from a rocky protrusion (plate 4B). Beaches almost everywhere are composed of chips of shale, and while not so pleasant for bathing as those of quartz sand, are nevertheless quite satisfactory except where shore currents have placed the fragments on edge. A further disadvantage lies in the competition for resort business which is offered by several other Finger Lakes and by Lake Ontario.

By 1876 the advantages of seasonal living in this scenic and accessible basin were recognized and resort development began, aided by regular steamboat connections on the lake itself, by railroad, and later by a trolley line overland from Rochester. By 1900 there were probably 150 summer cottagers in the area (in any case not more than 180 nor less than 50).

Partly because of greater accessibility in a period of slow travel, the western side of the lake had 50 percent more cottages than the eastern side, and the northern end a few more than the southern end in 1900. Even before automobiles became popular, and at about the period when the main roads were being paved, cottage construction entered its boom period. By 1911 Gorham Township had an average of one cottage to every 500 feet of shoreline.

Today there are more than a thousand cottages along the lake shore, an average of one every 174 feet, in spite of several miles with few cot-

[45] Cottage City, in Gorham Township, has 162 dwellings.

tages or none at all. Cottage densities can be summarized by townships as follows:

	Number of cottages	Number of miles of shoreline	Number of feet per cottage
Canandaigua	308	11.2	190
Gorham[1]	307	7.4	127
Middlesex	110	7.2	346
South Bristol	123	7.3	312
Italy	4	.5	660

[1] Cottage city, with 162 cottages, not included.

The northern half of the lake has twice as great densities as the southern half, which is from five to 15 miles farther from Rochester and has a much greater proportion of shoreline bluffs.

Canandaigua vacationists enjoy arguing the merits of the eastern shore versus the western shore as the ideal cottage location. Judged by the number of people who have settled on each side the decision goes conclusively to the "east-siders," for on that side there is a cottage every 143 feet, while on the west side dwellings are scattered at an average interval of 242 feet. Because any given place on the eastern shore is only a mile or two farther from Rochester than the corresponding point on the west side of the lake, and because the concrete environmental qualities are quite similar on both sides, one wonders whether such abstract factors as the beauties of the sunset and the view of the lofty Bristol Hills from the east side have really influenced population densities.[46] Easterliness is, however, less important than northerliness.

Cottages in the Back-Country. Partly for esthetic reasons, but largely because of cheaper real estate, many resort cottages have been built back in the hills, away from the lake. This movement did not gain importance until the economic depression of the 1930's, but already there are 38 of these isolated cottages. Thirty-five of them are in the regionally-famous Bristol Hills section of South Bristol Township and the southwest corner of Canandaigua Township. Of this 35, 20 are in valley-bottom locations and only 10 are on the lofty flat tops which provide such fine panoramic views, but are apt to be inaccessible in wet weather and in winter. Twenty-six of the 35 are in the extreme western part of the area, mostly in the Frost Hollow district, and only four are on the lake slopes. This, too, is the result of accessibility, for increasing distance from the lake means decreasing distance from Rochester, and the back-country cabin owners are more apt to be week-enders or over-night commuters than season-long occupants.

[46] No investigation of comparative real estate costs was made, nor of a possible tendency for west-siders to own wide beach frontages which they have not cared to subdivide.

Of the 35 hill-country resort cabins only three are on pavement, but all are within 1½ miles of it. At least half of them were farmhouse sites in 1900, a fact which helps to explain why 33 of them are on the poor Volusia soils and only two on the better Ontario soil.

The three remaining hill cabins are widely separated, two being in Naples Township and only one on the east side of the lake, in Italy. The great hills and valleys of Middlesex and Italy could support hundreds of such cottages in comparative isolation, and probably will do so as the best sites on the western side of the lake are taken, as automobile travel speeds up, and the working day is abbreviated. The popularity of hill-country cabins will increase in the future, somewhat as that of lake cottages has done in recent decades. As farm population continues, the resort development of the area can proceed almost indefinitely.

Changing Distribution of the "Urban"[47] Population

Because changes in urban population affect such small areas they do not constitute an important part of this study. But they deserve mention because the villages and cities of the Canandaigua region contain more than half the present population. In 1930 the area had 16,623 people, of whom about 10,003 were "urban" and 6,620 were "rural." On the basis of population changes since 1860, the villages can be divided into three groups.

The first category is that of agglomerations which gained population during each of the last two quarters. The incorporated city of Canandaigua with 7,541 persons or 46 percent of the total, is the only urban unit in this class. In contrast to all other areas studied, except that of the Ontario sandy loam, the site of this city gained population during each of the last two quarters, and in fact has never lost population during any decade since its history began. Growth has not, however, been continuous. Census figures since 1860 show that there have been two great waves of increase separated by periods of stagnation. The first wave, between 1870 and 1880, is adequately explained by the immigration of that period. More than one-third of the regional increase of that decade was localized in Canandaigua city. Three new railroads, within 25 miles of the city, were completed at that time, and several new manufacturing enterprises attempted.

Another surge, from 1900 to 1910, increased the Canandaigua population by 17 percent, yet was not accompanied by increases in any whole township in the region, nor even in the next largest village, Naples. Rapid increase in resort business, development of the Lisk Enamelware Manufacturing Company and of the McKechnie Brewing Company were important factors.

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[47] The term "urban," as used here, includes all agglomerations, even hamlets.

Appoximate stability has characterized the population since 1910, although the decade 1920 to 1930 brought slight increases, based largely upon resort activity.

The second category of urban population is the group of villages which show, like the first category, a net gain in population between 1860 and the present but which lack the populational increase of 1900 to 1910. Naples is the type example. It shows a definite surge between 1870 and 1880, but approximate stability ever since. Hence the curve for this village and of others in the group is more like the curve for rural population than like that for Canandaigua city. Included in this group, in addition to Naples (population 1,070 in 1930), are Gorham with 400 people,[48] Middlesex with 250, Cheshire with 150, and Bristol Springs with 50.

The third category is made up of the agglomerations which have remained stable, or have declined, since 1860. It includes Chapin, with about 125 people; Hopewell Center with about 70; Centerfield, with 50; Italy, 35; and Italy Hill, with only about 20 inhabitants. These are the hamlets whose reason for existence almost disappeared with the coming of the automobile. At best they are to the families of the neighborhood what the corner store is to the city resident. With but one exception (Chapin), they are the smallest agglomerations in the region. Situated on both plain and plateau, they indicate that their character is more a function of size than of location.

Thus it can be seen that population changes in villages and cities are more a function of size of village than of geographical location.

VI. RECAPITULATION AND SUMMARY

This study has described and analyzed the changes in number and distribution of people inhabiting the Canandaigua basin and some of the most important findings will be recapitulated here.

There are many similarities between the Indian occupance and that of the whites, even though the Indians were only one-tenth as numerous as their successors. Early Seneca history was marked by abandonment of the Allegheny Plateau in favor of the Ontario Plain, probably because of better agricultural conditions on the lowland. Indian population, even as that of the whites, had its periods of marked decline, although they were the result not so much of migration as of the Colonial Wars. At least one-half of the Senecas lived, as today almost half of the whites do, in a single village at the foot of Canandaigua Lake. The village was so large that if it were recreated today it would rank as the third largest agglomeration in the region.

[48] This figure and the following ones are only approximate, being based upon habitation counts.

The history of white settlement does not include a period of active competition with the Indians, for most of the aboriginals were driven westwards ten years prior to the arrival of the first New Englanders. Impopulation, begun at Canandaigua village, spread southward, the dates of settlement of most areas being a function of elevation above sea level, thus making the map of population at the close of the first quarter (1820) resemble a crude hypsometric map. Expansion from original township nuclei tended to be contiguous on the plain and scattered on the plateau, for on the latter the distribution of good farm land was spotty. The land settled first in about half of the townships had strategic significance, as proven by a tendency for original sites to maintain economic focality down to the present.

During the last half of white population history certain areas have been more favored than others. Thus, depopulation of the Ontario Lowland has been less rapid than that of the Allegheny Plateau. No other generalizations regarding large areas can be made. It was found impossible to construct an isarithmic map of either habitation or population change, because of the extremely spotty distribution of these phenomena and the absence of transition zones, facts which reflect complex environmental backgrounds on the plateau and widespread uniformity on the plain.

There are, however, many scattered points which fared better than average throughout either the third or fourth quarters (1860–1900, 1900–1937) or both. During the third quarter these were areas of actual net gain in habitations whereas in the fourth quarter they have been merely areas of minimum loss.

The localities of unusual third-quarter increment include part of the environs of the three largest towns and several sites with an unusual combination of viticultural advantages, such as open-valley topography with significant south-facing slope components less than five miles from an important town. The few remaining areas are based upon miscellaneous qualifications.

During the fourth quarter the only area which has been favored because of proximity to an "urban" site has been that around Canandaigua. In addition, some of the viticultural sites which had been important gainers during the preceding quarter have remained, by virtue of only slight losses, among the favored sites. Good roads were an additional asset shared by many, but not all, of these little-depopulated areas. But it appears that on the plateau each township tended to have a single area which was superior even if only in comparison with the poor land around it. Very few of the especially favored local areas were on the plain, because population changes there tended to be as uniform as the topography.

It is not easy to generalize on the characteristics of sites which suffered greater-than-average loss of population. During the third quarter most of these were localities of low accessibility, poor soil and steep slope, but a varying combination of these three items, rather than the predominance of any one, was responsible. Throughout the last quarter all the districts of maximum loss have been on plateau uplands, some of them being almost barren today after having supported as many as thirty or forty persons to the square mile.

Thus identification and study of areas of radical tendency showed that distance from town, quality of road, degree and direction of slope, type of soil, and several miscellaneous factors were involved. The next step was the evaluation of the relative importance of each of these factors by measuring the population changes which took place upon them.

The density of rural population in the Canandaigua region ranks in inverse proportion to steepness of land, level land having more than three times as many people per square mile as has steep land. But differences in gradient are less important today than they were in 1860, thus running contrary to the general principle that as civilization progresses, the returns, from the farming of steeper lands diminish. This exception is the result of the spread of viticulture after 1860.

Not all level or gently sloping land is densely populated, however. The summit peneplain remnants, with their poorly drained soils and their steeply-pitched connecting roads, have only one-sixth as many people to the square mile as have the valley bottoms below them, and only one-third the density found on the slopes which separate the uplands from the bottoms. This is true today in spite of the fact that the ratio of people to area on the valley floors has dropped from twice that of the plain to approximately the same number. Furthermore, the small peneplain remnants have somewhat smaller densities than the larger ones.

The four different types of glacial deposits in the region support widely differing population densities. Until very recently the thick, well-drained recessional moraine at the southern end of Canandaigua Lake, which played such an important part in the physiographic evolution of the lake, has supported more people per unit of area than has the ground moraine or the drumloids of the plain, and many more than the very thin-tilled areas characteristic of the plateau. Here, then, is an area on the plateau which has had a much denser population than that of the lowland.

The distribution of people throughout the Canandaigua basin is a function of thickness of A horizon of the soil, and bears only slight relationship to the texture of that soil. These statements apply today with slightly less force than they did in 1860. The Volusia soils, with eluviated zones averaging only four to eight inches in thickness, have less than one-half the population density of the Ontario soils, which are characterized by A horizons eight to ten inches thick. The same relationships apply, to almost as great a degree, to soil types or units.

Road condition, too, has a direct effect upon population density. Those thoroughfares which are surfaced today have always had at least twice the population of those at present unsurfaced. As the pavement is actually applied these differentials are increasing somewhat.

The presence of a village of more than five hundred people induced greater than average population densities to a distance of one mile until 1900, and to one and one-half miles since that date. Maximum effect was found in 1900, after the markets and transportation facilities represented by the agglomerations were well developed, but before the automobile had disseminated the influence of these factors over very large areas. Villages with fewer than five hundred people have exerted no influence during either period.

Finally, in a general way distance from lake bears a direct relationship to population density, for the median distance of farms from Lake Canandaigua has been constantly declining throughout the region as a whole. On the plain, however, where the tempering effect of water on climate is minimal and the opportunity to sell farm land for recreational uses is maximal, farms have gradually retreated from the shore.

Thus each of the factors analyzed correlates either directly or inversely, at least in a general way, with population density. The factors road type and distance from lake are increasing slightly in importance, while the others remain static or decline somewhat.

The first summer cottage in the Canandaigua basin was built about 1876, and since then seasonal dwellings have become so numerous that when all of them are occupied the population of the region is increased by 24 percent, the rural population by 49 percent, the number of people in one of the townships is doubled, and an entire village, desolated in winter, becomes the third largest town in the region.

Among the factors which give such magnitude to this seasonally-pulsating population change are the unusually long shoreline of attenuated Canandaigua Lake, and the presence of more than a half-million people within a distance of thirty miles. Almost two-thirds of the cottagers live around the northern half of the lake, in order to be near their permanent residences and to avoid the steep bluffs which flank so much of the southern half.

In recent years several additional cabins have been built in the hills of South Bristol, several miles from the lake, where distance from Rochester is at the minimum consistent with refreshing landscapes and isolation. Few of these cabins are on hilltops where the scenery is best, but most of them are on the valley bottoms, which are more accessible;

few of them are on pavement which can be travelled easily in all kinds of weather, but all are within one and one-half miles of it. The potential increase in the number of these habitations is almost infinite, whereas that of the lake-front cottages is limited by the already dense population, the unwillingness of many lake-front landowners to subdivide their property, and the presence of several miles of shoreline bluffs.

The only city in the region is Canandaigua, with 7,541 persons, or 46 percent of the total, although the presence of several villages and hamlets brings the number of people living in agglomerations to 60 percent. Based upon population changes, these towns fall into three classes: those which gained during both the third and fourth quarters; those which gained only during the third quarter; and those which gained during neither. Canandaigua is the only representative of the first class; several villages with populations ranging from 50 to 1,000 inhabitants constitute the second group; and hamlets having from 20 to 125 people comprise the third. Since there is little relationship between the locality of a village and the class in which it is found, it can be said that "urban" population change is a function of size rather than of direct environmental qualities.

In conclusion it should be stated that most, but not all, of the important findings of this study would have been impossible without the series of maps showing the location of individual habitations at various dates. On the other hand, not all of the possibilities of these maps have been realized. They are eminently suited, for example, to exploration of population changes by the method of correlation coefficients, too long neglected by geographers.

Regarding the broad problem of decadence in the Canandaigua region, it can be said that the principle of comparative advantage, operating in a region which has only limited physical assets in the usual sense of the term, holds both the explanation of the past and the key to the future. The once glorious farm lands of the basin were fertile and rich only in comparison with the inadequate agricultural resources of New England. As the rolling, calcareous prairies of the Midwest were turned to the plow, the comparative advantage of upper New York State in the production of grain and meat was largely neutralized, and later, when the route to the Midwest moved northwards onto lower, more level stretches of the Ontario Plain, decline set in.

The region has been able to offer two major challenges to decadence, each based upon an unusual economic advantage. One, her steeply-sloping grape land, was developed in the 1870's; another, her inland lake with its attractive scenic setting, came into productivity shortly after 1900. Future decades may bring some new activity which the lake or plain or hills of the Canandaigua region can turn to new advantage.

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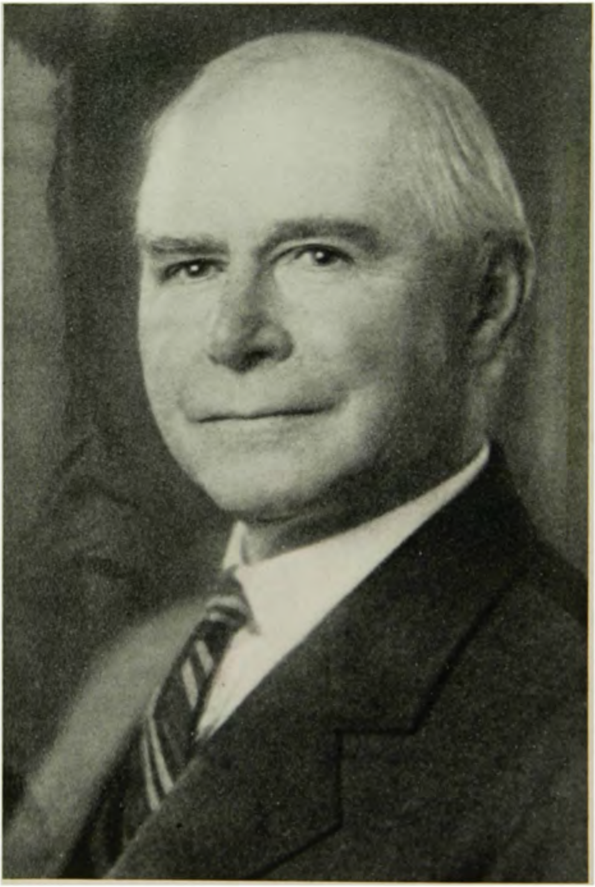
PLATE I



MILTON S. BAXTER
1856–1938

THE BOTANICAL SECTION OF THE ACADEMY

CELEBRATED ITS SIXTIETH ANNIVERSARY ON

APRIL 13, 1941

THIS NUMBER OF THE PROCEEDINGS IS DEDICATED

TO THE BOTANICAL SECTION

AND

TO THE MEMORY OF

MILTON S. BAXTER

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
VOL. 8, NO. 4, PP. 123-232 SEPTEMBER 10, 1942

EARLY BOTANISTS OF ROCHESTER AND VICINITY AND THE BOTANICAL SECTION, PART II[1,2]

ANNA B. SUYDAM[3]

CONTENTS

ILLUSTRATIONS

MILTON S. BAXTER
1856–1938

In the passing of Milton S. Baxter his family, his friends, and the community lost a unique and lovable character, and to the Rochester Academy of Science, particularly to the Botanical Section, the loss seems irreparable. He was for forty-five years a member of the Botanical Section of the Academy of Science, for thirty-two years its recorder, instructor and guide, and for ten years the curator of the Academy's

[1] Received for publication December 15, 1941.

[2] The article by Florence Beckwith, of the same title, Proc. Roch. Acad. Sci. 5: 39–58 (1912) is considered as Part I of this series.

[3] When the Botanical Section decided to prepare biographical memoirs of its most prominent deceased members and also a brief review of the Section to commemorate sixty years of its life, the author was asked to do the work. It would have been impossible except for the splendid assistance of the members of the Section. Special gratitude is due Dr. Grace A. B. Carter and Mrs. William L. G. Edson for their tireless and unfailing efforts. We are very happy that through the kindness of friends we have been able to secure pictures of the botanists of whom sketches are given.

Herbarium and of the Herbarium of the University of Rochester. He was a botanist unparalleled in knowledge of the flora of Rochester and adjacent areas.

Milton S. Baxter was of Scotch lineage. Two of his ancestors were signers of the Mayflower compact, and one, the Hon. John Carver, was the first governor of the Plymouth Colony, 1620–21. His paternal ancestor, Thomas Baxter, came from Scotland to Yarmouth, Massachusetts in 1679, and here he married Temperance Gorham. His great-grandfather John Baxter, of Sandisfield, Massachusetts, enlisted in the Revolutionary Army in November, 1775, and served until discharged in 1780. In 1813 the family was living in Westmoreland, Massachusetts, and from there his grandfather, Stephen Baxter, travelled to Western New York where he purchased a farm at Union (now Hamlin). He returned to bring his family and with them he brought two great iron cauldrons to use at a large deer lick he had found on the farm. By means of a caisson he deflected the water from a nearby stream and brought it down to his kettles. He heated the water with wood cut from his clearing and thus the Baxter Salt Works were formed. Men came on horseback from Monroe, Livingston and Orleans counties to carry home salt. This continued until the Erie Canal was completed, when the canal boats brought salt from Syracuse; the Baxter Salt Works then went out of business.

Milton S. Baxter was born in his grandfather's log cabin in Union on February 18, 1856. His father, James Harris Baxter, had married Esther Angelina Knowlton, who, with her father, emigrated from Rome, Massachusetts to Le Roy, New York, in an ox cart. James Baxter was a farmer and at twenty-one he took full charge of the farm from his father, who retired at forty-five. The farm was two miles north of Walker and two miles south of Lake Ontario. From here Milton Baxter and his brother Florus attended the North Star school which was only a quarter of a mile from their home. Years before, it had been known as the "Baxter School." One Joel Baxter, a cousin, would drive "to town" to get a newspaper and upon his return the neighbors would gather in this building to hear the paper read. Hence the name, Baxter School. In 1861 the family moved to Kane's Corners, now Walker, and James Baxter opened a grocery store. Here the boys attended the Rising Sun school. It was about three-quarters of a mile away and the road, following the vagaries of a brook, was as full of curves and twists, as the brook was full of good reasons to linger and loiter. One lovely spring morning their mother said: "Don't be late tonight. Come straight home." And they did, but in order to do so they had to ford the stream three or four times, and so arrived home more wet and bedraggled than ever. When their mother remonstrated with them Milton said: "But you told us to come right straight home and this was the only way we could do it." Thus he early showed his predisposition to have everything meticulously correct.

As soon as the boys were old enough, they helped in the store. At this time there were eight months in the school year, four in winter and four in summer. Milton went to school in winter and Florus in summer. The alternate months they "tended store." Very early they became interested in nature and all living things. Their parents were ever ready to encourage and assist them. Their father was a kindly, generous man with an experimental mind. He had played with magnets and electricity and had invented a machine for insulating wires. He fully understood the boys' desire to know the "whys and wherefores" of everything. He purchased Draper's *Insects Injurious to Agriculture* which became a storehouse of knowledge, not alone for them, but to the neighboring farmers as well. Patrons of the store brought in all sorts of insects and worms for identification. Their father bought a small printing press, intending to print small circulars advertising the goods in the store, but soon the brothers got out a little four by six inch pamphlet reporting news of the community and church and containing advertisements for local people. This became so popular, a larger press was purchased and the paper grew into a twelve by fifteen inch sheet called *Leisure Moments,* which was continued until both boys went away to school.

Another move of the family was to Garland (now Clarkson) in 1866, where they resided two years, moving to Adams Basin in 1868. Here was a good locality for more than one field of scientific observation. At the end of a half mile walk a stream flowed through limestone ledges exposed by the erosion of a sizeable creek. Trilobites and many other fossils were found here. In the same direction was what had been a woodland with the tree stumps still standing. Many ferns grew in the open spaces. About as far in the opposite direction was a cold bog, Jones Swamp (now Adams Basin Swamp) fed by seepage from the old Erie Canal. (The nearest similar swamps were Bergen and Mendon). This was a botanist's joy, so full of rare plants, among them Black spruce with its minute parasite Dwarf Mistletoe (*Arceuthobium pusillum*) sometimes called Witch's Broom. There were several orchids, including *Cypripedium hirsutum,* various pyrolas, with *Moneses uniflora,* and poison sumach (*Rhus Vernix*). Mr. Baxter often told of his introduction to poison sumach. Wanting fish poles, the boys went to the swamp to cut some. They selected two of soft, gray bark straight and limber. They used their father's saw to cut them and proudly carried them home. No ill effects resulted to either of them, but, after a day or two, their father used the saw and developed a good case of sumach poison. The spankings they received from an irate dad stamped poison sumach indelibly on their minds.

Milton Baxter entered Brockport Normal School from which he was graduated in 1878. It was here, working with Professor Lennon, that his love for botany was born. It was fostered by a visit to Dr. Samuel Beach

Bradley, one of the earliest botanists, if not the earliest, in this part of the country. Young Baxter, having heard Dr. Bradley was a great authority on botany, and that he possessed a fine herbarium, determined to make him a visit. He took what was then a long ride from Adams Basin to Rochester. He met with a most cordial reception, Dr. Bradley making particular inquiry as to what plants the young student was especially interested in, taking great pains to show him his herbarium, and treating him with the consideration he would have shown a grown-up. It was a memorable afternoon for the young visitor and he drove home a very proud and happy youth more than ever interested in botany. And not that alone, but the gratitude for Dr. Bradley's kindness stayed with him always, for so did he treat everyone, young or old, who came to him in the interest of botany, or any other natural science, for encouragement or assistance.

His first assignment for practical work was collecting, identifying, pressing and mounting twenty-five flowering plants. By the time that was completed his interest in botany was firmly fixed. His first mounted specimen was *Cypripedium acaule*. It is now the treasured possession of the Botanical Section. Even in those early days he discovered new plants, plants not to be found in Gray's *School and Field Botany* or any other book available to Prof. Lennon or himself. In a cleared woodland near his home grew two well-known ferns and midway between them was a third having the characteristics of the other two, but unlike either. The State Botanists to whom it was sent for identification pronounced it a hybrid. Here Mr. Baxter illustrated his habit of observing the most minute details and carefully weighing all points before deciding.

Mr. Baxter taught school in Adams Basin during the winter of 1878–79. After this he came to Rochester and began working with the Telephone Company shortly after the opening of the first office. Fifty-three subscribers were in the service and the operating force consisted of three, Baxter, another young man, and the chief operator. In 1880 he was transferred to the International Bell Telephone Company, and with three other American men was sent to Zurich, Switzerland, to build and put in operation a telephone system. He left Adams Basin on July 23, 1880, and Sandy Hook on July 28th. Arriving at Antwerp he signed the contract and then went on to Zurich, arriving there August 23, 1880. The work was completed in 1881, and turned over to a local Swiss Company. He then went to Amsterdam, Holland, where he had charge of the installation and drop gangs and later of all outside construction. In 1882 he laid out the work and began the construction of the Central Office at The Hague. He was transferred to Riga, Russia, in 1883, and put in charge of the plant work and traffic department of an exchange that had just been completed by the American construction gangs. He went to St. Petersburg in 1884 and after two years became Plant Superintendent.

In 1891 he returned to America and resumed his work with the Bell Telephone Company of Buffalo. In 1892 he went to Rochester as Chief Operator of the exchange that was then located in the Wilder Building.

While in Europe Mr. Baxter never lost sight of his vocation, nor did he lose interest in his many avocations. He collected hundreds of botanical speciments from the various countries, which have been of invaluable use for comparison and identification. They are now housed with the rest of his splendid herbarium as a part of the herbarium of the Academy at the River Campus of the University of Rochester. He brought back a rich mineral collection. He gained a speaking knowledge of the languages of the several countries, especially Germany and Russia, that he might converse more readily with charming Fraulein Julia Henko whom he met in Riga. Alike in their love of nature and of beauty, they so enjoyed their long walks that they decided from then to walk life's long path together. And so on January 12, 1884 they were married. She was the daughter of a prominent physician, an accomplished musician herself and the sister of a composer. Though quiet and retiring, Mrs. Baxter was gentle and lovely with a beauty of mind and spirit that fascinated one. She was keenly in sympathy with all of her husband's many interests and shared them whenever she could. She never became quite used to American ways and sometimes longed for the old home life in Russia. After a trying illness of eleven years, during which she was a most patient sufferer, she died September 23, 1929.

Their only child, Tamara Pauline, was born in St. Petersburg, April 16, 1885. She is now Mrs. Kendrick P. Shedd and resides at Kenmar, Naples, New York.

On coming to Rochester after one year in Buffalo the family went to 46 Bly Street, where Mr. Baxter, his daughter and her husband were still living when Mr. Baxter died. They sent their household goods from Buffalo to Rochester on the Erie Canal. On one side of the boat was their property and on the other side a load of lead. In the midst of a gale the poorly balanced boat was overturned and their goods were two nights and two days in the bottom of the canal. Among their possessions was Mr. Baxter's herbarium. The effects of the two-day soaking can still be seen on some of the specimens.

After the completion of the first Fitzhugh Street office in 1900, the first common battery office in Western New York, the Telephone Company transferred Mr. Baxter and he became trouble foreman and later installation supervisor. He was made chief clerk to the plant supervisor in 1908, continuing in that position for twenty years. At the completion of his fiftieth year in the service, a dinner was given in his honor. He was presented with a diamond service emblem, the first of its kind in New York State and perhaps in the country. He also received a purse of gold contained in a miniature apartment telephone. From then until the termination of his service with the company he held an advisory position at the plant. His retirement permitted him to devote all his time to his beloved botany.

Milton S. Baxter seems to have joined the Botanical Section in 1893, the year after his return to Rochester. At least at the regular meeting July 17th the minutes read: "Mr. Baxter exhibited *Calopogon pulchellus, Pogonia ophioglossoides, Nymphaea odorata* and *Rosa caroliniana* from Mendon," and from then until his last meeting with us, in September 1938, very rare were the minutes that he did not read "Baxter exhibited—." He made field trips to the then new and unworked stations with Prof. Lennon, receiving acknowledgment of rare plants from Adams Basin and Holley. And then came Bergen, Mendon, and Busnells Basin, all yielding new and unknown specimens to be studied and identified at the Section meeting. We have heard of his tales of botanizing on a bicycle; his driving over country roads with his pal, Mr. V. Dewing with horse and buggy, bringing back treasures from the Gulf, from Penfield Dugway, and from Sullivans; searching out unusual swamps and promising hillsides, fairly scouring the ground until he knew every grass and sedge and blossom as it appeared; and then farther afield, at Junius Ponds in Seneca County, Mud Pond in Wayne, Oneida Lake and the surrounding country, the Adirondacks, New England, Canada, Washington and its environs, and the hot sand plains of New Jersey. In the field he was always cheerful and happy, always oblivious of weather or untoward circumstances, always devising a way out of difficulties. We remember an early summer trip to the swamp at Coldwater when it rained all day. We had planned to cook a lunch and everything was soaking wet. Nothing daunted, Mr. Baxter tore down a rotting stump, lighted the dry punk within, raised an umbrella over it, and we cooked our meal. Some friends who went with him on a botanizing trip to the Sand Plains of New Jersey said that the mercury stood at 110° F., and although the others sought the shade, Mr. Baxter worked on unconscious of the heat which did not seem to affect him. No swamp was too deep for him to wade, no mountain too high to climb. Everywhere people meeting him realized his wealth of knowledge and the greatness of the man. Vacationing in Algonquin Park one summer we were talking with the Park Superintendent in his office and chanced to mention Rochester. A man asked "Rochester, New York?" "Yes." "Do you know M. S. Baxter?" Did we! Said he: "He is a wonderful botanist and a splendid man. A great treat to botanize with him." The man was Dr. Frank Morris.

Mr. Baxter frequently made special studies of a single species, carrying it through season after season, and from one to many locations. Soon after joining the Section he found that while Gray's *Field and School Botany* described only twelve species of *Crataegus*, there were endless variations among the hawthorns in the Genesee Valley. Specimens of flowers and fruit were discussed with Mr. C. C. Laney and Mr. John Dunbar and the results were reported to Dr. C. S. Sargent of the Arnold Arboretum of Jamaica Plains, Massachusetts. The following quotation from an article in these Proceedings [4] attests Dr. Sargent's appreciation of the work of the Section and its dependability: "During a visit which I made in Rochester in the autumn of 1899, Mr. C. C. Laney, the Superintendent of Parks of that city, called my attention to a number of forms of *Crataegus* which seemed unlike any of the described species and this hurried examination led Mr. Laney, his assistant Mr. John Dunbar and Mr. M. S. Baxter to make a careful and systematic study of the groups in the neighborhood of Rochester and in parts of the adjacent country. . . . Thanks to the industry of Mr. Laney and his assistants, *Crataegus* has now been systematically and carefully studied in Rochester for three years." All the members of the Botanical Section, who were working in it at that time, would recall those three years when a diligent study of *Crataegus* was a part of every meeting, with Mr. Baxter, the interesting instructor. It seemed as if we had gone on a mental diet of thornapples.

Mr. Baxter shared Bergen Swamp and other homes of orchids and other rare plants with Dr. Frank Morris and Dr. Edward A. Eames, authors of *Our Wild Orchids;* Dr. Homer D. House, State Botanist at Albany; Dr. Karl Wiegand of Cornell University, and a host of other delighted botanists. He visted Bergen Swamp regularly, season after season, year after year, until its richest treasures became his. He was leader of field trips to Bergen for countless numbers of people, carefully directing, patiently listening to their often stupid questions, generously sharing his knowledge and willingly giving his time. So well did he know Bergen Swamp that even the rattlesnakes were his friends, and though he would not fondle them as we would any other of our native snakes, he objected to having them killed.

Recognizing the inevitable extermination of many of our rare plants if the wholesale picking of the flowers or digging of the plants was not stopped, Mr. Baxter was an ardent conservationist. He was a charter member and trustee of the Bergen Swamp Preservation Society, whose purpose is to make Bergen Swamp a Sanctuary for Wild Life. He worked for the protection of the Northern Lotus (*Nelumbo lutea*) at Sodus Bay and he was one of the founders and most diligent workers of the Burroughs-Audubon Nature Club, and instrumental in establishing and maintaining the Club Conservation Station at Railroad Mills.

Milton S. Baxter was elected to membership in the Rochester Academy of Science in November, 1897, and was made a *fellow* in March 1898, and a councilor from 1911 to 1919. He was Secretary, pro-tem, of the

[4] Proc. Rochester Acad. Sci. 4:93–136 (1903).

Botanical Section from 1906 to 1909 and recorder from 1909 until his death in 1938. He was the Curator of the Academy herbarium and of the herbarium of the University of Rochester; and was a member of the summer school faculty of the University of Rochester from 1928–1938.

Although he spoke fluently in five languages, Mr. Baxter shunned the platform; the reading of the Annual Report of the Botany Section before the Academy was a real ordeal for him, but in a small group or with familiar friends he was an interesting and delightful speaker. His versatile mind had always a wealth of knowledge to impart and his keen understanding and ready wit were eagerly sought after. His interests were widespead, not alone for his special hobby of botany, but for geology, entomology, ornithology, archeology and numismatics, as well as history and literature. His home was a veritable museum: his herbarium with its thousands of sheets, self-collected or secured by exchange from many parts of the world; a fine coin collection; mineralogical and geological collections; a notable collection of Indian artifacts; Russian curios and a fine library.

Several plants were named for Mr. Baxter. We recall *Viola Baxteri* and *Crataegus Baxteri*. In the *Annotated List of the Ferns and Flowering Plants of New York State* (House). *The Flora of the Cayuga Lake Basin, New York* (Wiegand and Eames), and *Flora of the Niagara Frontier Region* (Zenkert), M. S. Baxter is frequently mentioned as finder of some new plant for Monroe County and adjacent territory.

He was the very heart of the Botanical Section giving to it his constant interest and untiring efforts. He was recorder, instructor, guide and to each member a familiar friend, generously sharing his knowledge, patiently bearing with inevitable errors. One of the greatest field botanists in this part of the country, he knew the remote spots where such vanishing Americans as wild orchids, the gentians, the arbutus and rare ferns may still be found. He was animated by an unquenchable enthusiasm for growing things which he shared liberally and infectiously. He was also truly one of the great men, gentle and lovable, with a happy spirit that saw always the good in people and the sunshine behind all clouds. Milton Baxter enjoyed excellent health until a short illness which resulted in his death on October 15, 1938.

PAPERS OF MILTON S. BAXTER

Beckwith, F., M. E. Macauley, and M. S. Baxter. 1910. Plants of Monroe County, New York and adjacent territory. Supplementary list. Proc. Rochester Acad. Sci. 5:1–38.

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APPRECIATIONS OF MILTON S. BAXTER

In any appraisal of the botanical work of Milton S. Baxter the first thought is of his remarkable knowledge of the local flora of the Genesee country. If we examine the source of this knowledge we find, as in the case of many other students of local floras, such as Sartwell, Bradley, Kneiskern, Day, to mention but a few, that this knowledge comes from extensive field work and the collection, preservation and study of herbarium material. There is sometimes an inclination to belittle the importance of an herbarium. I have only to point out in this connection that with the passing of time and the revaluation of diagnostic characters in regard to certain or many species of plants which show throughout their range a definite response to varying climatic or geologic factors, the collected and preserved herbarium speciments are invaluable in the redeliniation and varietal makeup of the species. For the student of special groups, such as sedges, grasses, ferns or any one of several large and complex genera of flowering plants, again the local herbarium affords valuable data for the region covered. Again I might mention the fact that someone is certain to undertake a restudy of the local flora of the Genesee country. Such a study must also revaluate all former reports of species for the area, and unless the specimens upon which the reports were based are available many such records may prove to be almost worthless. The point of all this is that Mr. Baxter's plant collection should be most carefully preserved.

I would like to approach this appraisal of Mr. Baxter in a more personal way. I have had, however, only a few but delightful trips afield with him. These few are sufficient to designate them as milestones along life's journey. Humor, goodwill, appreciation, and above all the glad willingness to share all he saw with his companions,—these were his characteristics. A keen discrimination of the rare and unusual in plant life was always uppermost. Hence his herbarium came ultimately to contain an almost complete representation of the Genesee flora.

Few of us knew much of his occupation. To most of us he was known as a botanist. That was his avocation, his recreation, and, almost I might add, his reason for living. It was almost by accident, while he once recounted to me some of his collecting experience in Russia, that I learned that he was in some way connected with the telephone industry. As an instance of his discerning sight, he collected in Russia some specimens of moonwort which are exact matches for the local plant known as the Onondaga moonwort (*Botrychium Lunaria* var. *onondagaense*), known to us only from Onondaga and Genesee counties. The incident is worth mentioning here as it indicated his ability to detect the unusual when afield.

Against all this the more practical minded may place the fact that he spent many, many hours and days in botanical work, using considerable of his private funds to promote it, and maintained at no inconsiderable inconvenience to himself and family a large and growing herbarium. Such is the usual experience of the scientist devoted to his subject, who is not professionally engaged in some more or less remunerative work along his chosen line.

Mr. Baxter reaped his own reward in doing what he liked best to do, perhaps sometimes under difficult handicaps. He made contacts and lifelong friendships and professional acquaintances which otherwise would not have come his way. He took a humble pride in placing some of his knowledge into printed and permanent record. Such was his reward and we honor him for his services to our local botanical work and regret that he did not leave to us in printed form a larger portion of that knowledge of the Genesee flora which he possessed.

H. D. House
State Botanist

* * *

There is no need for me to tell of Milton S. Baxter's reputation as a botanist,—he was altogether too well known. I shall try, rather, to tell some of the vivid impressions he made on me as a man and a scholar, as a companion on many a field jaunt, and as a teacher.

Mr. Baxter was so unassuming that it took some time for anyone to appreciate the broad scope of his interests. He was a specialist in but one phase of botany,—taxonomy—yet he knew what was being done in all phases of the subject. And botany was his "hobby," studied on holidays and late of nights; for his life occupation was with the Telephone Service. During the earlier years, driving, he came to know all the roads in the area centered around Rochester, and at the same time to know where the choicest collecting grounds for plants were to be found. Thus his two-way mind was alert to both his job and his hobby.

Of all the many trips we made together, I shall mention just two,—one by ourselves, the other in company with a large group of professional botanists,—as showing two different facets of his character.

One day Mr. Baxter and I went to Bergen Swamp for general exploration and also to get good specimens of a particular sedge, so small as to be hidden by its taller neighbors. You must picture two rather oldish men crawling on all fours, with the rain pelting on their backs. We got what we went for; our wet feet and backs were incidental spicing of the trip. Botanists never catch cold on a field trip. One year the Botanical Society of America met at Toronto; and the big excursion was to Owen Sound, where we spent a full day in the swamps. The car in which Mr.

Baxter rode got in ahead of me. My first sight of him was as he waded toward me through the water way over his shoes (of course it was raining), holding up a fine bouquet of his pet orchids, and saying *"Isn't this grand."* Perfectly typical of the man. As on all such trips, introductions were very informal. He soon knew who other men were, and they knew him at once when his name was mentioned.

In 1929, when I was absent on leave, I had arranged for Mr. Baxter to take the class in Field Botany, in the Summer School. From then on, till the end came, the course was his course. I easily persuaded my advanced students in the Arts Department to stay over for this summer course—and I went along mainly as a passenger. The students all liked him at once. He was young as the youngest, and incidentally could outwalk them.

Mr. Baxter was also Curator of the University Herbarium, and was a great help to everybody in the department. He declined a salary, preferring to be paid by the hour. This left him free to go out to the fields whenever the weather permitted. Except in the dead of winter, we never expected to see him on a "nice day."

This rambling account is perhaps the best way for one field botanist to describe another. After so many years of close association I could not be formal. Nor could I hope to tell the complete story. I have tried to illustrate some of the fine traits of Milton Baxter's character. Around these mere glimpses everyone who knew him can fill in from his own treasured wealth of memories.

WILLIAM DAYTON MERRELL,
Prof. of Botany, Emeritus
University of Rochester

* * *

I would rate Mr. Baxter as one of the most important botanists of New York State during the last generation. He was not only keenly interested in the wild flora of his own region, Monroe County and adjacent portions of New York State, but he was a keen student as well as having a careful analytical knowledge of the plants growing in this region. He was always a fine addition to field trips, his enthusiasm being contagious. No field trip was quite complete without him as a leader. Personally, I have enjoyed my acquaintance with him and have only regretted that distance has made personal contacts so infrequent.

K. M. WIEGAND,
Prof. of Botany
Cornell University

* * *

I am very happy to be given the opportunity of expressing my appreciation of having had the privilege of the friendship of our dear Mr. Milton Baxter. It will probably be only those who knew him who will guess what I mean when I say "dear" Mr. Baxter. One could not help but love him and one could not spend an outing with him but be influenced for a better life. Surely if it is possible for men or women to leave something behind them that endures, he is among those who have left something for those following to emulate and copy.

It was indeed a great thing for me to have had his friendship.

GEORGE WENDT
Rochester, New York

* * *

My first acquaintance with Mr. Milton S. Baxter dates back to about the year 1916 when I met him in the home of Alvin H. Dewey, one of the leading promoters of the archeological society then being formed. Before that time, however, I had had some correspondence with him in relation to the location of aboriginal sites in the Genesee Valley. It was always a pleasure to get his reports because they were not only thoroughly planned but generally accompanied by full quadrangles or sections cut from quadrangles of United States topographic maps.

Coming to Rochester in 1924, I found Mr. Baxter a good backer and sincere friend; in fact he was one of the three signers of my application to the Civil Service Commission. Mr. Baxter was frequently in the museum and was a great favorite with the young people upon hikes of which he was very fond. I well recall a spring hike with him through the swampy waters of Powder Mills Park where, spying an orchid, he waded in with his umbrella under his arm and several of us followed unaware that we were wading in the mire up to our knees. We looked at the flower and left it and he felt quite satisfied that it would remain there unmolested to spread its seeds and so multiply.

At another time we saw a great field of pink lady slippers on the hillside of Honeoye Lake, but oddly enough they appeared to have been affected by the frost for there had been a heavy snow about the 18th or 20th of May that year.

Mr. Baxter was always interested in the museum and in any subject which might advance its welfare. He sent a considerable number of pamphlets, books and frequently specimens to us as gifts. It was an occasion of frequent remark by those who were thrown with him that he was one of the most sincere characters that they had ever known. His graciousness and urbanity were truly winning and it was this quality of sincerity that permeated his entire life and affected his scientific studies as well as his relations with others.

ARTHUR C. PARKER, *Director,*
Rochester Museum of Arts and Sciences

FLORENCE E. BECKWITH
1843–1929

The Rochester Academy of Science and especially the Botanical Section owes a debt of gratitude to Florence Beckwith for the devotion of her high abilities and unfailing purpose to the work of the Section. Her sterling character and rugged worth came to her through a long line of noble ancestors. The family emigrated to New England in 1635 and later one branch moved to Cornwell, Nova Scotia. Here Florence Beckwith's grandfather, Samuel Beckwith, was born in 1773. He married Adelaide Le Brun, daugther of Jean Baptise and Mdme. Le Brun. They removed to Sugar Island, Maine, in the upper St. John's river, later tarried for a short time at Montreal, and went thence in 1809 to Fairfax, Vt. From there in 1813 he set out with his family for Ohio but sickened on the way and died in Buffalo, New York where he had intended to wait for spring. The family turned back to the Genesee Valley and in about 1813 settled at West Henrietta, Monroe County, New York. Francis Xavier Beckwith, son of Samuel and Adelaide Beckwith, was born on Sugar Island, Maine, May 29, 1808. There Francis Beckwith received his education finishing at Monroe Academy in East Henrietta. Between 1821 and 1828 he lived in Canada. Returning to Henrietta for two years he taught school. In 1830 he began the manufacture of furniture in Scottsville and was in that business more than thirty years. In 1876 he removed two miles westward to the town of Gates.

Florence E. Beckwith, daughter of Francis and Hannah Goodhue Beckwith, was born in Scottsville, New York, December 7, 1843. She was associated for many years with the firm of James Vick, Seedsman, as editor of *Vick's Magazine*.

She was one of the eleven charter members of the Botanical Section and from the first one of its most ardent and indefatigable workers. She was vice-president from 1886 to 1897 when upon the resignation of Miss Macauley she was elected chairman which office she held until her death in 1929. From the first Miss Beckwith took her membership as a serious duty and a pleasurable privilege. She was most punctilious in her attendance at the meetings. Neither heat nor cold, wind nor storm could deter her coming. From the minutes of the Section of Jan. 28, 1888 we quote: "No meeting was held on this date owing to the severe storm and intense cold. To Miss Florence Beckwith belongs the honor of braving the elements and constituting the Botanical Section." Not only was she concerned for herself, but she was quick to remind any member who seemed to her to be remiss in duty or neglecting his privileges by his absence. She would say "You should remember Monday night is Botany night. You should plan for it." Always before her was the same goal as an objective since the organization of the Section: "No tree or shrub or herb in Rochester or vicinity that has not yielded up one of its secrets" and happily she lived to see her aspiration practically attained.

She presided at the meetings with a serious dignity, frowning on all frivolity; to her it was business and any infringement was rebuked by her gavel. That she had always felt the usefulness of the gavel as a check to human frailty was evinced by a note in the minutes of Dec. 30, 1892: "Miss Beckwith made a few humorous remarks stating that she had noticed the difficulty the President experienced in preserving order in the meetings, therefore she would present her with a gavel in order that she should use the same to enforce her authority. The President responded in like manner, thanking her for the gift and assuring her that with its assistance 'order must and shall be preserved.'" She was most conscientious and meticulous in her work and a keen observer and careful collector in the field. She worked quite independently and would sometimes wander off and get separated from the group. On several occasions this happened in Bergen Swamp, much to the consternation of the others, but when discovered she would be quietly working, unconscious of having lost the way or caused any anxiety. Indeed she would have been affronted if she knew anyone was worrying about her.

No words can express what she accomplished for the Section. She was ever on the alert to further the interest or to add to the herbarium. Through her instrumentality several valuable collections were added to it.

She traveled to California, twice to Colorado, to Lakewood, N. J., and other interesting points sending home hundreds of pressed specimens, which upon her return, were identified, mounted and placed in the herbarium of the Academy. Very much of the spendid western portion of the herbarium is due to her. Untiringly she would climb mountains or ford rivers for a coveted flower, would labor patiently to press and repress it, carefully placing the plant to best preserve each least detail of form or color. She would change the driers again and again to make the perfect specimen.

After retiring from the firm of James Vick, Seedsman, she devoted all her time to the Botanical Section, spending long hours mounting and labelling, arranging and rearranging. Deep, indeed, is the debt of gratitude the Academy owes to her tireless devotion.

Miss Beckwith read several papers before the Academy, and her publications are listed below. Her name appears frequently in the State Report by Homer D. House. Dr. C. S. Sargent named one of the Genesee Valley species of Crataegus for her. For years she was a councilor of the Academy of Science by whom she was made a Fellow. She was deeply interested in the plan to make Bergen Swamp a Wild Life Sanctuary. As early as 1913 the records recount a correspondence with A. J. Squires of Genesee County, relative to the establishment of a Bird Sanctuary in Bergen Swamp. She was jealous for the preservation of all wild flowers

PLATE II

FLORENCE E. BECKWITH
1843–1929

JENNIE M. DENNIS
1852–1937

MARY E. MACAULEY
1851–1932

GEORGE T. FISH
1838–1926

he was twenty-three. He used to say that partly to make up for the short time spent in school he had been trying to learn something ever since school days. He was interested in the study of chemistry, geology, ornithology and entomology. His vocations were nurseryman and horticulturist. His spare moments were devoted to teaching parliamentary law and botany and making genealogical investigations. His hobbies were botany and genealogy.

Mr. Fish was a member of the Western New York Horticultural Society and the National Nurseryman's Association; also of the American Association for the Advancement of Science. He was a Life Member of the Rochester Academy of Science. On the organization of the Botanical Section in 1881, he became its first president, which position he held for a year. Before this he was actively interested in botany as his name, along with that of Mr. J. B. Fuller and Mr. E. L. Hankenson, appears in the *Botanical Directory of America*—1878.

It was Mr. Fish who discovered that a swamp in West Bergen contained many rare plants—Bergen Swamp which has become a Mecca for so many botanists. Here he also found the little white lady's slipper, *Cypripedium candidum,* the first time it was reported for New York State. He made botanizing trips with many prominent scientists including Asa Gray. He was an indefatigable worker, covering our own and the adjacent territories and bringing in many rare and beautiful specimens.

His large and varied herbarium containing many remarkably well preserved specimens was given to the Academy and is one of the most highly valued contributions to our collection of local plants. Mr. Fish's botanical work extended over many years and his keen interest never lessened. His memory was good and his presence at the meetings of the Section was greatly enjoyed by all.

He was most unassuming, gentle, quiet and retiring—enjoying to the utmost his love of nature and the beauty he found in the flowers. Very characteristic was a note written to the Section shortly before his death, in reply to a request to name the three most popular flowers:

"1. *Nymphea odorata.*

"2. *Cypripedium acaule* var. Rose Pink.

"3. Gentiana crinita.

"As No. 1 possesses such charm, grace, purity as well as fragrance, but also stands nearly at the head of the list of flowers in botanical construction, I fancy a number of others will also place this plant at the head of the list. As I was the first to find that *Cypripedium candidum* grew in this state, I might have placed the white lady's slipper as second on the list, but in the summer when I could not have been more than ten years of age, I found in bloom two species, one yellow and the other rose pink.

The latter won my heart and has retained my affections ever since. I lived at Sodus Bay the summers of 1844, '45 and '46. I did not have the privilege of seeing this species again until 1893. After I had seen all the species named in the botany save *C. arietinum,* I wondered why I had not seen my pretty rose pink beauty. I had carried the general shape and distinct beauty of color in my mind for forty-seven years; but did not have the privilege of seeing it again until the summer of 1893. It was a wonder to me that anything so distinctly beautiful was not described in the books.

"At last I found by the side of a large tree in Bartholf's woods, Greece, Monroe County, a clump of thirteen beautiful blooms and at once realized that the lost had been found. When I had examined both of my editions of Gray I saw that it gave in small type a variety of *C. acaule* as rose pink. We took it home in a bushel basket and planted it in our wild garden."

MARY E. MACAULEY
1851–1932

Miss Macauley was born in Rochester, New York, of Protestant Irish ancestry. Her parents, Robert and Jane Macauley, emigrated to America from North Ireland, and upon reaching New York came up the Erie canal to Rochester.

An apt, enthusiastic scholar, of keen perceptions, Miss Macauley succeeded in whatever she undertook. She attended the public school and was graduated from the Free Academy in 1872. She taught several years in Public School No. 14, resigning in 1882 to take a position in Miss Lewis' Private School, remaining until Miss Lewis married and the school was closed. From 1886 to 1890 she was Preceptress in Fairport Classical Union School. She taught English, physical geography, and the sciences. She was so fascinating and presented her work in such an attractive manner, she won the regard of all her pupils who were glad to co-operate with her in classroom or study hall. Botany was her favorite subject. She delighted in taking her class on long hikes. One of the favorites was the Genesee River Gorge. She would explain the geological features (the outcroppings along the gorge) and at the same time collect botanical specimens from the long familiar Maplewood trail for class study. She had a keen mind and a delightful sense of humor as well as a good bit of real "Irish wit." She knew her subjects and was interested in her pupils, helping them to look forward and to do their best. She taught school in Auburn for a short time, and then in 1893, more than twenty years after her graduation from High School, she matriculated at Cornell University from which she was graduated with high honors in 1898.

Mary E. Macauley was one of the eleven charter members of the Botanical Section, was secretary for two years and president for eleven years, from 1886–1897. She was a most tireless worker both in the meetings and in the field. Except for absences from the city she was a regular attendant at the meetings. For fifty-one years she watched the growth in interest for the Section, saw the limits of the field for collecting pushed farther and farther, saw many new and rare specimens from new and old stations, shared the enthusiasm and satisfaction of a greater and greater herbarium and exulted as the goal she had helped to fix grew nearer and nearer its fulfillment, rejoiced perhaps the most that it never could be reached. There will always be "new or rare specimens in new or old localities."

Miss Macauley made frequent trips into other states to study the flora. She spent weeks botanizing in Manitoba, California, Colorado, Tennessee and for the later years, as long as she was physically able, she spent the winters in Florida. From every place she brought large collections of unusual plants which she pressed, mounted, and identified and they are now a part of the herbarium of the Academy of Science.

Mary E. Macauley was a co-author of the three *Lists of Plants of Monroe County and Adjacent Territory,* published in these Proceedings (see page 138). She was a Life Member and a Fellow of the Academy. In later years because of serious eye trouble, she was prohibited from enjoying her much loved reading and study, nor could she analyze flowers, though she could usually recognize familiar ones. An operation was ineffective in restoring her sight sufficiently for reading or any detailed work, which was a grievous cross to one who had given so much of her life and always her love to it. She bore it patiently and uncomplainingly, keeping her interest alive and her mind alert and cheerful. She lived with a niece, Miss Jennie Adams, then of Pinnacle Road, at whose home she died in 1932, being the last of the Charter Members of the Botanical Section.

The following tribute comes from one who was her student in the Fairport Classical Union School:

AN APPRECIATION

The four years that I was in the academic department of Fairport Classical Union School, from 1886 to 1890, Miss Macauley served as Preceptress, teaching the Sciences and English; she had a brilliant mind and a choice spirit, was vivacious, enthusiastic, taking a personal interest in the individual pupil. Botany was her best-beloved subject and it was a joy to go with her classes when she took them on nature hikes; the Genesee Gorge was a favorite trail with her, and under her instruction geology and botany became living subjects. She was a wonderful teacher, yet it was not so much what she taught that stayed with her pupils, and became a part of their lives, as it was the influence that came from her high type of womanhood, for this could not fail to make a lasting impression. In the early days of the Botanical Section of the Rochester Academy of Science she was one of the enthusiastic supporters, an associate of Miss Florence Beckwith and Milton S. Baxter, giving freely of her strength and talents until failing health and impaired eyesight forced her to relinquish the work which she so dearly loved. In 1930 and 1931 she came frequently to our wild garden which she greatly enjoyed, and it was a delight to talk over old times in Fairport High School. Although frail in body, she never lost the sparkle and charm of personality that characterized her youth. It was a great privilege to have known her and it is a satisfaction to offer this as a tribute to her memory.

MRS. FRANK W. PUGSLEY,
Pittsford, New York.

JENNIE M. DENNIS
1852–1937

Mrs. Jennie Markham Dennis, the daughter of the pioneers Augustus and Olive Louise Parmalee Markham, was born in Bloomfield, New York, August 21, 1852. She attended the Lima Seminary and was later graduated in the art course from the famous Ingham Institute in LeRoy. She taught for some time in the home district school, Lime Kiln No. 8. At twenty-one she married John Dennis, at one time publisher of the Lima Recorder and for forty years on the editorial staff of the Rochester *Democrat and Chronicle.* They were married in the historic Markham stone house on the Markham Road, Lima. The officiating clergyman was the groom's father, Rev. John Dennis, a veteran Methodist minister.

From that time Mrs. Dennis' love for the artistic and beautiful was transferred to her home to which alone she ministered until her family was nearly grown. Always she had an interest and delight in flowers. In 1910 she joined the Botanical Section and immediately became one of its most interested and tireless workers both in the field and at the meetings. She loved all things in nature, but her keenest delight was in her garden which she truly created.

In 1912 the Dennises built a new home at 75 Bellevue Drive. The house was surrounded by sand which covered the entire lot. Mrs. Dennis had visioned a garden and immediately began working for it. Inch by inch and foot by foot she enriched and cultivated and then set out plants and scattered seeds. Many old garden favorites and hosts of wild flowers found a home there. On the field trips of the Section, instead of a press or portfolio, she carried a basket and trowel and brought in growing plants to transplant to her garden. As the space filled, she added more and more ground, until hers became one of the most interesting and loveliest gardens in this vicinity. Roses and daffodils, forget-me-nots and pinks hobnobbing with beds of native ferns and wild flowers; trees and shrubs not only from our area but from the Adirondacks, Yonkers, and Long Island. Everywhere Mrs. Dennis went she brought back some plant to add to her treasures until the one-time sand lot was made to "blossom like a rose." A small greenhouse made it possible to cultivate the more tender and exotic plants as well as to test seeds and try out new varieties. Mrs. Dennis' special pride was her very wonderful collection of Solidago and wild asters. Practically all known varieties and, by hybridization, many new ones, were included. When in bloom that was a beautiful corner of a beautiful garden. Mrs. Dennis spent many hours in her garden—cultivating, transplanting, or visiting—for to her flowers were her friends. To meet her there and share with her the joy of the "green things growing" was a coveted privilege.

While still active and interested in the Botanical Section and her garden she was stricken with a paralysis that, for four years, kept her a captive. Throughout it all the garden she could see from her window was still a comfort and joy to her. She loved every flower brought to her bedside. She died July 21, 1937. Mrs. Dennis was gentle, winsome and kindly—eager to show kindness, to praise, and not to censure. She looked for good in everything and in everybody. She was a devoted mother and a loyal friend.

WORK OF THE BOTANICAL SECTION

On the evening of April 13, 1881, a group of interested people accepted the invitation of their hostess and met at the home of Major and Mrs. William Streeter, 11 Scio Street, and organized the Botanical Section of the Rochester Academy of Science which has now attained its sixtieth year. Its first president was Mr. George T. Fish, and its secretary was Mrs. Mary E. Streeter. The other charter members were Mrs. Thomas Spencer, Mr. and Mrs. A. B. Leckenby, C. W. Seeley, C. M. Booth, J. B. Fuller, H. C. Maine, Miss Florence Beckwith and Miss Mary E. Macauley.

The avowed object of the society's existence was the work of making a collection of the flora of Rochester and vicinity. "We believe," wrote the secretary, "the work is in the hands of those who will not rest from their labors as long as there is an herb, shrub or tree that has not yielded up at least one of its secrets."

The young society was most interested and alert. Quoting the records of June 13, 1881: "About 130 specimens have been collected and named.

Thanks to the energy of a few members a large portion of the flowers collected will be in readiness to exhibit at the coming Annual Reception of the Academy as herbarium specimens. This will be the nucleus around which will gather our constantly increasing collection." Thus was laid the foundations of our still mounting herbarium.

That the work of the Section was arousing a widespread interest in people of other localities is evident by the following from the record of June 20: "The secretary has received letters from a number of persons in adjoining counties, making inquiries concerning our work, offering specimens and altogether exhibiting such a gratifying interest in our work and the affairs of the Academy as to call to mind the couplet 'See how far the little candle throws its beams.'

"So shines a good deed in this naughty world."

In September 1881 it was voted to adopt Gray's Botany for study in the Section.

Mr. George T. Fish was president for one year and was followed by Mrs. Mary Streeter who remained in that office until her death, June 1885. Very early in her first year the following program, to be used in each meeting, was adopted: first, reading the minutes; second, stated paper; third, discussion; fourth, report on periodicals; fifth, discussion; sixth, exhibits by members as called upon. For the most part the meetings have been held the first and third Monday of each month, for the entire year. For a time the Section met in the rooms of the Academy in Reynold's Arcade. In 1889 Mr. Streeter invited the Section to meet at his house which plan continued for twenty-six years, when it moved to the Eastman Building on the Prince Street Campus of the University of Rochester, its present place of meeting.

During the years at Mr. Streeter's, because of his splendid equipment and facilities, much microscopic work with algae, mosses and lichens was done; but always the primary objective has been collecting, identifying and preserving the native flowers. Through the years the specimens have come from near and far; members of the Academy have collected in southern states, western states, northern states and in Canada. By personal collections or exchange, we have contributions from many foreign lands. The first donation to the herbarium was in 1885, a collection of Arctic plants gathered by Lieut. Kislingbury and presented to the section by his brother. It is interesting to note some of the other collections now a part of the herbarium: The Charles W. Seeley collection of 1500 ferns; the Samuel Beach Hastings collection; the J. B. Fuller collection of 5000 mounted and 2000 unmounted native plants with many exchanges; the E. L. Hankensen collection of 2500 plants of Wayne and Monroe counties; Van Ingen collection of 700 plants of Cayuga Lake Basin; R. L. Jughan collection of 280 plants from the same locality; the George T. Fish collection of 1300 mounted, 500 unmounted specimens, all named;

200 western plants from Fred S. Boughton, also many plants from Jamaica. The Dr. Edson collection of 400 mounted, 300 unmounted plants; the Mary Macauley collection consisting of a large number of local plants and collections from Montana, Tennessee, Colorado, Florida, and Nova Scotia; the Florence Beckwith collection of western plants, 900 Colorado, 75 Arizona, 175 California, all identified by Dr. Rydberg; and in addition, a large collection of local plants all identified and mounted; the E. P. Killip collection of about 15,000 specimens; and the extensive collection of M. S. Baxter. Besides these, there have been many smaller donations such as 75 sheets given by Dr. and Mrs. L. R. Cornman, Mrs. F. H. Dennis—100 plants from Florida and elsewhere; Mary Francis Baker, plants and grasses from Florida; the Dewing collection under the label of V. Dewing and reading in many cases M. S. Baxter and V. Dewing; the Mary Streeter colllection; 113 algae presented by George Rafter and hundreds of sheets collected by members of the section. Besides a fairly complete local flora, begun before 1860, it contains representatives from all parts of the world. New plants have been obtained by exchange with other botanists and by donations from friends and members of the Section.

The Herbarium is housed with the University of Rochester in insect-proof cases and so splendidly arranged as to be easily accessible for study. Because of the destruction, scattering and isolation brought by war to the principal scientific collections of the Old World, our own, with every herbarium in America will become more and more valuable. The *Science News Letter* of April 5, 1941 says: "In this confused and abnormal world, the scientific collections in American museums and universities constitute oases in a flaming desert of war."

Field days, or excursions, by members of the Academy and friends have been the source of much pleasure and many additions of rarities to the herbarium. The first field day mentioned in the records was to the hills west of Mt. Hope. ("Among other things *Cypripedium acaule* grew there".) Other nearby locations which have been obliterated by encroachment of the city are the splendid light marsh and woods at the Simpson tract, just off St. Paul Blvd.—opposite Seneca Park. *Habenaria lacera* and *Habenaria clavellata* were there besides other rare flowers, some of which have become extinct in this vicinity. A section bordering Monroe Avenue, parts of the Dugway, the woods about Cobbs Hill, the Dingle by the Eastern Wide Waters (Lake Riley) all sacrificed to the "building booms."

The first Section trip to Bergen Swamp was June, 1882, "and," says the record, "in spite of wet feet and mosquitoes it was very enjoyable." Bergen Swamp is still the Mecca of botanists—still alluring with its promises of a "new find" which it generally delivers. Mud Pond, in Wayne County, Junius Ponds in Seneca County, and farther afield, Duck

Lake, Oneida Lake, the Adirondack Mountains, all are contributing to the unceasing growth of the herbarium.

Besides those whose biographies appear with this paper, we would mention several men and women whose ceaseless zeal and indefatigable efforts did much for the success of the Section. Miss Emma Isle joined the Section the first year and was long one of the workers in both field and study groups. Though unable to attend the meetings, she retains a keen interest in the work. Others who have contributed to the Section are: Mary Frances Baker, by personal work with us, on the occasions of her visits in Rochester, and exchanges and gifts from her home in Winter Park, Florida; Dr. and Mrs. L. R. Cornman, now of Los Angeles, California; Mr. James Laird who, though with us but a short time, endeared himself to every member by his tireless work in the field and his splendid personality; Mr. Ellsworth P. Killip, now a member of the staff of the Smithsonian Institution, Washington, D. C. Mr. Conrad Vollertsen is another of the early workers. As a boy he studied botany in the schools of Hamburg, Germany. Very beautiful are the mounted specimens which he did in those early days. He came to America as a young man, and for many years was designer and developer of some of Rochester's most beautiful gardens. He joined the Botanical Section in its early years and was long a valuable contributing worker, bringing many unusual plants to the meetings, and now, though an octogenarian, is still much interested in the work.

The Botanical Section still meets in the Eastman Building, on the Prince Street Campus of the University of Rochester, on the first and third Mondays of each month. The purpose of this Section is still to give a general knowledge of the plants of this and adjacent vicinities. Collections are made in field, forest and swamp and the material for exhibition and study is brought into the meetings. The greater portion of each evening is given to the systematic examination of the plants and the steps for their identification are traced through the analytical key until their scientific names are found. Rare or unusual specimens are mounted for the herbarium. Names of new stations are added to the list of plants of Monroe County.

At the winter meetings identification of trees and herbaceous plants, by their field characteristics is carried on. At present, the time is divided into three sections: first, minutes of the last meeting and discussions; second, study of trees, following Brown's *Trees of Northeastern United States* and identification of twigs through the analytical key; third, study of some particular order conducted by a member and illustrated by mounted specimens.

The Section is also working in co-operation with the Burroughs-Audubon Nature Club which has generously invited studies of the natural resources of the Conservation Station near Railroad Mills. This tract, of about twenty-five acres, is located on both sides of Irondequoit Creek and includes woods, hillsides, bogs, swamps and sandy knolls. It is an ideal spot for the study of the wild life of the county. A partial catalogue already lists about 500 specimens of native flowers.

The Botanical Section is open to all members of the Rochester Academy of Science and cordially welcomes any one who shares its interest in "plants of this vicinity."

FRED S. BOUGHTON

Fellow of the Academy

Any time from the first sunny day in spring to the snow fall in winter, anywhere in the vicinity of Pittsford, N. Y., in the woods, across the fields, along the roads, you might meet a little man with a basket on his arm and, if you accosted him, most volubly would he tell you he was

Plate III—Fred S. Boughton

a botanist and a mycologist. And, while he was really searching for mushrooms, he "Never passed by a flower without looking at it, especially if it was a rare one—never!"—for this was "Freddie Boughton."

Fred S. Boughton, the son of Seymour and Ella Moselle (Van Bergan) Boughton, was born in Pittsford, N. Y. on Sept. 12, 1859. At seven he started in the "little old stone school house" in Pittsford which he attended until he was twenty. He was a precocious child and early became interested in the three things that were to become the main objectives of his life. In the following manner he tells of the awakening of each of these interests. He says: "One day in our kitchen I had my first sight of a scarlet Lady-bird (a beetle) with a red spot on each wing cover and became very much interested in it. My father, coming in the door, looked at it and told me to take it up carefully and put it out of doors as those little beetles were very useful, destroying many insects, especially aphis. This was my first lesson in entomology. Later I learned to catch and mount butterflies and moths and put them in Riker mounts. With some foreign specimens I was able to acquire I now have quite a large collection."

Of Botany he says: "Many years ago we had an old man living here, by the name of Dr. Bennett, who collected herbs and wild plants for medicinal purposes. He came to see me one day and asked if I would read the description of some of the plant he was doubtful about, as his eyes were failing so that he could not read them himself. He came often and as I read he would explain each one so I understood it thoroughly. I realized I was getting some good lessons in botany. The last time he came he brought me some plants of white, blue and pink hepatica and said: 'Plant them in your yard and they will grow.' They were the beginning of what proved to be the first wild flower garden in Pittsford."

Of his first interest in mushrooms he says: "One day I was in the library of my brother-in-law, Mr. S. G. Crump. I picked up a New York State Report with colored pictures and began to look it over and to wonder if we had anything like them in our woods. Having nothing else to do, I took a small basket and went over into what was known as Sutherland's woods. I found fifteen species of several families. I looked them up, as well as I could, and named two of them. That was the beginning of my mycological career and very pleasant and profitable it has been to me and others as well. I soon began to hear of Dr. Peck, in Albany, who would be glad to name any specimen of mushroom sent to him. Through the years Albany has identified or endorsed my identification of scores of mushrooms for me."

Mr. Boughton was always an eager and interested botanist. He joined the Botany Section in 1911. His first contribution was the rare *Gentiana puberula* which he had found in Bushnell's Basin. It was the first time it had been shown in the Section.

Because of his leisure time Mr. Boughton was able to make many excursions to fields, woods and swamps and brought in, weekly, many flowers and often very rare ones. He visited frequently all the nearby stations and went repeatedly to Mendon Ponds, The Gulf, Mud Pond and Bergen Swamp. He botanized in the Adirondacks, making one climb to the summit of Mt. Marcy. He brought in treasures from Smuggler's Notch, Vt., and in 1915 went to the coast, visiting California, Arizona and other western and southern states and brought back an interesting collection of western flowers.

The height of his experience was a trip to Jamaica with Mr. E. P. Killip, of the Smithsonian Institution. As a boy, Mr. Killip had known Mr. Boughton in Pittsford and maintains it was "Freddie" who first interested him in botany. Knowing how greatly Mr. Boughton would enjoy the trip Mr. Killip urged him to go. In spite of the discomforts with which a sub-tropical jungle trip is bound to be beset, Mr. Boughton surely did enjoy it. No complaint did he make of the excessive humidity, the noxious insects, the hanging snakes, the chattering monkeys, even the little burros, which one was supposed to ride. Nothing diminished the joy and satisfaction of seeing tree ferns, hanging ferns, gold and silver ferns, hanging orchids and air plants, gorgeous butterflies vying in splendor with the birds of brilliant plumage and the rare and beautiful fungi, exquisite in color and form. To him it was a paradise from which he brought home a collection of rare plants and many happy memories.

While Mr. Boughton always retained an active interest in the higher plants, his prime objective became the collection and identification of the fungi. Through intensive study and increasing efforts in the field, he has acquired and identified, or had identified, a large and distinguished collection. So familiar have he and his little basket become that he is popularly known as the Mushroom Man. Many times in the season he has brought two large baskets full to the Section, which he would carefully spread out on the table before him and name and classify each one, voicing an emphatic warning of the poisonous varieties. Occasionally he would say: "It is said to be not poisonous, but I have not tried it."

Mr. Boughton is kindly and considerate especially of children. He has delighted in taking boys on field trips and many a one gained his first knowledge of the natural sciences from these trips.

In spite of the handicap of deafness that thwarted his desire for knowledge, limited his social intercourse and made his a self-centered life, Mr. Bougton has attained a recognized position in his chosen field. His patience in his infirmities and his genial friendliness are felt by all who know him.

MATHEMATICAL ANALYSIS OF THE RELATIVE GROWTH OF ORGANISMS*

Arthur J. Kavanagh and Oscar W. Richards
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As the study of the relative growth of parts of an organism, or of a part with respect to the whole, has grown in importance in recent years, a number of mathematical techniques have come into use for the description and interpretation of the data, most of them associated with the *allometric* equation (Huxley and Teissier, 1936),

$y = bx^k$ (1), or $\log y = k \log x + \log b$. (2)

Questions have arisen about the application and the meaning of the results obtained. Despite considerable discussion, satisfactory answers to many of the questions have not yet appeared. This paper undertakes a critical review of some of the mathematical treatment from first principles, and indicates some problems not previously discussed. Primary emphasis will be placed on the analytical technique rather than on the biology of growth, although the two cannot be separated except from the viewpoint of convenience.

The allometric equation has been used in a variety of ways (Huxley, 1932; Needham, 1934; Richards, 1935; Teissier, 1934, 1937). When k is positive the equation is a parabola; when negative, a hyperbola. Growth with respect to time may be represented by setting y for the measured size and x for time. The parabola has been found useful to describe the relation between different kinds of measurements. When y is a volume and x is a linear measurement, k is usually nearly 3. Volume (y) has been estimated from a surface measurement (x) taking k as 3/2. When weight (y) is used with a linear dimension (x), k is usually more than 3 and may vary during the course of growth when specific gravity or form of the organism changes.

In discussing the allometric equation it will be convenient to use the substitutions $X = \log x$, $Y = \log y$, $B = \log b$, so that (2) may be written $Y = kX + B$. (3)

LOGICAL STATUS

The allometric equation has been criticized concerning the equivalence of the dimensions in the two members. Needham (1934) for example says, "According to the Theory of Dimensions, the dimensions on the two sides of the relation must be equivalent. In this case, $y = bx^k$, they are so only when $k = 1$, which is comparatively rare. Ordinarily, since x is a mass, x^k cannot be. The equation, therefore, has no true physical meaning, that is to say, no new concept can be deduced from it as it

* Received for publication June 10, 1941.

stands, in the sense that the concept of acceleration arises from the relation, $mf = a$, between mass, force and acceleration." However Lumer (1939a) has shown that the dimensional inconsistency is made to disappear by assigning to b the dimension $(u)^{1-k}$, u being the unit in which x and y are measured. He shows that this dimension results necessarily when the equation is derived by the elimination of the time variable from pairs of certain special curves of growth.

It is possible to establish the dimension of b for all cases. It is well known that the formula arises from the differential equation

$$\frac{1}{y}\frac{dy}{dt} = \frac{k}{x}\frac{dx}{dt} \quad \text{or} \quad \frac{dy}{y} - \frac{k\,dx}{x} = O$$

which expresses the condition that the relative growth rates of x and y maintain a constant ratio throughout growth. This equation is obviously dimensionally valid; consequently any equation properly derived from it must also be valid. After multiplying through by yx^{-k} the second form becomes $x^{-k}dy - kx^{-k-1}y\,dx = O$. As k is a "pure number" the dimensions of each side of the equation are dependent solely on those of x and y. Thus if the units of x are $(u)^1$ and of y are $(v)^j$, the dimensions of each side of this equation will be $(u)^{-1k}(v)^j$. The expression on the left is an exact differential and can be integrated at once: $x^{-k}y = b$, which is easily seen to be equivalent to (1). Since integration is a process of summation, the dimensions of the integral will be the same as those of the differential, and of course those of b will be the same as those of the left hand side: $(u)^{-1k}(v)^j$. Thus if x is in $(\text{cm.})^2$ and y in $(\text{cm.})^3$, b is in $(\text{cm.})^{-2k+3}$. If x is in (gm.) and y in (cm.), b is in $(\text{gm.})^{-k}(\text{cm.})$. If both x and y are in (cm.), b is in $(\text{cm.})^{1-k}$, which is Lumer's result. It is futile to look for biological significance in b which will be different when growth is measured in metric or English units.

Another problem concerning the logical status of the allometric equation is its applicability to growth expressed by a sigmoid curve. Lumer (1937) has discussed the relation between the heterogonic formula and the assumption that the absolute growth curves of x and of y are sigmoid, limiting the discussion principally to the simple autocatalytic, the generalized autocatalytic and the Gompertz function. He demonstrates that if the curves of growth of x and of y are both of a single one of these types, then the allometric formula is not an exact representation of the relative growth relation, though it may give a reasonably good approximation. From these examples he draws the conclusion ". . . it appears that, in general, when the growth of the parts is determinate, the concept of a constant coefficient of growth partition, in the sense of Robb and Huxley, is not valid over the entire growth period. . . ."

While the demonstrations given in Lumer's paper are correct for the cases he considers, and although there are empirical cases showing the types of deviations he predicts, it must not be concluded that the sigmoid growth of both x and y is generally inconsistent with the validity of the heterogonic formula. In fact, it is not difficult to show that whatever be the formula of sigmoid growth followed by one of the variables, it is possible for the growth of the other to be sigmoid as well, and still have the heterogonic formula be exactly valid. Let us suppose that the growth of x is sigmoid for example. That is, dx/dt can be expressed in the form

$$\frac{dx}{dt} = f(x) \qquad (4)$$

in which $f(x)$ is a function of x which is small when x is small (usually it is zero when x is zero, or the initial value), which rises to a maximum point, and becomes zero for some finite value, A, of x. Upon integration, this differential equation must yield a relation between x and t which does not allow x to rise above a certain value as t becomes indefinitely great. (Vanishing of the derivative for $x = A$ is a necessary, but not a sufficient condition that x approach a horizontal asymptote; this point has been overlooked in theoretical discussions of sigmoid growth curves.) Let us suppose that the growth of x can be expressed by such a relation, and inquire what must be said of the growth of y if the allometric relation is to hold exactly. Differentiating (1) with respect to t, and substituting from (4)

$$\frac{dy}{dt} = bkx^{k-1}\frac{dx}{dt} = bkx^{k-1}\ f(x) \qquad (5)$$

When x is small, $f(x)$ is also small, by hypothesis, and dy/dt is correspondingly small. As $f(x)$ increases toward its maximum, x increases also, and consequently dy/dt must increase as well. As x approaches A, which is by definition a finite value, $f(x)$ approaches zero; consequently dy/dt simultaneously approaches zero. It follows that dy/dt starts from a small value, rises to a maxium, and finally decreases to zero. Further, since x is always finite, y must be also. Consequently we find that the growth of y is sigmoid, the differential equation being (upon substitution in (5))

$$\frac{dy}{dt} = bk\left(\frac{y}{b}\right)^{\frac{k-1}{k}} f\left[\left(\frac{y}{b}\right)^{\frac{1}{k}}\right]$$

For example, in the case that x is given by the autocatalytic equation $dx/dt = rx\ (A-x)$, the equation for y becomes

$$dy/dt = kry\left[A - \left(\frac{y}{b}\right)^{\frac{1}{k}}\right]$$

It follows that sigmoid or determinative growth in general is not inconsistent with the allometric equation.

LOGARITHMIC PLOTTING AND CHANGE OF SLOPE

In the analysis of data from studies of the relative growth of organisms the allometric equation has special importance for two reasons. In the first place it is shown on theoretical grounds that if the relative growth rates of x and y, respectively dx/xdt and dy/ydt, have a constant ratio throughout growth, the allometric equation describes the growth exactly and the value of the constant ratio is k. Secondly, when empirical data are plotted on double-logarithmic paper it is often found that they are well represented by a straight line, corresponding to equation (3).

The logarithmic plotting is important in these studies partly because of its use in establishing a criterion for the applicability of the allometric equation, and partly because, whether the plot is linear or not, the slope of the curve at any point represents the ratio of the percentage growth rates at the corresponding instant. (The use of the logarithmic coordinates requires some care as shown by Gray (1929) and others.)

It is not possible to lay down standards categorically for the applicability of the allometric equation. A fit far too inaccurate for one purpose may be quite satisfactory for another. Also, it is frequently true that the state of the science is not sufficiently advanced to deal with all the variations of the data, so that the most useful fit may be one which gives only the general trend. It is important to have some idea of the limits of accuracy of the particular representation chosen, to know the deviations of calculated from observed values, and especially to know whether these deviations are haphazard or systematic. In the case of the allometric equation, when one of the main objects is frequently a study of k as a basis for theorization, it is particularly important to know how well or how poorly the constancy or variation of k can be read from the graph, and what degree of variation is likely to remain unnoticed. Discussion of these points seems to be lacking in the literature.

To comprehend the effectiveness of graphical methods of testing linearity and the constancy of k we may examine a curve of known properties, much as a chemist testing an analytical procedure tries it on a "known" specimen. We may take for our example, $Y=1-\cosh X$, $\cosh X$ being the hyperbolic cosine of X. We have chosen this function because it has the useful property that motion a given distance along the curve always changes the slope a given amount. The curve has been drawn in figure 1, and the marked points have been spaced so that the difference in slope between any two adjacent ones is 0.25. The slope varies from 3 in the lower left corner to 0 in the upper right. Although the value of the slope changes in a uniform manner, the effect of the change is not equally obvious in all parts of the curve: the lowest third and the middle third could each be fitted by a straight line as satisfactorily as many curves found in the growth literature, although k decreases from 3.0 to 2.0 in the former and from 2.0 to 1.0 in the latter; in the highest third, however, the same amount of decrease in the slope results in a curvature which is much more obvious.

The curvature, on which the eye largely bases the estimate of linearity, is unfortunately not in direct proportion to rate of change of *slope* as one moves along the curve, though it is proportional to rate of change of *angle* of inclination (Granville, 1911a; Wilson, 1912a). Since the slope is the trigonometric tangent of the angle of inclination, the latter is much more sensitive to changes of a given size in the slope when the curve is nearly horizontal than when it has a steeper inclination. In other words, the sensitivity is greatest when the slope is zero, and decreases continually as the numerical value of the slope becomes greater.

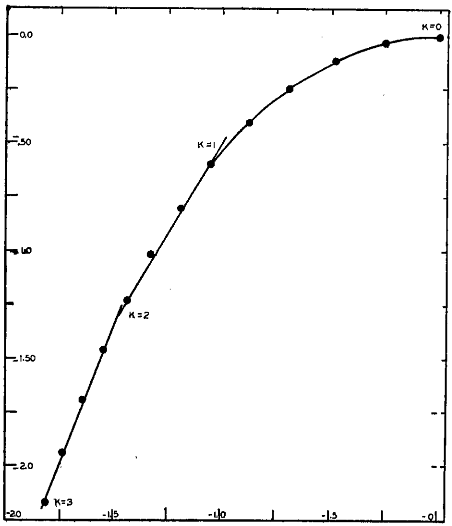

FIGURE 1. Curve showing effect of change of slope on the curvature. The points have been spaced to indicate constant amounts of change of slope. (*Cf.* text.)

Figure 1 covers a rather wide range of values of the slope. In practice the observed values tend to be much more nearly unity, particularly when x and y are of the same dimension. In figure 2, the curve A is an enlarged portion of the curve of figure 1, inverted so that $Y = \cosh X$.

In this figure the slope varies from 0.759 at the lower left to 1.254 at the upper right; this range includes a large part of the observed values of k to be found in the growth literature (*cf.* the tables in Needham, 1934), yet it is quite straight in appearance and can be "fitted" quite well by two straight-line segments! (Points in this curve are not spaced at exactly equal slope-intervals as they were in figure 1.) If it *were not known* that this is a smooth curve with a gradually changing slope it might be accepted with a fit of two straight line segments with a *break* between them. Actual growth curves should be examined by an adequately sensitive test before elaborating on a possible biological significance of a *discontinuity* in the curve, because the apparent break may be due to the size and form of the plot, and the limited acuity of the observer's eye.

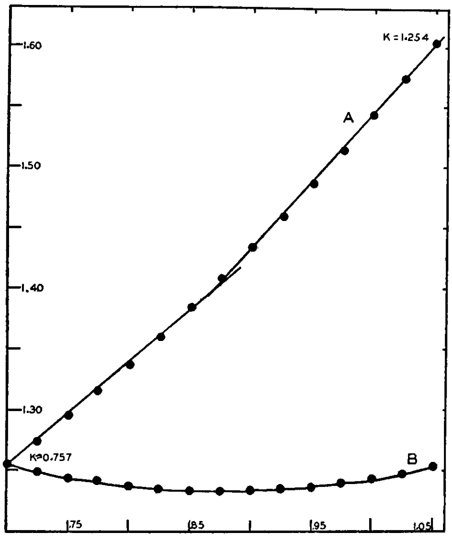

FIGURE 2. A. Apparent "break" in continuous curve. B. Test method shows regularity of curvature.

A method of plotting which is usually more sensitive to variation in k and possesses other advantages consists of plotting the ratio y/x against x on double-logarithmic paper, rather than merely y against x. If k is the slope of the curve at a point in the latter plot, then $k-1$ will be the slope at the corresponding point in the new plot. Consequently either curve will be a straight line when and only when the other is. However, since the values of k obtained in practice are usually nearly 1, the values of k–1 will ordinarily be near zero and the graph is most sensitive to changes in the slope when the slope is nearly zero. (In general, increased sensitivity will result provided k is greater than $\frac{1}{2}$.) As an illustration the ratio curve corresponding to figure 2A is given as 2B. The increased curvature is obvious. Figure 3 is an application to experimental data. Curve 3A is from figure 15 of Needham (1934) depicting the results of Bishop (1929) on lead in the chick embryo against dry weight of the embryo. Curve 3B is the corresponding ratio plot. The lack of constancy of k is much more evident in 3B than in 3A. (A method for plotting is given in the appendix.)

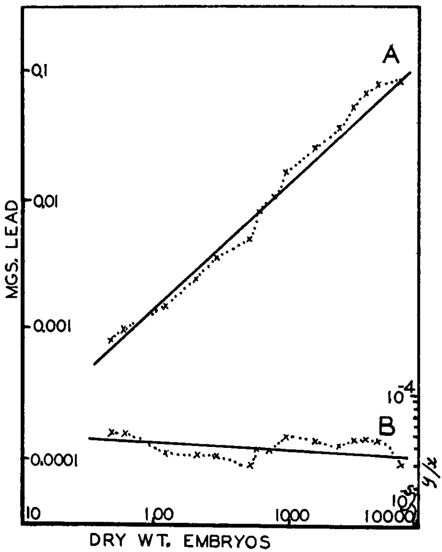

FIGURE 3. Example of test method applied to lead content of chick embryo. From Needham's (1934) Fig. 15. (*Cf.* text.)

Among other characteristics of the ratio-plotting method may be mentioned greater convenience in the analysis of changing proportions during growth. In the conventional plot it is difficult to follow the change in proportions without resort to calculation; in the ratio plot the ratio at any point can be read directly from the graph. Further, deviations of calculated from observed values of Y can be recognized more clearly from the ratio plot (provided k is greater than $\frac{1}{2}$) because though the vertical deviations are the same in the two cases the eye tends to estimate deviations by the perpendicular distance from point to curve rather than by the vertical distance, and these two distances nearly coincide when the curve is nearly horizontal. The value of k is nearly as easily and somewhat more accurately obtained from the ratio plot: it is necessary only to add 1 to the slope obtained from the ratio plot. However, the graph is somewhat misleading if the vertical deviation is not the important one —if for example the perpendicular or horizontal deviation is more important. When the horizontal deviation is more important, it is better to change it into a vertical deviation by reversing x and y and plotting the ratio x/y against y. The slope then is 1/k–1.

SEQUENCES OF DEVIATIONS FROM A CURVE

In estimating the goodness of fit of curves to relative growth data (and much other data) little attention has been paid to the significance of "runs" of points above or below the fitted curve. For a good fit the number of positive deviations should be nearly equal to the number of negative. In addition the arrangement of deviations should be haphazard, as a systematic series of deviations is a strong indication of a fundamental difference between the formula of the curve and the law controlling the observations. It is consequently desirable to know what numbers of "runs" of various lengths can reasonably be expected, a run being an unbroken series of deviations of the same sign. If p be the number of positive deviations, n the number of negatives, and c the total number of deviations, it can be shown that the expectation of runs of r deviations is given by the formula:

$$\frac{np\,(c-r-1)!}{c!}\left[\frac{(n+1)\,(p-1)!}{(p-r)!}+\frac{(p+1)\,(n-1)!}{(n-r)!}\right]$$

The formula was used to calculate the expected frequencies of runs of various lengths in Needham's (1934) figure 1 showing his data on the chick embryo as well as Bishop's analyses of lead in the check embryo used in our figure 3. Both examples show fewer short and more long runs than would be expected on the basis of chance. The systematic manner of deviation indicates a degree of unsatisfactoriness in the formula which was chosen to represent the data.

CLASSES OF DATA AND APPROPRIATE ANALYTICAL METHODS

The ultimate criterion of the desirability of using a given method of curve-fitting is the question of whether its use produces any significant addition to the fund of biological information. More practically, are the labor and expense of calculation justified by the resulting increase in biological knowledge? The determination of what knowledge actually is obtained depends on a thorough understanding of the mathematical principles involved, and a reliable comparison of a number of methods can be made only on the basis of a mathematical study.

The question of fitting the allometric equation to relative growth data has been much discussed and a number of techniques have been suggested, but review of the literature fails to show a logical or systematic development of the subject. Aside from graphical methods some form of the least squares technique is commonest. Much of the difficulty in determining the proper method of application of this technique has come from the fact that the method as originally developed for curve fitting and as ordinarily understood is suited for use only in cases where the error or variation is in one variable alone. In the case of relative growth the deviation of a point from the curve may result from deviation in x, in y or in both. For example in study of the size and shape of the growing clam an individual may be abnormally long, abnormally narrow, or both abnormally long and abnormally narrow. The technique ordinarily employed assumes in effect either that all the clams are of normal length with abnormalities in width only, or *vice versa.* These alternatives yield different curves, and neither gives the same result as the procedure based on error in both variables.

Theoretical justification for the use of the least squares technique, if any exists, arises from the condition that the errors follow the well-known "normal error law." No investigation seems to have been undertaken as to whether the errors in growth studies do follow the normal law. While normal distributions occur in biological material, other forms of distribution are often found. This point should be determined in each case before indulging in lengthy consideration of what variant of the least squares technique is to be used for that case (Yule and Kendall, 1937d). However if the law is satisfied, and the errors are independent of each other, it can be shown that the "best" values of the parameters are those which make a minimum the sum of the ("weighted") squares of the differences between observations and corresponding calculated values. The form of least squares procedure which has ordinarily been used minimizes the sum of the squares of errors in one variable only.

If the least squares procedure is indicated on theoretical grounds, it is necessary to include the squares of errors in both variables. Extension of the theory to the more general case, and the production of an effective technique for its use, are fairly recent. A thorough discussion of the extended technique is given by Deming (1938), including application to the fitting of both forms of the allometric equation. Even the theory as thus augmented is inadequate for one type of relative growth data; the necessary generalization will be discussed later.

The data from most studies on relative growth may be classified in five types. These will be described in turn, and the method of fitting and the significance of the resulting curve will be discussed in each case. It should be emphasized that the exact mathematical course to be followed in a study of relative growth must depend on the biological problem the investigator has set himself, and on the data, experimental or observational, available for the investigation. The first purpose of most growth studies and the principal one of many is the demonstration of an orderly relation, between the elements, structural or chemical, of the growing organism, and the description of the relation in reasonably precise mathematical terms, i. e., by a formula. Knowing the proportionality constants and how well the formula represents the data does not alone answer any biological question. However, the formula may show relations not apparent from reading the table of data and may make possible comparisons essential for the biological analysis of growth. Rather than condemning mathematical anaylsis because it is sometimes inadequately used, it is advantageous for the biologist to perfect the technique and utilize the information thus gained.

Type A.—In this type of data, simultaneous measurements of x and y are made on a single organism from time to time during the course of its growth. The measurements of this organism constitute the entire set. Data of this class are relatively scarce in the literature and can include only measurements made without injuring the organism. Such data are sometimes called longitudinal. Examples are the measurements of Anderson *et al* (1937) on each individual animal (*Daphnia*), and the data on children of the Harvard study used by Shuttleworth (1937). Such a set of data cannot yield the fundamental laws of growth of the species because of the difficulty of distinguishing between the characteristics common to members of the species and those which are peculiar to the individual under study.

At each instant of time each of the quantities x and y has a definite value. That is, in the strictest mathematical sense (Granville, 1911b; Wilson, 1912b) each is a function of the time: $x = f(t)$, $y = g(t)$. These equations may be taken as the parametric equations of a curve, using the word *curve* in the strict sense. Time may be eliminated giving y as a function of x, $y = h(x)$, or *vice versa.* The existence of this curve is evident quite apart from the biological laws producing it, and regardless of the difficulty that may be met in writing down a formula appropriate to describe it. The points are determined by their coordinates and can be plotted; their order on the curve is fixed by the order of the values of t to which they correspond. The curve is continuous, although the slope may vary, and the points (when error of measurement is negligible) *are all exactly on the curve.* Consequently if there is any deviation from the straight-line form in the double logarithmic plot, beyond that ascribable to pure error of measurement, the allometric equation cannot be considered theoretically satisfactory.

If the curve does fit the data within errors of measurement, the fitting process may be carried out by the least squares technique for errors in both variables (Deming, 1938) to obtain the most probable values of b and k. If the curve differs from the data by more than errors of measurement but it is desired to fit the allometric equation for purposes of approximate representation, rough interpolation or determination of an average relative growth rate the choice of method may properly depend on the object. If the resulting curve is to be used to predict values of y which correspond to values of x, the ordinary least squares technique is applicable, since it minimizes the squares of deviations in y. If instead the curve is to be used to predict x in terms of y, the least squares technique should be used which treats as x as the dependent variable. If a treatment symmetrical with respect to x and y is desired the technique for errors in both variables may be used, though the resulting values of the constants lack the theoretical significance they possess when the deviations are ascribable to errors of measurement alone.

In using any form of the least squares technique it is necessary to consider the question of weighting which arises when the logarithmic form (3) is used instead of (1). When the observations follow the normal error law, the justification for use of the least squares procedure is for the equation in form (1). If the logarithmic form (2) is used without weighting the sum of the squares, different results will in general be obtained. The question of weighting for the case of errors in two variables has been considered by Deming (1938) and need not be repeated here.

Feldstein and Hersh (1935) have discussed the question for the treatment of error in one variable, and have pointed out that the difference in results between the two forms of the equation can be eliminated by weighting each observation equation of the logarithmic form with the value of wy^2, the w being the weight of the corresponding equation in the original form. This position is correct, provided the deviations of the observed points from the curve are not too large. However, it is important not to overlook the factor w. On the basis of the principle of least squares it can be shown that the weight w is inversely proportional to the mean square error of y (Leland, 1921). Feldstein and Hersh do not discuss this point, nor is it clear whether the weights w were used in the numerical illustration they give. They were unable to decide whether the weighted or unweighted treatment of the logarithmic form is preferable in relative growth studies.

If the observations follow the normal law and the least squares technique is theoretically necessary, obviously the logically deduced method of weighting is indicated. When the decision must rest on the more empirical basis, it is necessary to keep in mind the nature of the changes brought about by use of the logarithmic form. In the form (1) the effect on the final result of a deviation of given size is the same no matter in what part of the curve it is located. In relative growth studies the large deviations tend to be located at the upper end of the curve, the deviations at the lower end being very small in comparison. Consequently fitting to form (1) (or the wy^2–weighted form (2)), is essentially fitting to the upper end of the curve, the lower end being relatively unimportant. In the unweighted logarithmic form, however, the effect of a deviation of given size in y is proportional to the deviation of log y. Thus a deviation of 10 *per cent* at the lower end of the curve has the same effect as one of 10 *per cent* at the upper, though the latter may be 100 or 1000 times the former in absolute value. Thus the logarithmic method of treatment lays greater emphasis on the lower end of the curve than does the arithmetical. It is interesting to note the effect of the wy^2 weighting as applied to relative growth data. Unfortunately few publications give the mean square errors, but a guess at least can be made from a study of representative graphs. Examination of such a set in Needham (1934) or Teissier (1934) shows that while there are exceptions the tendency is for variation in a logarithmic plot to be no more pronounced in one part of the graph than in another. This is evidence, such as it is, that the w and the y^2 tend to neutralize each other, and there would be little difference between the correctly weighted and the unweighted methods of treatment of the logarithmic form.

When the principal aim of an investigation is a study of the relative growth rate, much more detailed and accurate information can be obtained by the method used by Richards (1935) than from a fit of the allometric equation.

Type B.—A group of individuals is chosen as homogeneous as possible with respect to causative factors, especially age, and one set of measurements is made on each individual. Thus the aspect of growth as a process taking place continually in time is absent; instead we have a study of the variation in size of a group of individuals which have reached a certain stage of development. Such measurements portray relative size rather than relative growth. Sinnott's (1936) investigation of the relation of organ size to tissue development in the stem exemplifies this class. With such data there is no justification for a statement that the observations lie on a curve; there is present no unifying variable such as time to act as a parameter. Neither do observational results justify such a position: to a single value of x may correspond more than one value of y, and *vice versa;* the points obtained cannot be arranged in strict order on any logical basis, though high values of one variable are usually associated with high values of the other so that the plotted points tend to be grouped on the graph into an area which is quite narrow with respect to its length. Nevertheless one reads that the plotted points "lie practically on a curve" and that a curve was "fitted" to the data.

Such a curve can only mark the central tendency, a mean position about which the values vary. The choice will depend on the purpose for which the curve is to be used, much as a similar choice may be made between the median, the mean or the mode for representing the central tendency of a one-variable distribution (Yule and Kendall, 1937a). There can be no question of *the* correct curve to fit the data. Consequently if the allometric equation be used, it is not justifiable to consider the resultant values of b and k as *growth* constants.

The standard methods of correlation naturally suggest themselves for the study of type B data. The fundamentals of correlation technique are described in many textbooks: Yule and Kendall, (1937b); Elderton (1938). The correlation treatment is closely connected with the ordinary least squares treatment, and many considerations are the same in the two techniques. Here, as in type A, it is necessary to distinguish between treatment of the observations (x,y) themselves and treatment of their logarithms (X,Y). For the remainder of this paragraph statements will be made in terms of (x, y); they are also true of (X,Y). The correlation coefficient is useful in determining how close the relation actually is. There are two regression lines and it must be decided from the purpose of the study which one is to be used. One will give the most probable values of y corresponding to given values of x, and the other the most probable values of x corresponding to given values of y. Unless the correlation is perfect $(r = 1)$ these lines will be different. (*Cf.* Weymouth et al, 1925.) Obviously there are no grounds for considering one of these lines as being in general more significant than the other; the illustration of the dimensions of the growing clam given above in the discussion of the least squares treatment is applicable here also. A satisfactory study should calculate both regression lines as well as the coefficient of correlation. A coefficient of 0.90, which is sometimes considered to indicate fairly high correlation, means that the slope of the x-on-y regression line is 23% greater than the value from the y-on-x line. Only when the coefficient of correlation is very high will the two values be substantially the same.[1]

When the correlation study is carried out on (X,Y) rather than on (x,y) the regression lines obtained are precisely those obtained by fitting the logarithmic form (3) to the unweighted logarithmic data by least

[1] The two straight lines given in Fig 1 C'D' of Richards (1935) should be the same and the equation should be $y = 0.270\ x - 0.02225$. The difference was due to an error of computation and the omission of a large crab from the correlation computation by the student who did the numerical work.

squares for error in one variable only! Thus the fallacy of using one of these lines to the exclusion of the other is again evident.

The assumption is sometimes made that variation from a strict functional relationship in type B data is due principally to advanced or retarded development. While there is some evidence that this condition may be one causative factor, it cannot be accepted as the principal one without careful investigation, and class B data do not furnish the material for such an investigation. If it is found to be true, the situation becomes essentially that of a type D distribution with *biological* time the unknown variant instead of chronological time.

Type C.—This type combines features from both the above types. A number of organisms are chosen, forming as homogeneous a group as possible, and measurements of x and y are made from time to time upon the individuals of the group. When the measuring process harms the organisms different subgroups are measured at each successive period. That is, the complete set of class C data consists of a series of type B distributions arranged in order with respect to time like the successive observations of type A. Examples of this type are the work of Naito (1930, cf. Hamai, 1935) on the growth of Meretrix, and that of Bishop (1929) on the lead content of the embryo of the domestic hen. This kind of data is sometimes called "cross-sectional."

With type A data the principal difficulty was the inability to distinguish between the characteristics of the curve which were common to all members of the species and those which were peculiar to the individual measured. The usual method of treating type C data minimizes this difficulty by taking the arithmetic means $\bar{x}$ and $\bar{y}$ as the best representatives of the group of values at each stage. The successive points $(\overline{x,y})$ then form a curve in the strict sense described for Class A data. This plotted curve is taken as the growth curve of an *average* individual and the properties deduced from it are taken as the growth-characteristics of the species.

While this type of study yields much information it has the disadvantage of possibly obscuring some of the finer characteristics common to the separate curves of the individual organisms. The relation between the curve which fits the average values of a number of sets of measurements and the curve formed from averaging the individual curves has been investigated by Merrill (1931). While her conclusions apply specifically to growth curves with respect to time they may be extended to the present discussion. She states in her summary, "Therefore when observations on any biological form are taken on different individuals of varying ages and the description of growth is given in terms of averages of these observations, the form of growth of these averages cannot be assumed to be characteristic of the growth of the individual organism."

Rarely does the growth of any individual organism follow that of the hypothetical average individual.

Although the definition of the curve of averages is as exact theoretically as that of type A, there is nevertheless the uncertainty introduced by the fact that the data in hand are only a sample of the data which would be obtained from measuring all members of the species. As errors of measurement are usually small in biological work in comparison with errors of sampling, the latter is usually the principal cause of uncertainty in the mean values $\bar{x}$ and $\bar{y}$. On the one hand this uncertainty begets a corresponding uncertainty in the properties of the curve of average growth, an uncertainty which must be measured, allowed for and minimized as far as possible by appropriate statistical procedures. On the other hand it results from and its measures are also in a sense measures of the important natural variation of living organisms. The method of analysis generally used tends to short-circuit this variation.

The favorite method of fitting the allometric equation to type C data has been, as with other types, the least squares procedure for error in one variable, applied to the logarithmic form. Here however, as in type A, there is error in both variables which must be dealt with. Further, as noted above, applicability of the least squares procedure for any number of variables involves the assumption that the errors of observation are independent of each other. In the type C situation the errors in corresponding $\bar{x}$'s and $\bar{y}$'s are not independent, but correlated, for each $(\overline{x,y})$ is derived from a subset of type B in which x and y are usually fairly highly correlated. Hence for a theoretically satisfactory fitting technique it is necessary to take account of the errors in both variables and of the correlation between errors in the pairs (x,y). This more general technique, called "least quadratics" has been worked out (Kavanagh 1941); it proves to be similar in form to the least squares technique. Readers interested should consult this reference after having studied Deming's (1938) multivariate technique.

In cases in which the main aim of the fitting process is the determination of the average value of k during growth there is a simple method of procedure which leads to a value with a definite and easily understood meaning. It is of particular value in cases in which systematic deviations of the data from the allometric form vitiate any attempts at theoretical justification of the "least quadratics" treatment. Average values may be considered either from the statistical or the functional point of view. According to the former, an average is simply a central value intended to indicate the general character of the items it represents. (For a more complete description see Yule and Kendall, 1937c). A functional average of a variable quantity involved in a process is the constant value which could be substituted for the variable throughout the process and produce the same final result from the given initial conditions. (On the derivation of certain types of functional averages see Wilson (1912c).) In the present case the average value of k is to be determined from the formula, $k = (Y_f - Y_i)/(X_f - X_i)$, the subscript i denoting the initial and f the final values. The criticism most likely to be leveled at this formula is that its calculation involves only two of all the observed points along the curve. However the values of k at all points along the curve are involved implicitly in the calculation since the final growth is attained only as the result of the growth at all previous stages. In fact this formula can be obtained as the result of the process of averaging described by Wilson. It is the exact analogue of the method used to determine the average speed of a moving body: distance covered divided by elapsed time.

When the relative growth rate is to be studied more detailed and accurate information can be obtained by the method of Richards (1935) than from fitting the allometric equation.

It should be pointed out that the differences in the values of the constants obtained by the several methods of calculation result from the fact that the observed points do not actually fall on the heterogonic curve, whether because of errors of measurement or sampling, or because of fundamental differences between the law of growth and the allometric equation. If the agreement between observations and equation is very close there will be no appreciable difference in the results of the several methods of fitting.

Type D.—Measurements are made on a group of organisms without regard to the differing stages of development of the individuals; a two-dimensional distribution is made of all the data for study. The study of local variation in the shells of Meretrix by Hamai (1934) illustrates this type, the data from each locality forming a separate type D sample. In data of this sort the variation due to time, characteristic of type A, and that due to individual differences, characteristic of type B, are so intertwined that it is difficult or impossible to separate them. Consequently it is difficult to formulate a rational approach toward treatment of the data or a logical interpretation of the constants derived in fitting the allometric or any other equation to them. Obviously the strict curve relationship between x and y does not exist; usually the correlation kind does. Assuming that it is possible to represent the relation fairly well by a curve (using the word *represent* of course in the sense of giving a central line about which the data vary) there still remains the question of what biological significance to give the representation, and the related question of what is the best method of fitting the curve.

Considered purely as a correlation table the data may be used to predict the value of y most frequently associated with a given x, etc.

However, a difficulty arises here which seems to have been generally overlooked: that arising from uncertainty as to the age-composition of the sample. If clams of a certain age and 3.10 cm. long have an average height of 2.59 cm., while clams 2 months older and the same length have an average height of 2.68 cm., it is obvious the average height corresponding to a length of 3.10 cm. in the sample will depend in part on the relative numbers of clams of those two ages which happen to be included. A similar difficulty is attached to the attempt to determine any of the customary constants from the data. Hamai (1935) for example samples a population of clams at monthly intervals for a year, the data at each sampling forming a distribution of type D. For each samplying he calculated the constants of the allometric equation and assumed them to be growth-constants, i. e., indicative of the nature of growth at the time. He finds variations in the constants from month to month and concludes in effect that these variations can be taken as a measure of the changes in growth activity during the year. Inasmuch as the spawning of these clams occurs mostly during the summer months, it is obvious that there must be a considerable variation in the age-composition of the samples taken over a period of a year. It is equally obvious that any interpretation of the significance of the variation of the constants is open to serious question until the effects of age-variation have been allowed for.

It may be argued that the variation in size at a given age tends to be of the same nature as that in the total population so that, for example, the most probable value of the height corresponding to a given length is the same in each age group as it is in the whole population. However this possibility should not be accepted without statistical verification, which is possible only with type C data. A similar consideration is the dissatisfaction sometimes felt with chronological time as a marker for biological activity, and the resulting belief in the possibility of eliminating much apparent varation by use of appropriate biological states. Thus Anderson and his associates (1937) use instars of Daphnia as time untis. Whatever the limits of chronological time may be, some allowance must be made for the effects of difference in state of development, in *biological time* if a satisfactory one be obtainable, in chronological age if the better measurement be lacking. Type D data make allowance for neither.

If despite the ambiguity of the resulting constants it be desired to fit the allometric equation to type D data choice of method may depend on the purpose of the investigation. The simplest procedure is the least squares fit of (3) for error in one variable only; the variable chosen as dependent being the one whose value it is desired to predict in terms of the other. Attempts to approximate the curve which would be obtained from a type C treatment are hindered at once by absence of knowledge of the distribution with respect to age, or distribution within the separate age groups. The method of least squares for deviations in both variables may be used on either (1) or (2) if it is desired to employ a method symmetrical in its treatment of the two variables.

Type E.—It has been remarked that type A data permit study of the individual but not of the group, while type C data tend to obscure characteristics by the process of averaging. When possible, growth data should be recorded in a manner permitting study of the curves of individuals, and mathematical expressions should be deduced from them to express the common characteristics of these actual curves rather than the curve of a nonexistent "averaged" individual. The work of Anderson, Lumer and Zupancic (1937) previously referred to gives results on the growth of Daphnia individually raised, but their published treatment of the data is mainly of the type C form. In an analogous population problem Richards and Kavanagh (1937) have given a treatment corresponding in some respects to the one proposed here. The averaging of curves has been discussed above and by Merrill (1931). The development of the theory and methods for fitting type E data must await a larger amount of information from experiments and a knowledge of the requirements for the analysis.

TYPICAL PROBLEMS IN ALLOMETRIC GROWTH ANALYSIS

The logical status, problems of fitting and the analyses adapted to the available types of growth data have been discussed. Many of the published studies of allometric growth are incomplete with respect to data or treatment. A detailed review of the literature is not appropriate to the present paper. The relation between the relative growth rates of the parts of an organism and the transformed coordinates of Thompson (1917) has been worked out by the authors and will be published elsewhere.

Brief mention of some of the difficulties and variants of the allometric method is pertinent and the discussion of this section is intended only as constructive criticism aimed to advance the analysis of growth. The papers mentioned are useful contributions even though exception may be taken to them.

Meunier's (1937) contribution fails to mark the units on the ordinates of many of his curves, which precludes any analysis of use of his material. His figures 1 and 2 could be fitted better by curves than by straight lines and there is no evidence given to support the breaks between the lines.

Glaser (1938) has developed a variant form of the allometric equation to express the relation between the age of an animal and the weight of the whole body, or of the various chemical components. This form is $\log w = k \cdot \log(2t+1) + C$, t being measured from the instant of conception or, in the case of the chick, from the beginning of incubation.

That this is essentially the allometric equation is shown by shifting the time origin by means of the substitution $t = t' - \frac{1}{2}$. The equation becomes $\log w = k \cdot \log 2t' + C$, or, $\log w = k \cdot \log t' + C + k \cdot \log 2$, which is the same form as (2), with $w = y$, $t' = x$, and $C + k \cdot \log 2 = \log b$. He derives the formula at first from an empirical fit of the derivative form to the percentage growth rate of the chick, and then endeavors to develop general validity for his treatment of growth problems.

Tests of the adequacy of the formula to represent the data are made (at least in the presentation under discussion) only by visual estimation from graphs. In these graphs there are to be observed many illustrations of the types of questionable use of the equations discussed above. Thus in many cases a curve is *fitted* by segments of two straight lines, although a careful inspection of the plotted points, without regard to the lines, does not reveal any break or angular point justifying such fitting. The most striking examples of this kind of misfitting are his curves 6A, 7D, those of figure 9, 10B, 13B and 13C. In the other cases of this type of fit there is hardly one which does not offer some grounds for challenging the applicability of the method.

Again, in the curves fitted by a single straight line, there is frequently evidence of systematic variation as indicated by "runs" of deviations, curves 1C, 2A and 3E being examples.

In the absence of a priori reasons for expecting this form of the allometric equation to have special validity, it is reasonable to expect a distribution of curves of varying degrees of convexity or concavity, including occasional approximations to linearity. Inspection of the graphs presented in Glaser's paper reveals such a distribution. Figures 3 and 4 present several cases in which there is upward concavity. There are a few examples of linarity, as in figures 1A, 7A, B, C and 8A, and a large number of cases of upward convexity, as in figure 11. It is evident that the graphical evidence tends to refute rather than to support the theory that his form of the allometric equation is a particularly good description of growth. Lerner (1939) has published data which shows that a single linear growth curve is inadequate.

Glaser lays some emphasis on the inclusion of prenatal time in the presentation of data, basing the argument principally on the fact that when this is done the curves, presented on a double-logarithmic graph, tend to *straighten out*. This tendency is a characteristic of double logarithmic presentation of curves of this general type. The straightness could be improved still more by pushing the time origin further back, say to the average birth or hatching date of the mothers of the individuals used in the study. [A modernized preformation theory has been suggested by Glaser (1939).] However, the goodness of fit of theory to observations, as measured by ability to calculate actual weights from the formula, is not in the least improved. This is a characteristic of this type of trans-formation of the time axis which should be borne in mind in attempts to set up a *biological time scale.*

A caution should be urged against the use of unusual methods of treating the data without careful investigation of their implications. A case in point is that of Hersh's (1931) treatment of his data on facet number in bar-eyed stocks of Drosophila. In this treatment y represents the ventral and x the dorsal facet number. Let us consider the treatment of the data for a given stock. All the individuals for whom the sum of the two facet numbers(i. e., $x+y$) lies in the interval 30–39 are put in one group; those for whom the sum lies in the interval 40–49 are put in a second, and so on. The average of the x-values and the average of the y-values in the first group are computed, and the resulting pair (x,y) is taken as the representative of this group. Similar average pairs are computed for each group. The heterogonic equation is then fitted to these *average* points.

In order to understand the implications of this method of treatment, let us imagine the original ungrouped data plotted on ordinary rectangular coordinate paper. We then divide the plane into bands by drawing the lines $x+y=c$ where c takes the values 29.5, 39.5, 49.5, etc. These lines are parallel, and all have the inclination 135° to the x-axis. Then the points which find themselves together in a given band are those which were put in the corresponding group in Hersh's treatment. The exact effect of this method of grouping on the data in question cannot be told without examination of the data. The general nature of the effect can be seen from the following example.

Suppose that the ungrouped distribution can be represented by the law

$$w = ce^{-\frac{1}{2}[(x-a)^2 + (y-b)^2]}, \quad c = \text{a constant},$$

(a, b) being the center of gravity of the distribution. Then x and y are independent, the coefficient of correlation is zero, the regression lines are perpendicular to each other, k for the y–on–x line is zero, and all points a given distance from (a, b) have the same frequency. Now it is easy to see as a result of the symmetry that the average point of each band will lie exactly on the line through the point (a, b) which is perpendicular to the boundary lines of the bands, that is, on the line $x-y=a-b$. Consequently if we fit to the average points we will be treating a distribution in which the coefficient of correlation is 1 instead of 0; the value of k determined for the regression line of y on x will also be 1 instead of the 0 which is the true value! It is obvious that Hersh's results which depend on this method cannot be relied upon to give an accurate picture of the growth situation.

SYSTEMATIC VARIATION IN *k*

Attention has been given to the question of possible relationships between *b* and *k*. Thus Hersh observed a relation, $b = Be^{-rk}$, or log *b* = log *B*–*rk* in the values obtained from his study of facet number in bar-eyed Drosophila (Hersh, 1931) and again in a study of relative size in various species and genera of the Titanotheres (Hersh, 1934). In this formula, *B* and *r* are constants, and *e* is the base of natural logarithms. He expresses belief that the relation results from the operation of fundamental growth principles, but it is not hard to show that it is due to the mathematical treatment, and in particular to unwarranted extrapolation resulting from choice of the unit of measure. Lumer (1936) pointed out that Hersh's relation is the necessary and sufficient condition that the relative growth curves involved shall all pass through a common point, though in the data under consideration they did not. Later (Lumer, 1939b) he reconsidered the problem and presented a number of hypotheses which would result in such concurrence of the growth curves. These hypotheses are unnecessary, however, in view of the considerations now to be presented.

In a double logarithmic plot of either of Hersh's sets of data which is large enough to include the line $X = 0$ we find the points grouped in a fairly small portion of the plane, because the organs measured were all of roughly comparable size. In particular, the region is fairly small compared with the distance to the line $X = 0$. Now the numerical value of log *b* is the value of *Y* when $X = 0$. Therefore on the one hand the attempt to determine the value of log b from the data represents extrapolation a considerable distance beyond the data. On the other hand, if we do attempt such an extrapolation we have an approximation to Lumer's condition that the lines all pass through the same point. The approximation is of course due to the fact that the size of the region is small *relative* to the distance from the group to the line $X = 0$. Now this distance depends on the unit in which *x* is measured. The smaller the unit of measure, the further the line is to the left. On the other hand, by taking a larger unit of measure, the line $X = 0$ is moved closer to, or even into the group of points, the degree of extrapolation diminishes and disappears and Hersh's relation vanishes, as can be verified by actual calculation.

This explanation, presented on a somewhat intuitive basis, can be demonstrated rigorously. Let (C,D) be a convenient point within the group of data. By the use of two well-known formulae, one for the "normal" equation of the straight line and the other for the distance from a line to a point (Smith, Gale and Neeley, 1928) the equation can be put in the form $(X-C) \cos w + (Y-D) \sin w + d = 0$, *d* being the distance from line to (C,D) and *w* the inclination of the perpendicular from the origin to the line. To find the value of log b, set $X = O$ and simplify: $Y = \log b = D - kC - d/\sin w$, since $k = -\cot w$. Now if d, the distance from the line to the fixed point (C,D) is small in comparison with C, which is the distance from the line $X = O$ to the point (C,D), the term $d/\sin w$ may be neglected, giving $\log b = D - kC$. This is the logarithmic form of Hersh's relation, with $D = \log B$ and $C = r$. Thus if the distances d corresponding to the respective lines are fairly small with respect to C, the several pairs of values of b and k will follow Hersh's relation approximately.

Comparisons of b for different animals were made by Lapicque (1907) long before the present interest in relative growth. He has recently (1937) criticized Meunier and Teissier because he believes that the allometric formula should be reserved for morphological comparisons and not for the description of chemical processes in morphogenesis. The earlier publication of Lapicque compared the size of the brain with that of the body. Systematic variation of b depends on the measuring scales used. Proper chemical comparisons will be difficult and to this extent we may agree with Lapicque. Even in morphology care will be necessary to separate real differences from fortuitous results of the sizes of the measuring scale.

Reeve (1940) has examined the differences b and k for their use as taxonomic criteria. Length of skulls and parts of skulls of three genera of anteaters illustrate his paper. The logarithmic form (2) of the equation was used, because he believes that genetic and environmental differences distribute normally on a logarithmic scale. Correlation methods were used; $k =$ (covariance of x and y)/(variance of x). Formulae are derived for the standard errors of b and k and for testing differences in slope and position of the data following the R. A. Fisher school. The fit of the regression line was tested from the residual variance after fitting a single straight line, separate lines and parallel lines to the samples. The k's were different and useful, but the initial growth index (b) values and their errors were not helpful in his analysis. A critical discussion of the errors in this procedure and its advantages as an aid to classification is given.

His data are unequally distributed because most of the specimens available in the museum were fully grown. The *Tamandus* and *Cyclopes* data barely overlap and a series of sizes including more younger stages might change the relations and the interpretations. A single curve would fit the plots of the data on Cartesian coordinates as well and perhaps better than three separate curves. Class D data always limit the interpretation and an evaluation of his tests of significance will become possible when Class B data are available. The paper is an example of the maximum statistical analysis and certainly gives more reason for placing these within one family than in separate families.

Turning to the development viewpoint, it is known that different organs develop at different times and with different rates. The reproductive organs, for example, increase during the pubertal period. The relation of their size to body size would give a low value of k until then, followed by a greater k. Yet the pattern of growth for the individual is logical and consistent. Comparisons of b and k at different stages of development and for different species must be made with caution and consideration of the growth patterns and dimensions involved.

Addenda. Since this was written Needham and Lerner (*Nature,* 1940, 146:618) also emphasize the difference between comparing by stages or studying the course of relative growth. The former they propose to call allometry and the latter heterauxesis; with adjectives to characterize the kind of each. Later, Huxley, Needham and Lerner (*Nature,* 1941, 148: 25) restore allometry for both cases and recommend allomorphosis for comparisons of parts of organisms of a definite age to wholes or parts at a definite age. It seems to us that rather than changing terms every few years that all conditions should be considered and a simple, uniform and complete terminology proposed. Some further difficulties in this field are illustrated elsewhere (Richards, *Growth,* 1941, 5:171–173).

SUMMARY

A systematic treatment of the problems concerned with the analysis of relative growth by means of the allometric equation, $y = bx^k$, is given, wherein y is a measure of the size of a part and x of the whole organism and b and k are constants. The dimensions of b and k are given, the logical status of the equation is discussed and it is shown to be applicable in the study of sigmoid growth. The problem of fitting the equation directly and by logarithms, the significance of systematic deviations from the fitted curve and an improved method for assessing the constancy of k are described. The available data are grouped in five types and the logical status and proper method for the analysis of the types is given in some detail. More emphasis is given to analytical methods than to biological significance, although the limits of interpretation are stressed. Unusual and variant forms of the allometric equation are criticized.

APPENDIX

Rapid plotting of the ratio y/x against x on double logarithmic paper to investigate the constancy of k may be done by either of the following methods without actually calculating the ratios. (A.) If the points of the y-against-x curve have been plotted, measure with a pair of dividers the horizontal distance from a plotted point to the line $x = 1$; then lay off this distance vertically downward from the given point. The point thus reached will be the corresponding point of the ratio plot. (B.) A drawing board, 45° triangle and a T-square, or a drawing machine are desirable. Locate the value of y on the line $x = 1$. Through this point draw a line with inclination of 135°; its intersection with the vertical line for which x has the given value will be the required point, $(x, y/x)$. This method suggests a simple ruling for a special graph paper for this type of plotting. With either method the line $x = a$, may be used instead of $x = 1$, but if it is desired to estimate the ratios from the graph each value read from the vertical scale must be divided by a.

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A REVIEW OF THE SNAKE GENUS ADELPHICOS[1]

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The present survey of *Adelphicos* has been based upon a study of 92 specimens, distributed among all the five forms of the genus. One subspecies, however, includes two thirds the total number examined. All the material of the genus present in the American Museum of Natural History (AMNH), Academy of Natural Sciences of Philadelphia (ANSP), California Academy of Sciences (CAS),[2] E. H. Taylor-H. M. Smith collection (EHT-HMS), Field Museum of Natural History (FMNH), Museum of Comparative Zoology (MCZ), United States National Museum (USNM) and the University of Michigan Museum of Zoology (UMMZ) has been examined, and to the authorities of these institutions I wish to express my appreciation of their generosity in all respects. In particular I wish to thank Dr. Thomas Barbour, Dr. C. M. Bogert, Dr. Doris Cochran, Dr. E. R. Dunn, Mrs. Helen T. Gaige, Mr. Arthur Loveridge, Mr. K. P. Schmidt, Mr. Benjamin Shreve, Dr. Joseph R. Slevin, Dr. Leonhard Stejneger, Dr. L. C. Stuart, and Dr. E. H. Taylor. Dr. Taylor has very kindly permitted me to describe specimens in his collection. Dr. Stuart has discussed with me many of the problems that have arisen, and has turned over to me much data taken by him. I am indebted to Rozella Smith for the drawings.

This study was completed and a portion of the material on which it is based was secured during tenure of the Walter Rathbone Bacon Traveling Scholarship of the Smithsonian Institution.

Adelphicos Jan

Adelphicos Jan, Arch. Zool., vol. 2, 1862, pp. 18–19; Bocourt, Miss. Sci. Mex., 1883, pp. 553–4; Cope, Bull. U. S. Nat. Mus., no. 32, 1885, p. 85 (*Adelphicus*); *idem*, Trans. Amer. Philos. Soc., vol. 18, 1895, p. 205; *idem*, Ann. Rept. U. S. Nat. Mus. for 1898, 1900, pp. 778, 780; Dunn, Amer. Mus. Nov., no. 314, 1928, pp. 1–2; *idem*, Bull. Antiv. Inst., vol. 2, 1928, p. 23.

Rhegnops Cope, Proc. Acad. Nat. Sci., Phila., 1866, pp. 128–9 (genotype *visoninus*, by monotypy).

Atractus (*part.*) Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 300.

Genotype.—Adelphicos quadrivirgatus Jan, by monotypy.

Diagnosis.—Small snakes (maximum total length about 400 mm.) of the family Colubridae, with a relatively short tail (22 to 49 caudals, 121 to 148 ventrals), a small, rather conical head and a moderately stout body; hypapophyses absent on posterior part of vertebral column; hemipenis with an undivided sulcus, a belt of slender spines and tipped

[1] Received for publication, October 27, 1941.
[2] Only 56 of a series of 145 *sargii* examined.

with an area of papillae, in the lower part of which is a small flounce. Anterior chinshields enlarged, in contact with lip or not; seven supralabials normally, 3rd and 4th entering eye; an elongate loreal, entering eye; no preocular; normally two postoculars; temporals 1–1, the posterior typically much longer than broad (fused with a nuchal); nasal divided; rostral very small; head scutellation otherwise typical colubrid.

Scale rows 15 throughout; scales absolutely smooth, pitless; no sexual scale ornaments as chin or supra-anal tubercles; a marked sexual dimorphism in either caudal or ventral counts, or both, the males with the higher caudal and the females with the higher ventral counts.

Nomenclature of scales (See figure 3).—In recording ventral counts it was observed that in *sargii, quadrivirgatus* and *visoninus* almost invariably the first entire ventral is the third scale from the anterior chinshields; accordingly, in order to make all ventral counts in the genus exactly comparable, the third scale from the anterior chinshields was always counted as the first ventral, whether it was divided or not. Anterior to the first ventral, in the three subspecies mentioned, are two transverse rows of three scales; the median scale of each row is here termed the median gular, while the lateral scales are termed lateral gulars. These gulars are almost invariably present and distinguishable, although very frequently the posterior median gular is fused with one of the lateral gulars. Rarely a small, median scale, here termed the pregular, is present between the scales of the posterior pair of chinshields; it appears to be homologous with the median gulars, and indicates that the scales termed the posterior chinshields are juxtaposed lateral gulars.

Accordingly, all specimens regardless of species have one pair of posterior chinshields, rarely separated by a pregular; one row of gulars, the median gulars rarely absent; and a varying number of ventrals, the first one or two of which may be divided into two or three scales. In *veraepacis* and *nigrilatus* the first ventral is almost always divided, usually into three scales which simulate the rows of gulars; in the other three subspecies the first ventral is seldom divided, and never into three scales. In the first-mentioned two subspecies the gulars are rarely not separated from each other; in the other three subspecies the median posterior gular is fused with one of the lateral gulars in 63 per cent of the specimens.

Pattern.—The dorsal color is light brown to dark gray or brown, extending to the upper edges of the labials on the head and more or less to the ventrals on the body. There are five stripes typically, but the middorsal is frequently nearly or quite obsolete; the lateral stripes may be very broad or nearly indistinguishable; the dorsolateral stripes are the most constant and usually the best defined. In some specimens of *visoninus* all the stripes are poorly defined. The tail may have a middorsal dark stripe, according to subspecies. In one subspecies, the subcaudal surface is unmarked save a longitudinal, median dark line; in several others it is profusely stippled with dark; and in still another both types occur; all have dark markings of some sort under the tail. The belly is immaculate in two subspecies, variable in two, always stippled in one. The gular region and chin is immaculate or spotted, according to subspecies (save in one, in which both types occur).

Dentition.—All teeth are conical, sharply pointed and completely lack grooves. There are 9 to 12 dentary teeth, extending to the extreme posterior tip of the dentary; the teeth are greatly reduced in size posteriorly, and the anterior one or two are slightly smaller than the preceding. There are 9 or 10 maxillary teeth; they are largest near the middle of the maxilla, and strongly decrease in size posteriorly, somewhat anteriorly. There are 7 or 8 palatine teeth, slightly decreasing in size posteriorly. The pterygoid has 12 to 20 teeth extending posteriorly very nearly the full length of the bone; the teeth decrease slightly in size posteriorly; the bone is bluntly pointed or rounded posteriorly, strongly laterally compressed, and about two and one half times as broad (vertically) posteriorly as anteriorly.

Hemipenis.—The hemipenis is large, 11 to 14 caudals long in situ. The sulcus is invariably undivided. A little more than half the proximal portion is smooth and ridged. This is followed distally by an area, about a fourth the length of the hemipenis, of slender, elongate spines varying greatly in size, none conspicuously larger than the others; the larger spines are on the antisulcus side, and the spines decrease in size toward the sulcus; there is no large number of minute spines, but rather these are conspicuously absent, except in *visoninus* (in this they are in an intermediate evolutionary position between the extremes of numerous and of few, all well developed spines). The distal portion of the hemipenis is capped by a papillary area, in which calyces are not discernible; a pocket (flounce) is visible near the base of the papillary area on the antisulcus side.

Generic relationships.—By the possession of an undivided sulcus spermaticus, and by the absence of calyces in the papillate area at the tip of the hemipenis, *Adelphicos* holds a peculiar, isolated position. In other respects—in form, dentition and head scutellation—it resembles *Geophis*. Unfortunately the latter genus has the sulcus divided near the tip of the hemipenis, and calyces are present in the terminal area of papillae. Otherwise the hemipenes of the two genera are similar. In spite of these discrepancies in hemipenial structure in the two genera, all evidence points toward a close relationship between them, and in view of the numerous specializations of *Adelphicos* I conclude that it has been derived from *Geophis* or near ancestors of that genus. In turn, *Geophis* rather obviously has been derived from *Atractus,* a South American genus extending northward only to Panamá. In *Atractus* the hemipenis features a deeply bifurcate sulcus and even a cleft apex. Accordingly well-defined, continuous northward gradients from *Atractus* through *Geophis* to *Adelphicos* are apparent in (1) hemipenial structure (coalescence of the bifurcate elements), in (2) head scutellation (coalescence or loss through reduction in size of various scales), and in (3) body size (*Atractus* largest, *Geophis* intermediate, *Adelphicos* smallest, and primitive *Adelphicos* larger than modified *Adelphicos*). It is apparent that in any natural arrangement of genera into supergeneric groups these three must remain together. With this in mind, it is of interest to test this group against the arrangement proposed by Dunn (Bull. Antiv. Inst. Amer., vol. 2, 1928, pp. 19–24). This arrangement differs from that previously accepted (based on the character of the teeth) by placing emphasis upon the nature of the hemipenis, particularly the sulcus. In this scheme the Colubrinae are characterized chiefly by having a single sulcus, the Xenodontinae by having a divided sulcus. These criteria place *Adelphicos* in the Colubrinae, while *Geophis* and *Atractus* are placed in the Xenodontinae.

The only concept which will allow such a separation of *Adelphicos* from *Geophis* and *Atractus* must propose that all other Colubrine genera have been derived from Adelphicos, and likewise that all other Xenodontinae have been derived from *Geophis*. The idea is of course preposterous, and therefore it must be concluded that at least in this one American genus (*Adelphicos*) a Colubrine type of hemipenis (single sulcus) has been derived independent of other Colubrine genera from the Xenodontine (bifurcate) type of sulcus. If the evolution of the single sulcus has occurred independently once in American Colubrids, very possibly it has occured more than this number of times; just how many can be stated only with a more thorough study of numerous poorly known genera.

In Africa the independent evolution of the single sulcus has occurred many more times than once, as pointed out by Bogert (Bull. Amer. Mus. Nat. Hist., vol. 77, 1940, pp. 7–12). Accordingly, as concluded by Bogert, the nature of the sulcus cannot be considered a character stable in groups of genera as large or as ancient as the category of subfamily. Its use must be confined to groups of lesser size or age, sometimes as small or recent as a single genus (as *Adelphicos*). So far as I am aware, there is no variation in the nature of the sulcus in intra-generic groups or populations.

Obviously some other character or combination of characters must be used to construct a satisfactory subfamily arrangement of the Colubridae. Unfortunately, however, all single characters utilized in the past as subfamily criteria eventually have met with the same objections as are now raised to the hemipenial character. Apparently a successful (completely natural) arrangement must await a more complete study of the phylogeny of Colubrid genera; even then it seems doubtful that single characters will be found that will remain stable and sufficiently well characterize all the genera of their respective subfamilies. The genera will mold the rule, not vice versa, and it appears in this case the rule will be a highly complicated and devious one.

Species relationships.—Two groups are represented in the genus, each composed of a single species, one with two subspecies, the other with three. Group A consists of *v. veraepacis,* and *v. nigrilatus;* group B consists of *quadrivirgatus quadrivirgatus, q. visoninus* and *q. sargii.*

Evolutionary trends can be traced in (1) size of third infralabial; (2) number of palatine and pterygoid teeth; (3) number of hemipenial spines; (4) number of ventrals and caudals; (5) ventral pigmentation of body; (6) subcaudal marks (these independent of belly marks); (7) relative length and width of frontal; (8) and size.

Most significant of all is the size of the chinshields and of the third infralabial, since in these rests the most prominent peculiarity of the genus. Group A obviously shows less modification in this respect than group B, and on the basis of this evidence is assumed, for the sake of convenience, as the more primitive group. A comparison of the two groups, assuming that group A is the more primitive, shows very clearly that the direction of change in the genus are toward (1) reduction in size of the third infralabial, and a corresponding increase in size of the anterior chinshields; (2) increase in number of palatine and pterygoid teeth; (3) reduction in number of hemipenial spines; (4) reduction in number of ventrals and caudals; (5) loss of belly pigment; (6) restriction of subcaudal pigment to a midventral line; (7) shortening and broadening of frontal; (8) and a general decrease in size.

These trends show rather conclusively that *veraepacis* is, as previously assumed, the most primitive member of the genus, and that *nigrilatus* is a direct derivative of it; that *visoninus* represents the next living stage; and from it must have developed *sargii* and *quadrivirgatus;* and that *sargii* is the most highly evolved member of the genus. The accompanying diagram (figure 5) illustrates the relationships of the various species and subspecies.

Distribution.—The genus is restricted to southern Mexico and northern Central America, occurring on Atlantic slopes from central Honduras through British Honduras (apparently not in Yucatán) to central Veracruz (Jicaltepec); and on Pacific slopes from central Guatemala to central Oaxaca (Pochutla). It occurs also in the interior valleys of Guatemala and Chiapas. (See figure 6.)

Key to the Races of Adelphicos

1. Third infralabial nearly as broad as long, subequal in size to second; chinshields not greatly expanded toward lip 2
   Third infralabial absent, or greatly reduced in size and confined to labial border; chinshields greatly expanded toward lip 3
2. Ventrals 124 to 130 in males, 136 to 142 in female; caudals 40 to 42 in males, 27 to 30 in females; maximum length 392 mm. (females; males 358 mm.); chin distinctly dark spotted; all of anterior edges of ventrals dark; subcaudal surface generally suffused with black .... *veraepacis veraepacis*
   Ventrals 121 to 129 in males, 128 to 135 in females; caudals 31 to 37 in males, 22 to 27 in females; maximum length 318 mm. (females; in males 243 mm.); chin nearly or quite immaculate; belly immaculate or with *median* dark spots that do not extend along all of anterior margins of ventrals; a median subcaudal tail stripe .... *veraepacis nigrilatus*
3. Chinshields separated from lip by a very narrow third labial; caudals 43 to 49 in males, 36 to 45 in females; belly frequently heavily pigmented; subcaudal surface frequently suffused with black .... *quadrivirgatus visoninus*
   Chinshields bordering lip, third infralabial absent; belly not or little pigmented 4
4. Caudals 29 to 35 in males, 24 to 29 in females; ground color very dark, lines scarcely visible; never any pigment on chin or belly; subcaudal surface profusely pigmented .... *quadrivirgatus sargii*
   Caudals 44 to 49 in males, 32 to 36 in females; lines on sides and back distinct; belly sometimes with some pigment; a median subcaudal stripe .... *quadrivirgatus quadrivirgatus*

Adelphicos veraepacis veraepacis Stuart

Adelphicos veraepacis Stuart, Occ. Pap. Mus. Zool. Univ. Mich., no. 452, 1941, pp. 5–7.

Type Locality.—Cloud Forest above Finca Samac, seven kilometers west of Cobán, Alta Verapaz, Guatemala. Altitude about 1500 m. Type Mus. Zool. Univ. Mich. No. 89073.

Specimens Examined.—Four.

Diagnosis.—A full complement of seven infralabials; anterior chinshields relatively widely separated from lip; median gulars two, distinct and separate; first ventral divided; ventrals 124 to 130 in males (2), 136 to 142 in females (3); caudals 40 to 42 in males, 27 to 30 in females; frontal distinctly longer than wide; maximum length 392 mm. (in females; males 358 mm.); chin distinctly dark-spotted; all of anterior edges of all ventrals dark.

Dentition.—In No. 89075 there are 9 dentary, 9 maxillary, 7 palatine, and 12 pterygoid teeth.

Hemipenis.—In No. 89074 the hemipenis is eleven caudals long (not everted); the basal five caudal lengths are spineless, ridged; two slender spines, of unequal length, are somewhat larger than others, and are on the antisulcus side; 58 other, smaller spines are present, the smaller ones toward the sulcus side. Flounce (pocket) present.

Variation.—The supralabials are 7–7 except in one, in which the third is split on one side to produce a count of 7–8; the infralabials are regularly 7–7. The preoculars are regularly absent, but the postoculars are variously fused with adjacent scales; in two the lower is fused with the fourth labial on each side, and in one of these the upper postocular is fused with the supraocular. The temporals are regularly 1–1, and the secondary is invariably fused with a nuchal scale, producing a large scale considerably longer than broad. The third labial, loreal and prefrontals regularly enter the eye. The first infralabial is in contact with its mate in all. The posterior chinshields are separated in two, in contact medially in two.

In all the median gulars are distinct, not fused with the lateral gular scales. The first ventral is divided in all, into three scales in two specimens, into two in the other two. There are four entire caudals in one specimen.

The largest female measures 392 mm. in total length, the tail 54 mm. The largest male measures 358 mm. in total length, the tail 6 mm.

TABLE 1.

Scale counts and measurements (in mm.) of A. v. VERAEPACIS.

Number	Sex	Ventrals	Caudals	Length of Frontal	Width of Frontal	Snout
89073	♂	124	40	..	..	..
89074	♂	130	42	3.8	2.8	2.9
89075	♀	136	30	3.8	2.8	2.9
89076	♀	142	28	3.6	2.4	3.2
B472	♀	137	27	2.9	2.3	2.0

In all the general tone is very dark. A very dark brown or black lateral stripe is present in all except one, which shows no evidence of it whatever; in two the stripe involves all of the first and second scale rows, most of the third and the edges of the ventrals; in one its lower edge involves the upper portion of the scales in the first row, while the upper edge involves the lower portion of the fourth scale row. Between the lateral stripes the somewhat lighter ground color generally shows no or irregular evidence of stripes; in the smallest, however (261 mm., total length), narrow dorsolateral dark stripes are present, involving the center of the 6th scale row; it also shows some evidence of a middorsal dark stripe.

The belly is heavily stippled with black or dark brown; the anterior edges of all the ventrals are dark, and near the middle of each ventral the dark color expands posteriorly and nearly or quite reaches the free edge; the expansion of the black areas on each ventral is more pronounced on the posterior part of the belly. The tail is either entirely black, or the middle and posterior edge of each subcaudal is light, the remainder black. The chin is rather strongly marked with black.

Range.—Known only from the type locality, Finca Samac, 7 kilometers west of Cobán (UMMZ 89073), from Finca Chichén, 10 kilometers south of Cobán, Alta Verapaz (UMMZ 89074–6), and Todos Santos, Huehuetenango (UMMZ B472), Guatemala.

Adelphicos veraepacis nigrilatus subsp. nov.

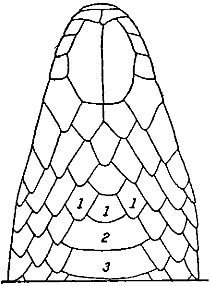
(Figure 1)

Holotype.—EHT-HMS No. 15335, an adult female, from San Cristóbal, Chiapas, collected by H. Devlin Thomas. *Paratypes.*—Eleven, EHT-HMS Nos. 15331–4, 15336–42, all topotypes.

Diagnosis.—A full complement of infralabials, usually seven, seldom eight; anterior chinshields widely separated from lip; median gulars distinct and separate; first ventral generally divided; ventrals 121 to 129 in males, 128 to 135 in females; caudals 31 to 37 in males, 22 to 27 in females; frontal longer than wide (usually distinctly); maximum length 318 mm. (in females; in males 243 mm.); a usually well-defined, dark lateral stripe, and no well-defined markings on the dorsal surface between them; gular region completely immaculate or with very few, small, dark flecks; a median longitudinal subcaudal dark stripe; belly white or with a median dark stripe or series of spots; all of anterior edges of ventrals never black, partly light.

Description of Holotype.—Rostral slightly visible from above; internasals small, a little more than half as wide and a little less than half as long as prefrontals; length of frontal (3.2 mm.) a little greater than its distance from tip of snout (3 mm.) and greater than its own width (2.7 mm.), considerably less than maximum length of parietal (5 mm.), a little greater than length of median parietal suture (3 mm.); sides of frontal convex; supraocular a little wider posteriorly than anteriorly, greatest width (1.3 mm.) slightly less than half width of frontal; nasal completely divided, naris in anterior section; latter very small, deeply wedged between rostral and first labial, about a third size of posterior section; latter rounded, about as high as long; loreal very elongate, narrow, widest posteriorly, its maximum width slightly more than its length, narrowly entering orbit; no preoculars; prefrontal entering orbit; greatest diameter of latter (1.3 mm.) a little greater than its distance from labial border (1.2 mm.); two postoculars, upper a little the larger; temporals 1–1, the second fused with a nuchal scale; supralabials 7–7, 1–2–6–5–3–4–7 in order of increasing size, 3rd and 4th entering orbit, 3rd rather elongate.

Infralabials 7–7, four in contact with chinshields (both first and second pairs, the latter in contact only with 4th labial); first infralabial in contact with its mate medially; anterior chinshields much enlarged, each separated from labial border by about a third its maximum width, their combined width (3 mm.) a little less than their maximum length (3.4 mm.); posterior chinshields small, scale-like, in contact medially; two median gulars and a single pair of lateral gulars; first ventral entire.



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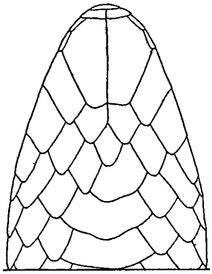

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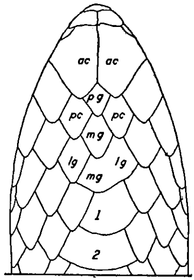

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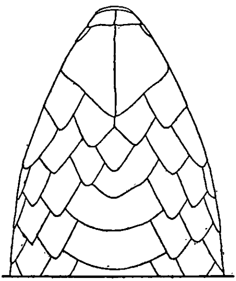

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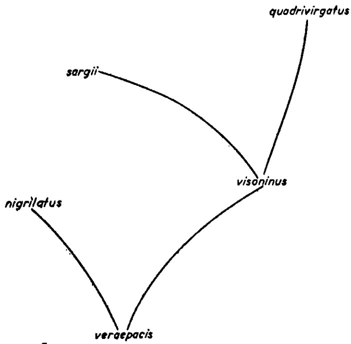

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FIG. 1. Ventral head scales of *A. v. nigrilatus,* from paratype, EHT-HMS 15333. 1, 2, 3, first, second and third ventrals.

FIG. 2. Ventral head scales of *A. q. visoninus,* from MCZ 25893.

FIG. 3. Ventral head scales of *A. q. quadrivirgatus,* from ANSP 11714; *ac,* anterior chinshields; *pc,* posterior chinshields; *pg,* pregular; *mg,* median gular; *lg,* lateral gulars; 1, 2, first and second ventral. The pregular is absent in most specimens.

FIG. 4. Ventral head scales of *A. q. sargii,* from CAS 66843.

FIG. 5. Possible phylogeny of the races of *Adelphicos.*

Ventrals 128; anal divided; caudals 23. Total length 318 mm., tail 38 mm.

Dentition.—No. 15339 has 10 dentary, 10 maxillary, 7 palatine and 14 pterygoid teeth.

Hemipenis.—No. 15333 has a hemipenis 12 caudals long (not everted). There are two large, slender spines of unequal size, somewhat curved at tip, rather conspicuously larger than the others, on antisulcus side; 36 smaller spines are present; the spinose area covers a length of about three and one half caudals; the basal seven caudal lengths are spineless and with longitudinal ridges. Flounce present.

Color.—Upper surface of body light brown, stippled with black; no vertebral dark stripe, except very feebly indicated posteriorly by a slight concentration of stippling; a very distinct, well-defined, uniform, jet-black lateral stripe on body, involving all of third, all except extreme upper edge of fourth, and upper third or half of second scale row; lower portion of second scale row, and all of first, white (cream), except for dark-stippled edges on each scale; belly white (cream), with a few flecks of black on anterior (concealed) edges of some ventrals (especially on posterior part of body).

Head dark slate (almost black) above, this color reaching to and involving upper edges of supralabials and rostral, darker at lower edge; labial border and entire ventral surface of head white (cream), entirely devoid of dark marks.

Tail mostly black above, somewhat lighter medially toward base, where the brown ground color of the dorsal surface of the body is evident; an interrupted, irregularly-edged light line extending along the middle of the first scale row, becoming less distinct distally; a narrow dark line extending along the adjacent edges of the first scale row and subcaudals; subcaudal surface white (cream), except for a rather broad, median, longitudinal black stripe with serrate outer edges, involving a third or fourth of the subcaudal scales.

TABLE 2.

Scale counts and measurements (in mm.) of A. V. NIGRILATUS.

Number	Sex	Ventrals	Caudals	Length of Frontal	Width of Frontal	Snout
15332	♂	126	35	2.1	1.9	1.8
15333	♂	123	31	2.8	2.3	2.2
15336	♂	125	33	2.1	1.9	1.9
15338	♂	129	37	2.5	1.9	1.8
15340	♂	126	31	2.4	2.0	2.1
15342	♂	121	31	2.3	2.2	1.9
15331	♀	135	22	2.5	2.1	2.2
15334	♀	134	27	2.3	1.9	1.9
15335	♀	128	23	3.2	2.8	2.9
15337	♀	130	23	2.3	2.0	1.9
15339	♀	134	24	2.3	2.2	2.2
15341	♀	134	25	2.1	1.9	1.9

Variation.—The supralabials are 7–8 (the anterior section of the third split off on one side), the infralabials 8–8 (the third split on both sides) in one specimen; otherwise both supra- and infralabials are 7–7 in all specimens; they are shaped as in the holotype. In the absence of preoculars and presence of two postoculars there is no variation. The temporals are regularly 1–1, but on one side in two specimens, and on both sides of one, the secondary temporal is not fused with a nuchal; in the others it is fused with one nuchal, producing a single scale longer than broad. The third labial, loreal and preocular enter the eye in all specimens, but in one the loreal is split vertically near the middle on both sides. The first labial is in contact with its mate in all. The posterior chinshields are in contact medially in all.

In all specimens the two median gulars are distinct, not fused with the lateral gular scales. In all except two the first ventral is divided; in six of these the first ventral is divided into three sections, so that there appear to be three succeeding gulars; in four the first ventral is either split in the middle or else the median section is fused with one of the lateral sections. In one specimen, the second ventral also is split (medially). In none are there entire caudals.

The largest female is the type; the largest male measures 243 mm. in total length, the tail 40 mm.

In some specimens there is very faint evidence of dorsolateral or mid-dorsal dark stripes; in general, however, the dorsal surface between the lateral dark lines is practically free of any clearly-defined dark marks. The lateral dark line is well defined in all but one, in which the postero-ventral or posterolateral edges of the scales involved by the stripe are light. The stripe involves two complete rows (second and third) and the edges of the adjacent rows in one specimen; in the others it is about as in the holotype, except that the upper edge does not usually involve such a large portion of the fourth scale row.

Invariably a well-defined, median longitudinal dark line is present under the tail; in none is the subcaudal surface diffusely stippled with dark. The amount of black on the belly varies. Some specimens have none, three have a median series of dark spots on the anterior edges of the ventrals, while two have a practically continuous, midventral dark line; the edges of the line are serrate, as the anterior portion of the spot on each ventral is broader than the posterior position. The ventral surface of the head and neck is unmarked, except for a few, very minute, dark flecks near the sutures between the anterior chinshields and infralabials in some specimens.

Comparisons.—The only race of the genus similar to *nigrilatus* is *verae-pacis*. These two differ from each other in ventral and caudal counts, ventral coloration and maximum size. Together they form a unit well differentiated from the remainder of the genus: (1) both have broad labials, while others have a very narrow third labial or none; (2) both have a long frontal, distinctly longer than broad, while the others have short frontals, not or very little longer than broad; (3) both invariably have two distinct median gulars, and seldom the first ventral entire, while the others usually have but a single distinct median gular and the first ventral entire; (4) both have a reduced number of dentary (9–10), palatine (7) and pterygoid (12–14) teeth, while the others have 11–12 dentary, 8 palatine and 19–20 pterygoid teeth; (5) and both have numerous spines on the hemipenis (38 to 60), while only *visoninus* (with 52) of the other three has numerous spines.

That *v. nigrilatus* is a derivative of *veraepacis,* rather than the reverse, is indicated in the former by the reduction in ventral and caudal scale counts, loss of chin markings, great reduction of ventral markings, and coalition of the subcaudal pigment to form a single, midventral line. All these modifications are trends away from the primitive condition, as shown by the characters of *sargii* and *quadrivirgatus,* the end forms of the genus.

Adelphicos quadrivirgatus visoninus (Cope)

(Figure 2)

Rhegnops visoninus Cope, Proc. Acad. Nat. Sci. Phila., 1866, pp. 128–9.

Adelphicos quadrivirgatus (?)Müller, Verh. Naturf. Ges. Basel, vol. 7, 1882, p. 142 (Tenosique, Guatemala); Bocourt, Miss. Sci. Mex., 1883, pp. 554–5, pl. 32 fig. 11 (Alta Verapaz); (?)Müller, Verh. Naturf. Ges. Basel, vol. 8, 1887, p. 261 (Guatemala); Günther, Biol. Centr. Amer., 1893, pp. 94–95 (*part.*); (?)Dugès, La Naturaleza, ser. 2, vol. 2, 1894, p. 376 (Tabasco); (?)*idem,* 1896, p. 482; Dunn and Emlen, Proc. Acad. Nat. Sci. Phila., vol. 84, 1932, p. 32 (Carmelina, Honduras); Stuart, Misc. Publ. Univ. Mich. Mus. Zool., no. 29, 1935, p. 51 (La Libertad, Guatemala).

Adelphicos visoninus Cope, Bull. U. S. Nat. Mus., no. 32, 1887, p. 85 (Honduras).

Atractus quadrivirgatus Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, pp. 312–3 (*part.;* specimen *c* only, from Honduras); (?)Werner, Verh. Zool. Bot. Ges. Wien, 1896, p. 10 (Guatemala); *idem,* Sitz. Akad. Wiss. Bay., vol. 27, 1897, p. 210 (Guatemala); *idem,* Abh. Akad. Wiss. Berlin, vol. 22, 1903, p. 361 (Guatemala); *idem,* Zool. Jahrb., vol. 57, 1929, p. 161 (*part.*).

Type Locality.—Honduras. Type U. S. Nat. Mus. No. 24899.

Specimens Examined.—Ten.

Diagnosis.—A full complement of infralabials (seven, unless fused together), but the second and third very narrow, barely excluding chinshields from labial border; ventrals 126 to 129 in two males, 127 to 148 in females; caudals 43 to 49 in two males, 36 to 45 in females; dorsolateral dark stripe involving mainly the fifth row of dorsals, sometimes encroaching on the edges of the fourth and sixth scale rows; no distinct middorsal tail stripe.

Dentition.—In MCZ 32008 there are 11 dentary, 10 maxillary, 8 palatine and 19 pterygoid teeth.

Hemipenis.—In FMNH No. 21880, the hemipenis is 14 caudals long (not everted); the area of spines begins 7 caudal lengths from the base; the last two caudal lengths are covered by papillae; about 52 spines, two a little longer and larger than others, all varying greatly in size; apparently a flounce (pocket).

Variation.—The supralabials and infralabials are 7–7 in all. No preoculars, 2–2 postoculars, and 1–1 temporals in all; in one the secondary temporal is not fused with a nuchal. The loreal is normal, and it, the third labial, the prefrontal enter eye in all. The first infralabial is in contact with its mate in all. The posterior chinshields are separated from each other by a pregular in one. In six there is but one free median gular, the posterior fused with one of the lateral gulars; in three both gulars are free. The first ventral is divided medially in one. There are no entire caudals in any specimen.

The largest specimen (MCZ 32008, female) measures 322 mm. from snout to vent (tail broken).

TABLE 3.

Scale counts and measurements (in mm.) of A. Q. VISONINUS.

Author or Museum	Date or Number	Sex	Ventrals	Caudals	Length of Frontal	Width of Frontal	Snout
USNM	109706	♂	129	49	1.9	1.9	1.7
FMNH	21880	♂	...	44	..	..	..
Boul.	1894	♂ ?	126	43	..	..	..
Werner	1897	♀ ?	139	45	..	..	..
Werner	1903	♀ ?	139	41	..	..	..
USNM	24889	♀	136	36	2.2	2.2	2.2
USNM	62971	♀	127	41	1.9	1.8	1.8
MCZ	25893	♀	142	45	2.8	2.8	2.2
MCZ	32008	♀	140	..	3.1	2.9	2.8
MCZ	38726	♀	134	36	2.0	2.0	2.0
UMMZ	829	♀	141	42	2.3	2.6	2.6
UMMZ	867	♀	141	..	2.2	2.6	2.8
UMMZ	74887	♀	148	37?	2.2	2.3	..

A considerable variation in color occurs. The belly is immaculate in three (Hond.; Carmelina, Hond.; Petén), feebly marked in two (Tela, Hond.; Chiapas), and in the remainder the belly is rather heavily stippled with black (Portillo Grande and Mataderos Mts., Honduras; St. Lucas and La Primavera, Guatemala). In the latter specimens the ventral surface of the tail is irregularly mottled, while in the others a distinct, midventral longitudinal stripe is present on the tail. The lateral dark stripes involve the adjacent edges of the second and third scale rows, or are greatly expanded to include all the second and third, and a portion of the first and fourth scale rows. The dorsolateral dark stripes involve the fifth, and sometimes adjacent portions of the sixth and fourth. The middorsal dark stripe is poorly defined or absent. The tail is irregularly marked above, and lacks a distinct middorsal stripe; the dorsolateral body stripes disappear at about the middle of the tail. The lateral body stripes extend onto the tail and involve the edges of the subcaudals, or in some a narrow light line interrupts the lateral dark line on the middle of the first scale row of dorsals (on tail).

Comparisons.—The present form is a close relative of *quadrivirgatus,* from which it differs in the presence of a narrow third labial separating the chinshields from lip, certain average differences in pattern, and by having numerous spines on the hemipenis. Intergradation with *quadrivirgatus* is assumed on the basis of the "Honduras" specimen of the latter subspecies, in which the color pattern of *visoninus* is closely approached.

That *visoninus* is the most primitive race of its species is indicated by the possession of more numerous spines on the hemipenis; presence of the third labial; variability of the ventral color, some specimens retaining the primitive pigmentation, others having lost it; and the variability of the subcaudal marks, some having diffuse marks as in *veraepacis,* others with a single midventral line as in *q. quadrivirgatus.*

Range.—Foothills on Atlantic slopes from Tabasco south and east to central Honduras.

Locality Records.—(?) *Tabasco* (Dugès, 1896): (?) Tenosique (Müller, 1882; said to be in Guatemala, but I can find no town of such name in that country). *Chiapas:* Palenque (USNM 109706). *Guatemala:* St. Lucas, Sololá (MCZ 25893); La Libertad, Petén (UMMZ 74887); La Primavera, Alta Verapaz (UMMZ 2 spec.). *Honduras:* Carmelina (USNM 62971); Mataderos Mts., 3500 ft. (MCZ 38726); Portillo Grande, Yoro (FMNH 21880); Tela (MCZ 32008); "Honduras" (USNM 24899; Brit. Mus.[8]).

Adelphicos quadrivirgatus quadrivirgatus Jan

(Figure 3)

Rhabdosoma lineatum Günther (*non* Duméril and Bibron), Cat. Snakes Brit. Mus., 1858, p. 11 (Sallé specimen from Mexico); Lichtenstein, Nom. Berol., 1856, p. 23 (*part.*); Müller, Reisen Ver. Staat. Can. Mex., vol. 3, 1865, p. 605 (no specimens; record from Günther).

Adelphicos quadrivirgatum Jan, Arch. Zool., vol. 2, 1862, pp. 18–19, pl. 8; *idem,* Elenco Sist. Ofidi, 1863, p. 32; Jan and Sordelli, Icon. Gén., livr. 11, 1865, pl. 3, fig. 5; Cope, Proc. Amer. Philos. Soc., vol. 22, 1895, p. 381 (Jicaltepec, Veracruz); Ferrari Perez, Proc. U. S. Nat. Mus., vol. 9, 1886, p. 190; Cope, Bull. U. S. Nat. Mus., no. 32, 1887, p. 86; Günther, Biol. Centr. Amer., 1893, pp. 94–95

[8] Schmidt suggests (Zool. Ser. Field Mus. Nat. Hist., vol. 22, 1941, p. 503) that the "Honduras" specimen in the British Museum may be from British Honduras, as are other Dyson specimens. In such case the specimen probably should be referred to *A. q. quadrivirgatus;* data available at present are not sufficient to definitely allocate the specimen without reference to locality.

(*part.*); Cope, Trans. Amer. Philos. Soc., vol. 18, 1895, pl. 21, fig. 9 (hemipenis); *idem*, Ann. Rept. U. S. Nat. Mus., for 1898, 1900, pl. 19, fig. 9 (hemipenis); Dunn, 1932, Copeia, no. 4, p. 163; Taylor, Kans. Univ. Sci. Bull., vol. 26, 1940, pp. 453–5 (*part.;* Ocozucoautla, Chiapas).

Adelphicos quadrivirgatum acutirostrum Bocourt, Miss. Sci. Mex., 1883, p. 555, pl. 32, fig. 12 ("Mexico") (*acutirostris* in explanation of plate).

Atractus quadrivirgatus Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, pp. 312–3 (*part.;* only specimen *a*, "Mexico," collected by Sallé); Amaral, Mem. Inst. Butantan, vol. 4, 1929, p. 189 (*part.*); Werner, Zool. Jahrb., vol. 57, 1929, p. 161 (*part.*).

Adelphicos visoninus Schmidt, Zool. Ser. Field Mus. Nat. Hist., vol. 22, 1941, p. 503.

Type Locality.—"Mexico."

Specimens Examined.—Four; only seven known.

Diagnosis.—Chinshields in contact with labial border; no third labial (absent or fused with chinshields), second greatly reduced; ventrals 124 to 136 in males (3), 133 to 142 in females (3); caudals 44 to 49 in two males, 32 to 36 in 2 females; tail with a longitudinal dark streak on under side; belly typically immaculate; chin not or little spotted; four dark lines, the dorsolateral more prominent than the lateral; generally a mid-dorsal dark streak on tail; dorsolateral dark stripe involving mainly the 6th scale row.

Dentition.—In No. 11714, there are 12 dentary, 10 maxillary, 8 palatine and 20 pterygoid teeth.

Hemipenis.—In No. 11714, the hemipenis is eleven caudals long (not everted); the spinous area covers a length equivalent to four caudals; four spines larger than the others; a total of 28 spines, the smaller ones toward sulcus side; tip papillate; a flounce present.

Variation.—The supralabials are 7–7 except in one (No. 19742), which has 6–6 (6th and 7th fused); the infralabials are regularly 6–6. No preoculars, two postoculars and 1–1 temporals in all; on one side in one the secondary temporal is not fused with the upper post-temporal. The loreal is normal, and it, the third labial and prefrontal enter eye in all. The first infralabial is in contact with its mate in all.

In three there is but a single, distinct, median gular and the second is fused with a lateral gular in each; in one there are no median gulars, but the lateral gulars meet on the midventral line; in one a pregular separates the posterior chinshields (No. 11714). In two the first ventral is divided medially. In none are there any entire caudals.

The only adult (No. 11714, male) measures 239 mm. in total length, tail 40 mm.

The three Mexican specimens examined are nearly identical in pattern. A fine dark line is present on the adjacent edges of the first and second scale row; except for this line, and the extreme upper edge of the second scale row, the first two rows are white (cream), like the belly,

TABLE 4.

Scale counts and measurements (in mm.) of A. Q. QUADRIVIRGATUS.

Museum	Number	Sex	Ventrals	Caudals	Length of Frontal	Width of Frontal	Snout
FMNH	794R	♂	124	49	1.9	1.9	1.9
EHT-HMS	5461	♂	136	44	2.1	2.0	1.9
ANSP	11714	♂	131	..	2.3	2.3	2.3
AMNH	19742	♀	138	32	1.7	1.8	1.8
Milan	.....	♀ ?	142	36	..	..	..
Paris	.....	♀ ?	135	32	..	..	..
British	.....	♀	133	35	..	..	..

while dorsally the ground color between the stripes is light brown. The lateral dark stripe occupies the third and edges of adjacent scale rows, but it is split by a median longitudinal, light brown line, or else all except the edges of the scales in the third row are light. A solid, dark brown, dorsolateral stripe occupies the sixth and the edges of the adjacent scale rows. In the Chiapas specimen a narrow middorsal dark stripe is present, although represented near middle of body by a series of spots; in it the middorsal dark tail stripe is formed solely of the middorsal body stripe, and the dorsolateral body stripes disappear at about the middle of the tail. In the other two the middorsal tail stripe (vague in Veracruz specimen) is formed by coalition near the base of the tail of the two dorsolateral body stripes, since there is no middorsal body stripe. In all three there is a narrow lateral tail stripe and a fine dark line along the adjacent edges of the subcaudals and first dorsal caudals. In the Veracruz specimen there are a few dark flecks about the adjacent edges of the anterior chinshields and infralabials; in the other two the ventral surface of the head is unmarked. The belly is completely unspotted in all, and there is a midventral longitudinal dark stripe on the tail. The specimen from British Honduras has a fine dark line along the adjacent edges of the first scale row and the ventrals; the lateral dark stripe occupies the lower portion of the third and upper edge of the second scale rows; the dorsolateral stripes occupy most of the fifth and adjacent edges of the sixth scale rows; a middorsal dark stripe (less intense than the other two) occupies the vertebral scale row; on the tail the middorsal stripe is formed by the vertebral body stripe, while the dorsolateral body stripes disappear on the tail; the center of each ventral scale (except the extreme anterior one) is stippled with black, forming a dim, broken, midventral dark line; otherwise this specimen agrees with the others.

Comparisons.—For reasons stated previously, it is believed that *quadrivirgatus, visoninus* and *sargii* together form a compact group considerably different from that including *veraepacis* and *nigrilatus.*

From members of its own group, *quadrivirgatus* is distinguished largely by (1) absence of the third labial and contact of the anterior chinshields with lip (this character held in common with *sargii*); (2) color pattern, characterized chiefly by (a) presence of a median subcaudal dark stripe; (b) predominance of the dorsolateral body stripes (which form the middorsal tail stripe), and (c) absence of the middorsal body stripe (these characters held in common with some *visoninus*); and (3) ventral and caudal counts (higher than in *sargii,* about the same as in *visoninus*). In pattern this race is the most highly evolved of the genus.

Although *quadrivirgatus* and *visoninus* differ rather widely in number of hemipenial spines, it appears probable that these two subspecies intergrade in the region about the base of the Yucatán peninsula. The British Honduras specimen of *quadrivirgatus,* in external features, is just like *visoninus,* except in the absence of the third labial; the nature of the hemipenis cannot be determined. Further specimens from this area will be of much importance in demonstrating more precisely the region of intergradation of the two races.

There is no very conclusive evidence of intergradation of *sargii* and *quadrivirgatus.*

Remarks.—It is remarkable that the four specimens of *quadrivirgatus* examined are from as many different biotic provinces. This fact suggests the possibility that certain variations occurring in the subspecies may have geographic significance, since each of the four differs from the others in some notable respect. The Veracruz specimen has a pregular and the posterior chinshields separated; the British Honduras specimen has no median gulars; the Oaxaca specimen has the last two supralabials fused into a scale which does not look like a double scale, but rather like a single, large scute; only the Chiapas specimen has no noteworthy peculiarity in scutellation.

There is considerable variation in shape of the head in *visoninus* and *quadrivirgatus;* in both subspecies specimens with conical heads (as in *sargii*) occur, as well as specimens with more flattened, blunt heads. This difference was one which led to the description of *acutirostrum,* but I can find no satisfactory means of segregating two groups on the basis of this character. In applying *acutirostrum* to Mexican specimens, Bocourt was under the erroneous impression that Jan's name *quadrivirgatus* applied to specimens from Alta Verapaz. His figures of *Adelphicos* are vague concerning the character of the third labial; I attribute this not to an intermediate nature of the specimens but rather to imperfect observation, since Bocourt does not mention whether the chinshields actually are in contact with the lip.

Range.—Foothills from central Veracruz on the Atlantic coast and central Oaxaca on the Pacific, to British Honduras on the Atlantic and northern Chiapas on the Pacific.

Locality Records.—The only specific localities known are Jicaltepec, Veracruz (ANSP 11714); Pochutla, Oaxaca (AMNH 19742); Ocozucoautla, Chiapas (EHT-HMS 5461); and Silkgrass Creek, British Honduras (FMNH 794.R).

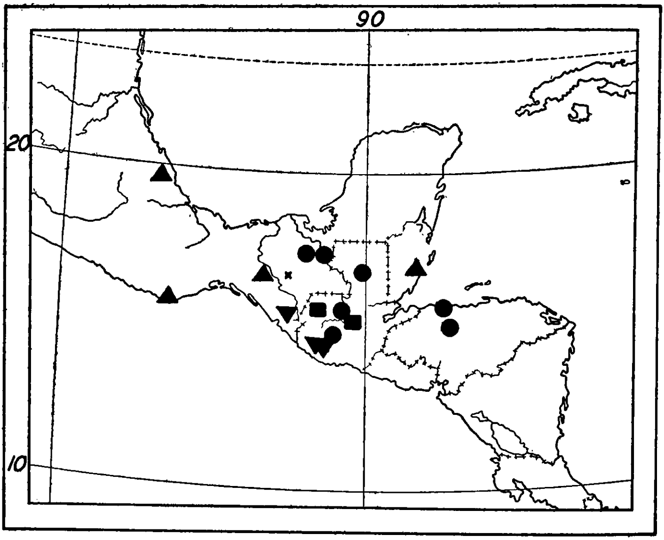

FIG. 6. Distribution of the races of *Adelphicos.* Inverted triangles, *A. q. sargii;* triangles not inverted, *A. q. quadrivirgatus;* dots, *A. q. visoninus;* rectangles, *A. v. veraepacis;* x, *A. v. nigrilatus.*

Adelphicos quadrivirgatus sargii (Fischer)

(Figure 4)

Adelphicos quadrivirgatus Müller, Verh. Naturf. Ges. Basel, vol. 6, 1878, pp. 645-5 (Costa Grande, Guatemala); Günther, Biol. Centr. Amer., 1893, pp. 94–95 (*part.*); Slevin, Proc. Calif. Acad. Sci., ser. 4, vol. 23, 1939, pp. 403–404.

Rhegnops sargii Fischer, Jahrb. Hamb. Wiss. Anst., vol. 2, 1885, pp. 92–93.

Adelphicos sargii Cope, Bull. U. S. Nat. Mus., no. 32, 1887, p. 85.

Atractus quadrivirgatus Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, pp. 312–3 (*part.;* specimens *c* and *d,* from Guatemala and an unknown locality).

Type Locality.—Guatemala.

Specimens Examined.—Sixty-two.

Diagnosis.—Anterior chinshields fused with third infralabial, bordering lip; ventrals 125 to 136 in males, 135 to 147 in females; caudals 29 to 35 in males, 24 to 29 in females; ventral surface of body and head always immaculate; subcaudal surface profusely stippled with dark color.

Dentition.—In No. 46514 there are 11 dentary, 10 maxillary, 8 palatine and 19 pterygoid teeth.

Hemipenis.—In the same specimen, the hemipenis is eleven caudals long (not everted); the basal six caudal lengths are spineless, with small, longitudinal ridges; the next three caudal lengths are occupied by six large, slender spines on antisulcus side, and about 20 smaller spines of varying size, extending toward sulcus; tip with papillae and a flounce at base of papillate area, just distal to the larger spines.

Variation.—The supralabials are 6–7 in two (5th and 6th fused on one side), 7–8 in four (3rd split on one side), 7–7 in fifty-six. The infralabials are very variable; in one the chinshields are separated from the lip by a third infralabial, and there is a total of 6–7 infralabials (4th and 5th fused on one side); there are 6–6 labials in 41, 5–6 in 11, 5–5 in 9, and 4–6

TABLE 5.

Ventral and caudal counts of A. Q. SARGII.

Museum	Number	Sex	Ventrals	Caudals	Museum	Number	Sex	Ventrals	Caudals
USNM	46612	♂	130	35	USNM	46514	♀	140	26
USNM	46614	♂	129	30	USNM	46615	♀	137	25
CAS	66727	♂	126	32	MCZ	25216	♀	143	..
CAS	66728	♂	125	30	FMNH	6973	♀	136	29
CAS	66729	♂	128	..	CAS	66725	♀	136	27
CAS	66733	♂	130	31	CAS	66726	♀	137	28
CAS	66738	♂	126	30	CAS	66730	♀	135	27
CAS	66739	♂	129	32	CAS	66731	♀	136	25
CAS	66742	♂	130	32	CAS	66732	♀	139	26
CAS	66743	♂	129	32	CAS	66734	♀	143	29
CAS	66744	♂	129	..	CAS	66735	♀	138	26
CAS	66745	♂	125	33	CAS	66736	♀	140	25
CAS	66746	♂	125	31	CAS	66737	♀	137	27
CAS	66749	♂	125	32	CAS	66740	♀	138	..
CAS	66750	♂	125	35	CAS	66741	♀	138	27
CAS	66751	♂	128	30	CAS	66747	♀	142	25
CAS	66745	♂	129	32	CAS	66748	♀	136	26
CAS	66843	♂	134	33	CAS	66752	♀	135	28
CAS	66846	♂	126	32	CAS	66753	♀	141	28
CAS	66848	♂	133	29	CAS	66844	♀	143	27
CAS	66850	♂	132	33	CAS	66845	♀	145	25
CAS	66851	♂	132	33	CAS	66847	♀	137	28
CAS	66852	♂	136	32	CAS	66849	♀	136	27
CAS	66853	♂	129	30	CAS	66854	♀	138	27
CAS	66857	♂	130	34	CAS	66855	♀	142	28
CAS	66859	♂	129	32	CAS	66856	♀	147	26
CAS	66860	♂	128	..	CAS	66858	♀	138	24
CAS	66861	♂	136	29	CAS	66863	♀	136	24
CAS	66862	♂	129	31	CAS	66865	♀	138	25
CAS	66864	♂	129	32	CAS	66865	♀	137	27
CAS	66867	♂	126	32					
CAS	66868	♂	128	32					

in 1; generally when there is a reduction to 5 the 4th and 5th are fused. There are regularly no preoculars, and the postoculars are 2–2 in all except 2 specimens, in one of which the two are fused together on both sides, while in the other the lower postocular is fused with the 4th labial on one side. The temporals are 1–1 in all; in 8 the secondary temporal is separated from the nuchal on one side, and in 3 this is the condition on both sides. The loreal is split vertically near the middle on one side in 4, on both sides in one; it does not reach the eye in two (both sides). The third labial is separated from the eye in 3 (both sides). The 1st infralabial is in contact with its mate in all but 1. The posterior chinshields are separated medially in two, in which there is a pregular. There are two distinct median gulars in 23, only one distinct gular in 38, and in 1 there are no median gulars (lateral gulars meet on midventral line); in one the posterior gular is fused with both lateral gulars, producing a scale similar in form to the ventrals. The first ventral is split(into two sections) in 16, and the second is split in two. In five specimens there are one to three entire caudals near base of tail.

The largest specimen examined (FMNH 6973, female) measures 309 mm. in total length, the tail 41 mm.

The species is relatively constant in color and pattern. The dorsal ground color is very dark, and the stripes, although present, are greatly obscured, even in young specimens. Most characteristic is the light, unmarked chin and belly. The ventral surface of the tail is heavily stippled, sometimes more heavily near midventral line. The sides of the body are dark, the color involving the edges of the ventrals and the lower part of the third scale row; a dorsolateral dark stripe extends along the adjacent edges of the 4th and 5th scale rows; a middorsal dark stripe is generally present, and in young specimens it can be seen extending nearly to the tip of the tail. The dorsolateral stripes disappear on the tail, and the broad, lateral dark stripes extend nearly to the tip of the tail.

TABLE 6.

Head measurements (in mm.) of A. Q. SARGII.

Museum	Number	Length of Frontal	Width of Frontal	Snout
MCZ	25216	2.4	2.3	2.9
USNM	46612	2.2	2.2	2.2
USNM	46615	1.9	1.8	2.1
USNM	46614	2.0	1.9	2.1
CAS	66856	2.2	2.1	2.1
CAS	66854	2.1	2.1	2.2
CAS	66745	2.2	2.0	2.2
CAS	66857	2.0	1.8	2.0
CAS	66732	2.1	1.8	2.0
CAS	66858	2.2	2.2	2.2
CAS	66751	2.3	2.2	2.2
CAS	66740	2.3	2.1	2.6

Comparisons.—This subspecies is a close relative of *quadrivirgatus,* with which it agrees in all respects except in ventral and caudal counts and in the dark ground color.

Remarks.—While specimens are available from "St. Lucas, Guatemala" of both *visoninus* (MCZ 25893) and *sargii* (MCZ 25216), I do not feel that these locality data are sufficiently exact to warrant supposition that the two forms occur together. This possibility is suggested, however, and places some doubt upon the present arrangement of *sargii, quadrivirgatus* and *visoninus* as subspecies of the same species.

It appears probable that *sargii* was derived from *visoninus* rather than from *quadriviragatus,* since it has retained the primitive subcaudal and dorsal pigmentation. Specimens of *visoninus* from interior regions have the same subcaudal markings as *sargii,* while peripheral specimens resemble *quadrivirgatus* in this respect. In scutellation *sargii* is the most highly evolved race of the genus, and shares with *quadrivirgatus* the complete loss of belly and chin markings.

Range.—Foothills on Pacific slopes from southern Chiapas to central Guatemala.

Locality Records.—Chiapas: Chicharras (USNM 46514, 46612, 46614–5). *Guatemala:* Patulul (FMNH 6973); St. Lucas (MCZ 25216); Finca El Ciprés, Volcán Zunil (CAS 66725–66869).

REMARKS ON THE MEXICAN KING SNAKES OF THE TRIANGULUM GROUP [1]

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One of the most intricate herpetological problems in Mexico is the interrelationships and limits of variation of the members of the *triangulum* group of *Lampropeltis.* It is a problem which has received considerable attention, and the fact that a state of some confusion and doubt still exists is perhaps largely due to inadequate locality data for specimens which, with data, would very nearly be sufficient to solve the problems that so far have arisen. Accuracy of locality data cannot be overemphasized; lack of it, and actual misrepresentation of it, have greatly hampered progress toward an understanding of the distribution and status of many forms.

This study has been completed during tenure of the Walter Rathbone Bacon Traveling Scholarship of the Smithsonian Institution.

Lampropeltis triangulum annulata Kennicott

Lampropeltis annulata Kennicott, Proc. Acad. Nat. Sci. Phila., 1860, p. 329 (Matamoras, Tamaulipas).

Lampropeltis triangulum annulata, Blanchard, Bull. U. S. Nat. Mus., no. 114, 1921, pp. 159–164 (*part.*); Taylor, Kans. Univ. Sci. Bull., vol. 26, 1940, p. 466 (Mamulique Pass, Nuevo León).

Diagnosis.—Scales in red areas never black-tipped; snout black, never with light marks; 19 to 26 white rings on body and tail, all complete ventrally; red bands broad, interrupted on belly by broad black areas; belly thus with a series of long, black blotches separated by narow white rings; black rings not confluent dorsally across red areas.

Range.—A lowland-inhabiting subspecies, occurring from extreme southern Texas to central Nuevo León. Presumably intergrades with (or is separated from) *polyzona* in the Tampico area. Intergradation with any other form in Mexico improbable.

Remarks.—Under this name Blanchard confused two distinct subspecies: one of them *annulata* as above diagnosed, the other *arcifera* as below discussed. The latter is represented by the "Puebla" (MCZ) specimen, figured and described in detail by Blanchard, and probably by the "Tehuantepec" specimen (of Boulenger) tentatively referred to *annulata* by Blanchard. Several other specimens, referred to *polyzona* by Blanchard, actually belong to *arcifera,* the characters of which are discussed below. It is here sufficient to remark that *annulata* does not ap-

[1] Received for publication November 21, 1941.

proach it either geographically or in pattern, and that in all probability the two do not directly intergrade.

Lampropeltis triangulum nelsoni Blanchard

Lampropeltis triangulum nelsoni Blanchard, Occ. Papers Mus. Zool. Univ. Mich., no. 81, 1920, p. 6, fig. 1 (Acámbaro, Guanajuato); *idem*, Bull. U. S. Nat. Mus., no. 114, 1921, pp. 155–158, fig. 65 (*part.*); Taylor, Kans. Univ. Sci. Bull., vol. 26, 1940, p. 465 (*part.*).

Diagnosis.—Scales in red areas never black-tipped; snout light, mottled; red, white and black rings complete around body; red rings broad, not enclosed dorsally (a tendency toward the eastern part of range).

Range.—A highland-inhabiting subspecies, occurring from southern Sinaloa to Colima, eastward to eastern Michoacán and eastern Guanajuato. Intergrades with *arcifera* in eastern Michoacán. Intergradation with *blanchardi* in Guerrero indicated; intergradation with *annulata* very improbable.

Remarks.—With the exception of specimens from the Tres Marías Islands (*schmidti*), *nelsoni* of Blanchard is the same as that here considered under that name. He notes, however, that "While the color pat-

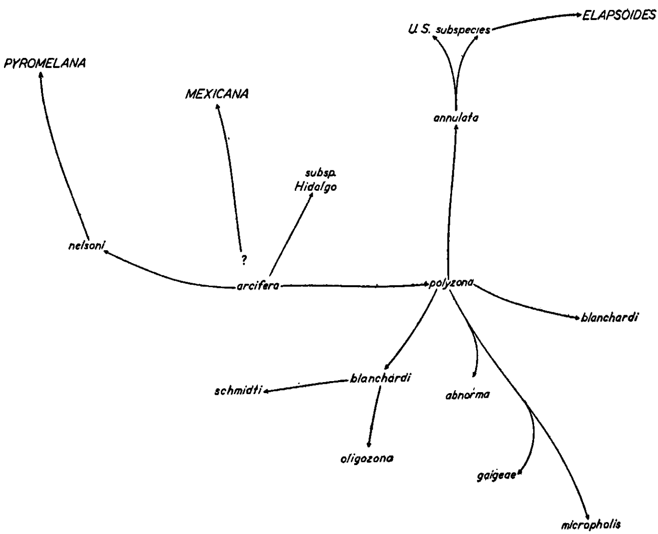

FIGURE 1. Possible phylogeny of the Mexican subspecies of *Lampropeltis triangulum*. Names in capital letters are of subgroups of the *triangulum* group.

tern seems to be constant on the west coast [not the coastal plain], it is very noticeable that toward the interior of Mexico some specimens have the spaces on the belly opposite the dorsal red area partially or completely filled with black, presenting in this a striking approach to *annulata.* The snout, too, may be blacker and the red interspaces between the pairs of black rings may be much narrower and strongly encroached upon by the latter." These tendencies are not toward *annulata,* but toward *arcifera,* a subspecies occupying an adjacent area on the plateau.

It is conceivable that *nelsoni,* with its complete rings, is ancestral to the forms of the *pyromelana* subgroup (see figure 1).

Lampropeltis triangulum arcifera (Werner)

Coronella micropholis arcifera Werner, Zool. Anz., vol. 26, 1903, p. 250 (Mexico).

Coronella micropholis Boulenger, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 205 (*part.;* the "Tehuantepec" specimen).

Lampropeltis polyzona polyzona Blanchard, Bull. U. S. Nat. Mus., no. 114, pp. 139–148, fig. 64 (*part.;* certain specimens from "Mexico," "Orizaba" and "Mirador").

Lampropeltis triangulum annulata Blanchard, *op. cit.,* pp. 159–164 (*part.;* specimen from "Puebla"); Mertens, Abh. Mus. Magdeburg, vol. 6, 1930, p. 160 (Cuautla, Morelos).

Lampropeltis triangulum nelsoni Taylor, Kans. Univ. Sci. Bull., vol. 26, 1940, pp. 465–466 (*part.;* specimen from 15 kilometers west of Morelia, Michoacán).

Diagnosis.—Scales in red areas black-tipped toward the eastern part of range, not toward the western; belly irregularly mottled, or suffused with black, or black areas only opposite red areas; black rings very broad, encroaching upon red areas and sometimes meeting middorsally; red rings seldom longer than a single black ring middorsally; few (usually one) tail bands split with red. (See Plate 1, fig. 1.)

Range.—A highland-inhabiting subspecies, occurring from Morelos and eastern Michoacán eastward to the edge of the plateau in Veracruz, and probably southward toward (not to) Tehuantepec. Intergrades with *nelsoni* and *polyzona,* probably not with *annulata.*

Remarks.—The chief character of this subspecies is the close approximation of the black bands, which frequently meet across the red bands. This peculiarity is found in U.S.N.M. 110823, 30222, from Orizaba (the locality for the former is authentic; it was captured on the city golf links); U.S.N.M. 25012, "Mirador," Veracruz; U.S.N.M. 1854, 32278, no locality; Mus. Comp. Zool. 9555, Puebla (fig. 66, Blanchard); EHT-HMS 15868, 15 km. west of Morelia, Michoacán; a specimen reported by Mertens (*loc. cit.*) from Cuautla, Morelos; and a specimen reported by Boulenger (*loc. cit.*) from "Tehuantepec." These records show a range covering the southern apex of the Mexican plateau. From within this area no other type of pattern has been reported; and from without the *arcifera* type of pattern is mentioned in only one case: by Stuart (Occ. Pap. Mus. Zool. Univ. Mich., no. 309, 1935, p. 3) for MCZ 29242 from Chichen Itza, Yucatán, in which "the black bands expand dorsally to crowd out the intervening pink." These facts leave little doubt of the validity of *arcifera,* and its separation greatly clarifies an understanding of the interrelationships of the Mexican subspecies.

It is possible that *arcifera* may be further split, since extreme eastern specimens have the scales in the red areas black-tipped, while central and western specimens have the scales uniform red. However, because of the existence of these two phases within *arcifera,* I believe this form is a connecting link between the species *polyzona* and *triangulum* of Blanchard, and that it, not *annulata,* is the most primitive of the group. It gives definite evidence that the *triangulum* group originated from a form with simple black and white rings or blotches—obviously some form not greatly different from certain ones in the *getulus* group.

Lampropeltis triangulum blanchardi Stuart

Lampropeltis triangulum blanchardi Stuart, Occ. Papers Mus. Zool. Univ. Mich., no. 309, 1935, pp. 1-6 (Chichen Itza, Yucatán); Taylor, Kans. Univ. Sci. Bull., vol. 26, 1940, p. 467, pl. 49 (El Limoncito, near Acapulco, Guerrero).

Diagnosis.—"Readily distinguishable from *polyzona,* to which it is closest, by the absence of the white snout band, producing an entirely black snout; by its lower average number of ventrals, 208 as compared with 225 in *polyzona;* and by its lower average number of annuli, 25 in *polyzona* and 19 in *blanchardi.*"

Range.—Lowlands of Yucatán and Guerrero. Intergrades with *polyzona,* perhaps with *nelsoni.*

Remarks.—I can see no reason for separation of Guerrero specimens from Yucatán *blanchardi,* in spite of the fact that the former may (not proved) approach *nelsoni.* Both populations of *blanchardi* are pretty obviously derivatives of *polyzona,* and neither is related to the other except through *polyzona.* If the characters of the two populations are the same, however (as they are, for all practical purposes), and they are derived from the same stock (as they definitely are), I see no reason whatever for holding them as different subspecies, although different populations they undoubtedly are. These perhaps are examples of parallel evolution. It is to be noted that an established trend in *polyzona* and its close relatives is decrease in number of bands; this is followed by *annulata, micropholis, and nelsoni,* as well as *blanchardi.*

It is possible that Guerrero *blanchardi* gave rise to *schmidti,* since it, not *nelsoni,* is the adjacent lowland species on the mainland. The fact that *schmidti* lacks dark spots at the tips of the red scales does not necessarily mean that it must be a derivative of *nelsoni*, similar in this character, for there is a very marked tendency in northern and high altitude derivatives of *polyzona* to lose these spots: *annulata* toward the north (and all its derivatives in the U. S.) has lost them, as have *nelsoni* toward the northeast, and high altitude Chiapas and Guatemala *polyzona*. Except for ancestral *polyzona* (more properly, eastern *arcifera*) and *lowland* derivatives *toward the south* (*blanchardi, micropholis*), all derivatives of the *polyzona* stock have lost the spots at the tips of the red scales. It is not likely that *nelsoni*, a highland species, was ever distributed over the lowlands of western Mexico and became established on the land that now forms the Tres Marias Islands; it is much more probable that the island form, *schmidti*, was derived from the lowland race, *blanchardi*.

Lampropeltis triangulum schmidti Stuart

Lampropeltis triangulum schmidti Stuart, Occ. Papers Mus. Zool. Univ. Mich., no. 323, 1935, pp. 1–3 (Tres Marías Islands).

Diagnosis.—"A *Lampropeltis* very similar to *Lampropeltis triangulum nelsoni* from which it may be distinguished by: 1. Greater number of ventrals, 228 to 233 in *schmidti* as compared with 200 to 221 in *nelsoni*. 2. Much wider yellow bands between the black annuli, at least 2½ scales wide in middorsal region in *schmidti* as compared with 1 to 1½ scales wide in *nelsoni*. Conversely the red (in life) spaces between the pairs of black annuli are narrower in *schmidti*. 3. Much lighter snout. 4. Posterior chinshields always separated."

Range.—Restricted to the Tres Marías Islands. Not known to occur on the mainland, although lowland specimens on the mainland may prove the same. Does not intergrade with any form, so far as now known, but apparently is a derivative of *blanchardi*.

Lampropeltis triangulum polyzona Cope

Lampropeltis polyzona Cope, Proc. Acad. Nat. Sci. Phila., 1860, p. 258 (Cuatupe, Jalapa, Veracruz).

Diagnosis.—Scales in red areas tipped with black; black rings not encroaching middorsally upon red areas; red rings nearly or quite as long as adjacent triads of black and yellow rings, rarely not at least twice length of a single black ring; usually a white band across top of a black snout; usually white rings closed (black) ventrally; ventrals 208 to 239; annuli 18 to 32.

Range.—Atlantic coastal regions from northern Veracruz into Guatemala, avoiding Yucatán.

Remarks.—The preceding discussion has indicated that Guerrero, Yucatán and all highland specimens from the central plateau of Mexico may be removed from *polyzona polyzona* of Blanchard. Remaining are specimens from the lowland of Veracruz; the lowland of Guatemala and other Central American countries; the Pacific highland of Chiapas; and the Atlantic highland of Guatemala. I cannot see that the *lowland* Veracruz, Guatemala and Honduras specimens differ appreciably from each other; they appear to me to form a unit, approaching the characters of *micropholis* toward the south, as pointed out by Dunn (Occ. Pap. Mus. Zool. Univ. Mich., no. 353, 1937, pp. 3–9). This is the race to which Cope's name *polyzona* is applicable.

The residue of specimens are from foothill zones in two isolated areas: one in southern Chiapas and Guatemala, and the other in the Alta Verapaz area of Guatemala. The latter is in some doubt, since the four specimens inferred to be from that area are labelled simply "Guatemala" (U.S.N.M. No. 6761, three specimens collected by H. Hague, and Field. Mus. Nat. Hist. No. 187). These four are characterized by nearly complete or complete absence of dark tips on the red scales (F.M.N.H. specimen not seen), numerous white rings (29 to 37), and numerous ventrals (225 to 239). These specimens may be considered to represent a direct derivative of an ancient population which north of the Isthmus gave rise to *polyzona*. *Coronella formosa abnorma* Bocourt (Miss. Sci. Mex., Rept., livr. 10, 1886, pl. 39, fig. 4) was proposed for a specimen from this area ("Haute Vera Paz"), but it agrees with the other specimens only in the high ventral count (239, p. 614, under *anomala*). The bands on the body number only 25, and although there is no specific reference to the black tips on the red scales, Bocourt's statement that the coloration is identical with that of *L. polyzona* leads to the inference that the black tips are present. The type very possibly is an intergrade between the typical lowland and the typical highland or foothill race. Since there is no other name which could be used for the highland race, it is suggested that Bocourt's name be restricted to it; the name accordingly should stand as *Lampropeltis triangulum abnorma* (Bocourt). The race may possibly enter Mexico in the ranges of northern Chiapas.

A specimen from Huehuetan, southern Chiapas (U.S.N.M. No. 46439), like those from Guatemala, is characterized by the complete absence of black tips on the red scales, but it is unique in having only 17 white rings (18, minimum in *polyzona sensu strictu*). With it is to be associated U.S.N.M. No. 62210, in which the red scales completely lack tips and the white rings number 16; unfortunately this specimen lacks locality data; it was collected by Sumichrast and therefore may be from some locality east of the Isthmus of Tehuantepec in the mountains of Chiapas or extreme eastern Oaxaca. These specimens seem to represent a well-characterized race which was named *Coronella formosa oligozona* by Bocourt (op. cit., p. 614, pl. 39, fig. 8) on the basis of eight specimens from "Tehuantepec" (Sumichrast) and the western slopes of Guatemala. The figured specimen (from Tehuantepec) lacks black tips on the scales in the red areas, and the description says the body bands vary from 10 to 16, the ventrals from 206 to 227. A brief diagnosis is appended below.

A final color phase represented by specimens available at present is exemplified by U.S.N.M. No. 7103, from "Orizaba" (almost certainly incorrect) and No. 4506, from "Mexico" (collected by Montes de Oca). These specimens are typical *polyzona,* except that the whole belly is suffused with dark color, and is practically uniform black. This condition is indicated in one of two *polyzona* presumably from Tuxpam, Veracruz, and in an *arcifera* from unknown locality. While this may be merely individual variation in *polyzona,* its occurrence in northern specimens, and especially in *arcifera,* leads me to believe it possibly characterizes a form intergrading with *arcifera* and perhaps with *polyzona.* It cannot be a recognizable lowland form, since *annulata* nearly meets *polyzona* (and may actually do so), and since the identifying character occurs in a specimen of the highland *arcifera.* If such a subspecies does exist, therefore, it may be a highland-inhabiting form. It may occur in the eastern mountains of Hidalgo, since no specimens are definitely known from this area. No name is available for it.

Lampropeltis triangulum oligozona (Bocourt)

Coronella formosa oligozona Bocourt, Miss. Sci. Mex., Rept., livr. 10, 1886, pp. 614–615, pl. 39, fig. 8 (in color).

Diagnosis.—Like *t. polyzona,* except: no black tips on scales in red areas (present in *polyzona*); and white rings on body 14 to 17 (18 to 32 in *polyzona*).

Range.—Foothills of southern Guatemala northwestward through the mountains of southern Chiapas to the Isthmus of Tehuantepec.

Lampropeltis mexicana (Garman)

Ophibolus triangulus mexicanus Garman, Mem. Mus. Comp. Zool., vol. 8, 1883, p. 66 (San Luis Postosí, S. L. P.).

Lampropeltis mexicana Blanchard, Bull. U. S. Nat. Mus., no. 114, 1921, pp. 245–247, fig. 77.

This species, one of the rarest of *Lampropeltis,* is now represented in the Museum of Comparative Zoology by twelve specimens, including the two cotypes. The types are from near the city of San Luis Potosí, while the others are from Alvarez, S. L. P. (Nos. 19022–5,[8] 24976–81). The only other known specimen of the species is the type of *Oreophis boulengeri,* now in the Alfredo Dugès Museum in the State College in Guanajuato city. The latter has been examined by me, and in addition, through

[8] These were reported by Loveridge in 1924 (Occ. Papers Bost. Soc. Nat. Hist., vol. 5, pp. 138–139) as *leonis.*

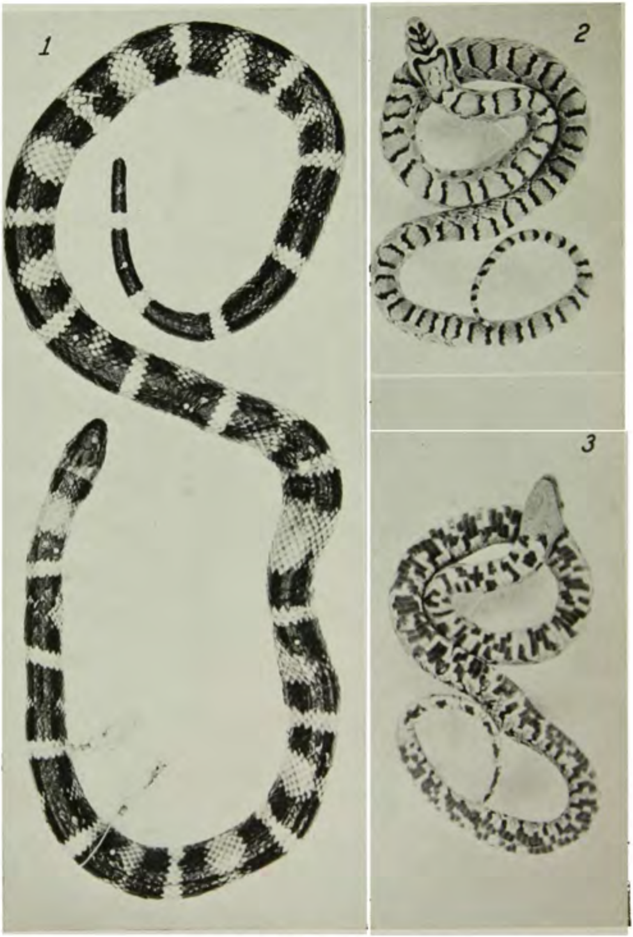

PLATE I

FIGURE 1. *Lampropeltis triangulum arcifera*, dorsal view. From EHT-HMS No. 15868, 15 kilometers west of Morelia, Michoacán.

FIGURE 2. The type of *Oreophis boulengeri*, dorsal view.

FIGURE 3. The type of *Oreophis boulengeri*, ventral view.

the courtesy of Messrs. Loveridge and Shreve, the entire series from Alvarez has been made available to me for study. The following notes on variation are based upon these eleven specimens. (cf. Table 1, p. 207.)

The head patterns of the Alvarez specimens are essentially like that of the type of *Oreophis boulengeri* (plate 1, fig. 2). In none, however, are there two separate extensions of the frontal spot onto the prefrontals, although in several the frontal spot is much enlarged and involves the posterior part of the prefrontals. Usually the black border is incomplete anteriorly when the frontal spot is large. The parietal spots may be fused medially or completely separated (not even the black borders touching) from each other and from the frontal spot. The postocular dark spot is present and well defined in six, absent or poorly defined and small in four.

The nuchal spot is invariably the largest on the body, and usually has a light spot (certainly in seven, possibly in another, absent in two), and occasionally a few other anterior blotches are light-centered.

In one specimen the belly is almost entirely light, with a very few small dark marks toward the sides of the belly. Other specimens show conditions intermediate between this extreme and that represented by the type of *Oreophis boulengeri* (plate 1, fig. 3). The tail is mottled below, and occasionally the dark marks show some tendency toward formation of a midventral line; in none is such a line distinct.

The size of the dorsal blotches varies considerably; they cover from a little less than two to seven and one-half scale lengths; the spaces between them, however, are very constant in size, including one or two scale lengths middorsally. All the tail blotches (except sometimes the extreme distal blotch) are mixed or split with red.

In all specimens measuring 450 mm. or more in total length, the dorsal ground color is heavily suffused with black pigment, except for narrow, irregular areas about the blotches. In smaller specimens the general darkening of the ground color is not obvious, although the same areas show fine, black stippling under the microscope.

Hemipenis of No. 24981 (not everted) about nine caudals long, perhaps very slightly bilobed; extreme distal tip fringed calyces, abruptly grading into an area (equal to the length of about three and one-half caudals) of very small spines; latter somewhat increasing in size toward base, very numerous and closely placed; remainder of hemipenis ridged, each ridge surmounted by a row of widely spaced, extremely minute spicules or spines. Sulcus single.

It is to be noted that the hemipenial characters of this species definitely place it with the *triangulum* group, to which it is similar in essential features of the color pattern.

Lampropeltis alterna (Brown)

Ophibolus alterna Brown, Proc. Acad. Nat. Sci. Phila., 1901 (issued 1902), p. 612, pl. 34 (Davis Mts., Jeff Davis Co., Texas).

Lampropeltis alterna Stejneger and Barbour, Check List N. Amer. Amph. Rept., 1917, p. 87.

A male specimen of *alterna* collected by Mrs. Smith and myself near Saltillo, Coahuila (U.S.N.M. 110819) has a hemipenis typical of the *triangulum* group. It is about seven caudals long; the extreme distal portion is covered by fringed calyces, which grade into an area, reaching to middle of organ, of very numerous, small, straight spines slightly increasing in size proximally.

These hemipenial characters indicate that *mexicana* and *alterna* are more closely related *inter se* and to *triangulum* and *pyromelana* (with their immediate relatives) than any of these is to *elapsoides,* which Blanchard was able to place without question in the *triangulum* group. The chief hemipenial differences of *elapsoides* from the other members of the *triangulum* group are (1) the greater extension of the spinous area toward the base of the organ, and (2) decrease proximally in the size of the spines. In other members of the *triangulum* group the spines reach only to the middle of the hemipenis, and they gradually increase in size proximally.

Accordingly, there is less reason to entertain the idea that *alterna* should not be included in *Lampropeltis* than there is for *elapsoides,* so far as indicated by hemipenial characters. It certainly is closer to *triangulum* than to any member of other groups of the genus, since all others have few, hooked spines on the hemipenis, and the calyces are not fringed. Moreover, it appears that *alterna* may have been derived from *mexicana.* It is apparent that its peculiar pattern, with red in the alternate black bands, rather than in all the black bands as in other members of the group, has been brought about by an antero-posterior contraction of the black bands, carried to such an extreme that only about half the black bands remain with red. Usually these are alternating bands, but not always, for sometimes the "secondary" black bands also have red, as shown by both Murray's specimen from the Chisos Mts. (Contr. Baylor Univ. Mus., no. 24, 1939, pp. 9–12, figs.) and my own from Saltillo. In the former "some of the narrow bands on the anterior portion of the snake are bordered by red," while in the latter several of the posterior bands are split with red. It is apparent that only by mere coincidence did the type specimen of *alterna* have only the alternate bands split with red.

It is obvious that *alterna* must have been derived from a form having many bands, all split with red; from a form with a dark-pigmented ground color; and from one with a tendency toward elimination of head markings. *Lampropeltis mexicana* fits these requirements. There is in that species a tendency toward multiplication of the bands; the head markings tend to be restricted to three spots (frontal, two parietal); and the ground color obviously tends to be very dark in adults.

An essential link in the *mexicana-alterna* chain is *leonis,* a species known only from the type ("Nuevo León") in the British Museum (well figured by Günther, Biol. Centr. Amer., 1893; pl. 39, fig. A). This species was placed by Blanchard in the *calligaster* group, but it cannot belong there.

In evolution of head pattern, *leonis* exhibits a condition intermediate between that of *mexicanus* and *alterna;* the basic three-spot pattern of the former is shown, but a great reduction in the size of each spot demonstrates a reduction trend which in *alterna* reaches its extreme.

In evolution of nuchal pattern also, *leonis* is intermediate. It shows a reduced, but elongate nuchal blotch, partially split medially, obviously derived by reduction from the type exhibited by *mexicana.* In *alterna* (Saltillo specimen) the blotch is still further reduced to two, elongate, lateral spots in exactly the same position as their counterparts in *mexicana* and *leonis.*

In body pattern *alterna* is intermediate between the other two. It retains almost exactly the usual belly color of *mexicana* (mottled). In *leonis* the pattern is greatly reduced, beyond the condition found in *alterna:* most of the dark ventral marks are eliminated, and on the subcaudal surface there remains only a median longitudinal stripe; scarcely any of the narrower, black bands remain on the dorsal surface, there being only the widely spaced, narrow, red bands bordered with black; the narrower bands, corresponding to those of *alterna,* are mostly reduced to a small, lateral spot, and only one or two remain visible as bands; finally, the lateral extensions of the bands split with red are eliminated.

All three species exhibit a darkened ground color, characteristic of their own subgroup.

It appears, therefore, that *leonis* and *alterna* were derived from a form or forms much like *mexicana.* In the evolution of these species the blotches were increased somewhat in number, from that occurring in *mexicana,* until a considerable crowding of them occurred (as is shown on certain parts of the body in some *mexicana*). As the tendency is to retain a certain distance between blotches, regardless of number, some of them of necessity were so narrow the red was eliminated from them. As in many other groups of snakes, this multiplication in number of spots was the forerunner of general pattern reduction, and not only did certain blotches or bands lose their red, but all of them then were constricted antero-posteriorly. At the same time the head pattern was being reduced. *L. alterna* and *leonis* evolved no further in common (or along parallel paths), but were separated at about this stage. In the former the reduction of head pattern became complete, but change in body pattern was slowed. In *leonis* the reverse was true. The trend is toward a unicolor snake, nearly approached in *leonis*.

The peculiar method of pattern reduction in the *mexicana* subgroup—by elimination of alternate blotches—is remarkably similar to that apparent in the *biscutatus* group of *Trimorphodon*, in which *quadruplex*, a forms with numerous, subdivided blotches, gives rise to *biscutatus*, a form with about half the complement of the former. In each case suppression of alternate blotches is evident. The same procedure is indicated in the evolution of certain other end forms of *Trimorphodon*, although the evidence is not so complete as in the described cases. Apparently, then, this may be one of the more frequent methods of pattern reduction in snakes.

It appears that *mexicana* and its two relatives form a subgroup in the *triangulum* group, comparable to the *elapsoides* and *pyromelana* subgroups. The arrangement of the subgroups accordingly is as follows:

triangulum subgroup
- t. arcifera
- t. abnorma
- t. blanchardi
- t. schmidti
- t. oligozona
- t. gaigeae
- t. micropholis

———

- t. nelsoni

———

- t. annulata
- t. gentilis
- t. amaura
- t. syspila
- t. triangulum
- t. temporalis

elapsoides subgroup
- e. elapsoides
- e. virginiana

pyromelana subgroup
- thayeri

———

- ruthveni
- knoblochi
- zonata
- pyromelana

mexicana subgroup
- mexicana
- leonis
- alterna

KEY TO MEXICAN LAMPROPELTIS

1. Pattern of narrow crossbands of black, the alternate bands mixed or split with red .... *alterna*
   Not so 2
2. Pattern without red, of two colors (black or brown, and white) 3
   Pattern with red, of three colors 4
3. Light crossbands separating broader dark rings which are unmarked with white on the dorsal scales .... *getulus yumensis*
   Light crossbands absent or, if present, separating narrow dark blotches which do not reach the ventral scales; lateral scales white-centered .... *getulus splendida*
4. A zigzag lateral white line on third and fourth scale rows; red bands (blotches) numerous (70 in types), only a few broken medially by contact of adjacent black borders .... *knoblochi*
   No such lateral line; red bands (blotches) rarely so numerous, and when about 70, most are broken medially by contact of adjacent black borders 5
5. Pattern of dark-edged dorsal blotches of red 6
   Pattern in rings 7
6. No markings on sides of body; blotches on body 27; separated from each other by twice (or more) their own length, areas between covering four to seven scale lengths .... *leonis*
   Irregular dark markings on sides of body; blotches on body 31 to 47, the spaces between covering one to one and one half scale lengths (less than the length of a single blotch) .... *mexicana*

7. White rings or crossbands on body and tail more than 40 .... *pyromelana*
White rings less than 40 8

8. Scales in red areas black tipped 9
Scales in red areas not black tipped 12

9. Red rings narrowed middorsally by expansion of the black rings, which sometimes meet across red areas; latter seldom longer than a single black ring middorsally .... *triangulum arcifera*
Red rings not distinctly narrowed middorsally, longer middorsally than black rings 10

10. Whole belly suffused with black .... *triangulum* subsp. (Hidalgo?)
White bands usually interrupted ventrally, black bands complete; belly sometimes mottled, but not wholly suffused with black 11

11. Ventrals 208 to 239, usually 220 or more; white annuli on body and tail 18 to 35, usually 21 or more .... *triangulum polyzona*
Ventrals 203 to 219; annuli on body and tail 17 to 22, usually 20 or less ...... *triangulum blanchardi*

12. Red rings narrowed middorsally by expansion of the black rings, which sometimes meet across red areas; latter seldom longer than a single black ring middorsally .... *triangulum arcifera*
Red rings not distinctly narrowed middorsally, longer than black rings 13

13. Red bands interrupted on belly by broad black areas connecting the black rings, white rings complete about body .... *triangulum annulata*
Red bands not interrupted completely; white rings complete or interrupted .. 14

14. Head uniform black to tips of parietals; white rings on body and tail 30 ...... *ruthveni*
Head with light markings 15

15. A red band or blotch on top of head, remainder of head mottled white and black; white rings on body and tail 31 .... *thayeri*
Head black and white, not mottled (except snout) 16

16. White rings two and one half scale lengths middorsally; ventrals 228 to 233 .... *triangulum schmidti*
White rings narrower, about one and one-half scale lengths 17

17. Ventrals 200 to 224; snout light .... *triangulum nelsoni*
Ventrals 227 to 235; snout dark, with a transverse white bar .... *triangulum oligozona*

TABLE 1.

Variation in LAMPROPELTIS MEXICANA (*Garman*).

Number	Sex	Scale Rows	Vent.	Caud.	Supl.	Infl.	Proc.	Ptoc.	Spots	Total Length (mm.)	Tail Length (mm.)
19022	♂	21–23–19	199	60	7–7	10–10	1–1	2–2	36–9	257	43
19023	♂	21–23–19	191	58	7–7	9–9	1–1	2–2	39–11	245	41
19025	♂	21–23–19	193	56	7–7	10–10	1–1	2–2	35–11	250	41
24977	♂	19–23–19	192	59	7–7	9–9	1–1	2–2	31–9	594	100
24979	♂	21–23–19	195	56	7–7	9–9	1–1	2–3	41–9	288	46
24981	♂	23–23–19	194	57	7–7	9–9	1–1	2–3	37–10	777	128
19024	♀	21–23–19	196	53	7–7	10–10	1–1	2–2	47–11	745	118
24976	♀	21–23–19	193	..	7–7	9–10	1–1	2–2	32–?	643+	93+
24978	♀	23–23–19	199	56	7–7	9–10	1–1	2–2	36–9	638	105
24980	♀	23–26–21	199	..	7–7	10–10	1–1	2–2	34–9	622+	95+
4652	♀	23–21–19	193	55	7–7	10–10	1–2	2–2	39	803	...
4653	♀	23–21–19	199	55	7–7	10–10	1–1	2–2	39	452	...
Gto.	♀	21–23–19	191	51	7–7	10–10	1–1	2–2	33–8	380	60

WILLIAM BARTRAM'S NAMES OF BIRDS[1, 2]

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The names to be discussed here were all published in Bartram's *Travels* (original edition of 1791). The vicissitudes that they have experienced constitute an interesting and rather strange chapter in the annals of Amercan ornithology.

We need not here concern ourselves particularly with the use of some of Bartram's names by Wilson and others in the early part of the past century. That was largely before the day of the serious discussion of nomenclatural principles and the adoption of codes of nomenclature (beginning with the Stricklandian Code of 1842).

We may take up a historical review of these names at the point where they began to be discussed by Dr. Elliott Coues, their principal and almost sole champion hitherto. In the original edition of his *Check List of North American Birds* (1873; reissued in his *Field Ornithology* of 1874), he utilized certain of Bartram's specific names; *e. g., Cathartes atratus* (Bartr.), *Aphelocoma floridana* (Bartr.), and *Quiscalus purpureus* (Bartr.).

In 1875 Coues published a brilliant and (in a large measure) justifiable defense of such of Bartram's names as are binominal. He reprinted the descriptive catalogue of 215 birds from pages 289 to 296 of the *Travels,* and identified the species, in so far as he was able, in the light of contemporary ornithological knowledge. Coues maintained (1875, p. 342) that Bartram "is systematically binomial on principle, with occasional lapses, which, however, do not invalidate his system any more than the similar deviations from strict binomiality in the . . . cases of Schlegel or Bonaparte." And further, that "Such of his species as are binomially named and fully identified must take their rightful place in the curriculum of synonymatic quotation; and those names which are found to possess the quality of priority must be adopted."

Under the present International Rules (Art. 25), a technical name, to be valid, must be "accompanied by an indication, or a definition, or a description." The mere addition of a vernacular name does not fulfill this requirement (Opinion 1). Otherwise the arguments advanced by Coues remain perfectly sound to-day. In his championship of Bartram, however, the prophet was little honored by either his contemporaries or his successors.

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[1] This paper represents part of an investigation of the works of John and William Bartram, which has been supported by the John Bartram Association of Philadelphia and aided by a grant from the Penrose Fund of the American Philosophical Society.
[2] Received for publication April 6, 1942.

J. A. Allen, the inveterate opponent of Coues, took up the cudgels at once (1876a). While making much of Bartram's partial polynomialism, he did not deny the validity of certain of the binominal names in the *Travels*. He did, however, whittle down the list of 21 names "which Dr. Coues wishes to see set up" to a mere six or seven—"the only ones that, in justice to all parties, can rightfully stand." Coues had admitted a number of technical names that were identifiable solely by means of the accompanying common names and perhaps by the ranges assigned to the species; but Allen was right in rejecting such names.

In his reply (1876), Coues pointed out that there were only ten Bartramian species that he had proceeded to "newly set up"; and that "the only actual disagreement between Mr. Allen and myself is that he is able to identify satisfactorily rather fewer of Bartram's species than I succeeded in doing."

In temporarily closing this debate, Allen (1876b) stated: "The point at issue is not whether 'Bartram's identifiable, described, and binomially named species' are entitled to recognition, for no one would be foolish enough to deny that."

After this clarification of issues, Coues utilized, in the second edition of his *Check List* (1882), the following Bartramian names (here set down in the order of their appearance on pages 289–296 of the *Travels*):

Catharista atrata (Bartr.)
Elanus glaucus (Bartr.)
Ictinia subcoerulea (Bartr.)
Corvus maritimus Bartr.
Corvus frugivorus Bartr.
Aphelocoma floridana (Bartr.)
Quiscalus purpureus (Bartr.)
Dendroeca pinus (Bartr.)
Meleagris gallipavo americana Bartr.
Spizella domestica (Bartr.)
Melospiza palustris (Bartr.)
Spizella agrestis (Bartr.)
Troglodytes domesticus (Bartr.)
Telmatodytes palustris (Bartr.)
Grus pratensis (Bartr.)
Botaurus mugitans (Bartr.)
Aramus pictus (Bartr.)
Phalacrocorax dilophus floridanus (Bartr.)

Herewith the Bartramian nomenclatural tide may be said to have reached its peak. The four successive editions of the *American Ornithologists' Union Check-List* (1886 to 1931) by degrees obliterated almost the last vestige of his names. The first two editions (1886 and 1895) retained, of the above-mentioned 18 names, only *Catharista atrata* and *Aphelocoma floridana*. This action may seem remarkable, in view of the fact that Coues was chairman of both committees that prepared the first and second editions; but as he himself said (1899, p. 84), he had "always been in a minority of one on this subject."

The third edition of the *Check-List* (1910) recognized not a single Bartramian name! The preface naively admitted (p. 8) "the tendency heretofore to ignore rules of nomenclature when their observance entailed unwelcome changes in technical names." In the meantime, in a paper entitled *The Finishing Stroke to Bartram* (1899), Coues had given up the unequal fight, and had himself proposed that the Committee, to be consistent, eradicate the two Bartramian names retained in the first two *Check-Lists*. At the same time he maintained his personal conviction that Bartram "is a binomial author who sometimes lapses, and whose identifiable binomials which rest upon descriptions are available in our nomenclature." This view is perfectly sound in the light of the present International Rules of Zoological Nomenclature (as issued in Paris in 1905, with subsequent amendments), but Coues was considerably ahead of his times! The A. O. U. Committee in 1899, under the chairmanship of Robert Ridgway, accepted Coues' suggestion and ruled as follows (Auk, vol. 16, p. 112, 1899): "As Bartram was not a strict binomialist his names are not tenable, although in two instances they have been heretofore inadvertently used in the Check-List."

As a matter of fact, it does not seem possible to find any specific justification for this attitude even in the old A. O. U. Code of Nomenclature (1886 and 1908), and most decidedly not in the current International Rules.

In the fourth edition of the *A. O. U. Check-List* (1931), the Committee, under the chairmanship of Witmer Stone, stated (p. vii): "The International Code of Nomenclature which corresponds closely with the A. O. U. Code has been adopted as a basis for the nomenclature of the Check-List but where the latter Code is more explicit and carries its rulings to further detail it has been followed." But by this time the Bartramian names were apparently an almost forgotten issue. It is true that three of the names (*Coragyps atratus atratus, Grus canadensis pratensis,* and *Aramus pictus pictus*) were revived, but curiously credited to F. A. A. Meyer (1794), who had merely published a free translation of some of Bartram's descriptions of animals, with added comments of his own. There is apparently nothing in print to indicate that Bartram's names have ever been seriously reconsidered in the light of the International Rules.

Peters, in his *Check-list of Birds of the World* (vol. 1, p. 190, 1931; vol. 2, pp. 152, 155, 1934), has credited one of the above-mentioned names to Bechstein (1793) and two to Meyer (1794).

As I have said elsewhere (1940, p. 695), "any particular binominal name proposed by Bartram may be judged upon its individual merits, regardless of the fact that many of his other names are polynomial." It merely remains, therefore, to select those of Bartram's names that are binominal, are accompanied by nomenclaturally valid descriptions, are identifiable beyond reasonable question, and have priority. The restoration of these names to their rightful place in current nomenclature can hardly be denied. A few other names that come into consideration, but seem to require rejection, are also discussed.

It may be remarked here that a German translation of Bartram's *Travels*, edited by E. A. W. Zimmermann, was published in Berlin in 1793. The editor added certain notes of his own that gave a new status to some of the names proposed by Bartram (*cf.* Mathews, 1914). These cases, however, are not included in the present discussion.

Bartram's plant names, in so far as they are identifiable and have priority, are fully accepted by botanists. This is particularly significant in view of the fact that the International Rules of Botanical Nomenclature (1935), unlike those of Zoological Nomenclature, require the rejection of specific names "when they were published in works in which the Linnean system of binary nomenclature for species was not consistently employed" (Art. 68).

The following bird names are taken up in the order of their appearance in the catalogue on pages 289 to 296 of the *Travels*. Some of them, however, were introduced at various places in the text preceding or following this catalogue. Designation or restriction of the type localities have been facilitated by recently acquired information on the details of Bartram's itinerary (*cf.* Harper, 1939).

To each name in Bartram's catalogue is prefixed one of five different symbols, indicating the bird's status as a migrant or a resident in various parts of the country. In certain cases where such a symbol is important in identifying the species, the use of the symbol will be mentioned.

Page 289. "Strix acclamator, capite levi, corpore grisco [misprint for "griseo"], the whooting owl." (Introduced as "strix acclamatus" (a *nomen nudum*) on p. 286.) This species, especially when compared with the five other species of *Strix* introduced on the same page, is clearly identifiable as the Northern Barred Owl, currently known as *Strix varia varia* (*Strix varius* Barton, 1799). The prefixed symbol (¶) indicates that this is one of the species that "breed and continue the year round in Pennsylvania." Bartram's name, with eight years' priority, will supplant Barton's (which, incidentally, was derived from "Bartram. MS."). The type locality may be restricted to West Philadelphia, Philadelphia County, Pennsylvania (where Bartram's home was located). The names of the various subspecies will stand as follows:

Strix acclamator acclamator Bartram. Northern Barred Owl.

Strix acclamator georgica (*Strix georgica* Latham, 1801). Florida Barred Owl.

Strix acclamator sablei (*Syrnium nebulosum sablei* Nicholson, 1938). Cape Sable Barred Owl.

Strix acclamator helveola (*Syrnium nebulosum helveolum* Bangs, 1899). Texas Barred Owl.

Strix acclamator sartorii (*Syrnium nebulosum* var. *sartorii* Ridgway, 1873). Mexican Barred Owl.

Strix acclamator fulvescens (*Syrnium fulvescens* Sclater and Salvin, 1868). Guatemalan Barred Owl.

Page 289. "Vultur atratus, black vulture, or carrion crow." (An adequate description, under the name of "coped vulture" or "carrion crow," is given on p. 152.) This must be recognized as the original reference of the Black Vulture (*Coragyps atratus atratus*), and it may be cited as follows: *Vultur atratus* Bartram, Travels, ed. 1, pp. 289, 152, 1791. Since the description on page 152 occurs at a point in Bartram's narrative where he is describing his voyage on the St. John's River just above Lake Dexter, Florida, the type locality may be fixed accordingly. Bartram's drawings ("Tab. VII" and "Tab. VIII") of "The Caron Crow of Florida," which are preserved in the British Museum, may be considered to represent the type specimen.

Page 290. Here three species of "Falco" are introduced under the heading of "Milvus. Kite Hawk." There is also a brief characterization of "Kite hawks" in a footnote. The symbol "||" indicates that all three species "are natives of Carolina and Florida, where they breed and continue the year round." All three are readily identifiable, as follows:

"Falco furcatus, the forked tail hawk, or kite," is the Swallow-tailed Kite (*Elanoides forficatus forficatus* (Linnaeus, 1758)).

"F[alco] glaucus, the sharp winged hawk, of a pale sky-blue colour, the tip of the wings black," is the White-tailed Kite, currently known as *Elanus leucurus majusculus* Bangs and Penard (1920). On this point both Coues (1875, p. 345) and Allen (1876a, p. 28) agree. The name of the northern subspecies will now become *Elanus glaucus glaucus* (Bartram), supplanting *majusculus* of Bangs and Penard. Apparently the first actual specimen on record from Florida was obtained by Titian R. Peale on the estate of Prince Achille Murat at Moses Creek, about 8 miles south of St. Augustine (Bonaparte, 1828, vol. 2, p. 24). The type locality may be restricted to that area. Bartram had frequently been in the vicinity of St. Augustine in 1765 and 1766. The name of the South American subspecies will become *Elanus glaucus leucurus* (*Milvus leucurus* Vieillot, 1818).

"F[alco] subcerulius, the sharp winged hawk, of a dark or dusky blue colour," is the Mississippi Kite, currently known as *Ictinia misisippiensis* (*Falco misisippiensis* Wilson, 1811). Again Coues (1875, p. 345) and Allen (1876a, p. 28) agree. The name will now become *Ictinia subcerulia* (Bartram). The type locality may be restricted to Oldtown on the Suwannee River, Dixie County, Florida. This locality was visited by Bartram (p. 235), and the species was formerly abundant there (Wayne, 1893, p. 337; 1906, p. 62).

Page 290. "Corvus carnivorus, the raven," is probably identifiable as the Northern Raven (*Corvus corax principalis* Ridgway, 1887). Without an accompanying description, however, the name must be considered a *nomen nudum*.

Page 290. "C[orvus] maritimus, the great sea-side crow, or rook," is apparently either the Northern Raven (just introduced as the preceding species) or some otherwise undescribed and presumably extinct species or subspecies of Florida. It is evidently the same bird that Bartram refers to in his manuscript report to Dr. Fothergill (vol. 2, p. 49, 1774?; original in Brit. Mus.) as a "very large" Crow that "keeps near the Sea coast [of East Florida], has a loud course voice like the Raven." Barton, a close friend and collaborator with Bartram, has some further remarks upon it (1799, p. 11, footnote). I cannot agree with Coues (1875, p. 346) in identifying it as the Fish Crow (*Corvus ossifragus* Wilson), which Bartram apparently did not distinguish from the various subspecies of *Corvus brachyrhynchos*. Wilson (1812, vol. 5, p. 29), in describing *C. ossifragus,* differentiates it from Bartram's *C. maritimus.*

Page 290. "C[orvus] frugivorus, the common crow." I am inclined to consider this composite, including both the Eastern Crow (*Corvus brachyrhynchos brachyrhynchos* Brehm) and the Fish Crow (*C. ossifragus* Wilson). The latter species, according to Ord (in Guthrie, 1815, p. 325), was "always confounded with the foregoing [Common Crow], until Mr. Wilson introduced it as a distinct species." In Coues' opinion (1875, p. 346), *C. frugivorus* Bartram was the equivalent of *C. americanus* Audubon. In any event, however, it is a *nomen nudum.*

Page 290. "C[orvus] Floridanus, pica glandaria minor, the little jay of Florida," is further described on page 172, and is unmistakably identifiable as the Florida Jay, currently known as *Aphelocoma coerulescens* (*Corvus coerulescens* Bosc, 1795). Bartram's name was recognized in the first two editions of the *A. O. U. Check-List,* and must now be revived, as *Aphelocoma floridana* (Bartram). The original reference may be cited as *C*[*orvus*] *Floridanus* Bartram, Travels, ed. 1, pp. 290, 172, 1791. The particular bit of Florida "scrub" to which Bartram refers (pp. 171–172) as the habitat of this species is located 13 miles southwest of Palatka, between Rodman and Deep Creek, Putnam County, Florida; and this may be designated as the type locality.

Page 290. "Gracula quiscula, the purple jackdaw of the sea coast," may be identified as the Atlantic Boat-tailed Grackle (*Cassidix mexicanus torreyi* Harper, 1935)—at least this subspecies for the most part. The symbol "¶" is employed by mistake for "‖." The name is evidently a *nomen nudum;* even if valid, it would be preoccupied by the *Gracula quiscula* of Linnaeus (1758), who proposed it for the Florida Grackle.

Page 289 *bis.* "Gracula purpurea, the lesser purple jackdaw, or crow blackbird." The prefixed symbol (*) indicates birds that "arrive in Pennsylvania in the spring season from the South, which, after building nests, and rearing their young, return again Southerly in the autumn." The words "lesser purple" imply a comparison with the preceding species, "the purple jackdaw of the sea coast," and serve to identify the bird as some form of the genus *Quiscalus* breeding in Pennsylvania. Bartram's name, if valid, would have priority over any one of the three names now applied to Pennsylvania forms of *Quiscalus* (*cf.* Chapman, 1936, p. 411, map). If, however, the English words supplied by Bartram may be interpreted as constituting merely vernacular names, rather than a description, his name may be discarded as a *nomen nudum* (*cf.* Opinion 1, Intern. Comm. Zool. Nomencl.). Thus existing nomenclature need not be disturbed.

Page 289 *bis*. "Certhia rufa, little brown variegated creeper." Here again we must decide whether the English words quoted constitute a description or merely a vernacular name. The latter interpretation will enable us to preserve the current name of the Eastern Brown Creeper (*Certhia familiaris americana* Bonaparte, 1838). In 1805 Bartram gave a detailed description and a figure of this bird, but supplied no specific name with the generic name *Certhia*.

Page 289 *bis*. "Lanius griscus [misprint for "griseus"], the little grey butcher-bird of Pennsylvania." This case may be decided in the same manner as those just preceding. There is also some slight uncertainty as to which shrike Bartram was attempting to name, although it was probably the Migrant Shrike (*Lanius ludovicianus migrans* W. Palmer, 1898).

Page 289 *bis*. "M[uscitapa] [misprint for "Muscicapa"] cristata, the great crested yellow bellied flycatcher." The prefixed symbol (*) indicates a breeding bird of Pennsylvania. Thus Bartram clearly had in mind the Northern Crested Flycatcher, currently known as *Myiarchus crinitus boreus* Bangs (1898). The case, however, is similar to the several immediately preceding. Moreover, Bartram's name is preoccupied by *Muscicapa cristata* J. F. Gmelin (1789).

Page 289 *bis*. "M[uscitapa] [misprint for "Muscicapa"] subviridis, the little olive cold. flycatcher." Both Wilson (1810, vol. 2, p. 77) and Coues (1875, p. 348) consider this the Acadian Flycatcher, currently known as *Empidonax virescens* (Vieillot, 1818). However, no less than four species of *Empidonax* breed in Pennsylvania, and there is virtually nothing in Bartram's words to differentiate between them. His name is best considered unidentifiable. In any event, it is probably a *nomen nudum*.

Page 290 *bis*. "Merula flammula, sand-hill redbird of Carolina," and "M. Marilandica, the summer red bird." The identification of these two names, even though they are *nomina nuda*, has been an intriguing puzzle. They obviously apply to the two common tanagers of the Eastern States. Since Bartram was thoroughly familiar with the works of Catesby (1731–1743) and of Edwards (1758–1764) and frequently referred to them, one would expect him to preserve their name of "Summer Red-Bird" for *Piranga rubra rubra* (Linnaeus). In fact, his remark (p. 302) on "classing the summer red-bird with the muscicapa" is very strong evidence on this point. For of the two species in question, only the Summer Tanager (*P. r. rubra*) is treated as a *Muscicapa* by Catesby (1731–1743, vol. 1, p. 56), Edwards (1758, pt. 1, p. 63), and Linnaeus (1766, p. 326). Moreover, in his manuscript report to Dr. Fothergill (vol. 2, p. 50, 1774?; original in Brit. Mus.), Bartram writes: "The Summer Red bird is here [in East Florida] in summer season. a species with black wings & Tail only pass along in the spring to the N°. Colonies where they breed." This shows clearly that his "Summer Red bird" is the same as Catesby's. Again, in Bartram's own copy of the *Systema Naturae* of 1758 (acquired by him in 1808), there is an annotation, apparently in his own script, "Summer Red Bird," beside the name *Fringilla rubra* (which applies to Catesby's bird). With all this evidence at hand, it seems quite safe to conclude that the "Merula flammula" of the *Travels* is the Scarlet Tanager (*Piranga erythromelas* Vieillot, 1819), while the "M. Marilandica" is the Summer Tanager. Coues (1875, p. 349) made his identifications accordingly (the name *rubra* in his day being erroneously applied to the Scarlet Tanager).

At the same time it may be well to admit that there is some slight evidence on the other side of the question. The Scarlet Tanager, as the species of more northerly distribution, might be the one more likely to receive the specific name of "Marilandica," since the other is referred to as a bird of Carolina. As a matter of fact, the specimen of the Scarlet Tanager figured by Edwards (1764, pt. 3, p. 278, pl. 343) was sent "from Maryland." Furthermore, in Bartram's diary of 1802–1822, which contains numerous notes on birds of the vicinity of Philadelphia, there is only one entry referring to the "Sandhill Redbird" in contrast to five records of the "Summer Redbird." Since the Scarlet Tanager presumably has always been the commoner of the two species about Philadelphia, Stone (1913, p. 348) identifies the "Summer Redbird" in this case as *erythromelas*, and the "Sandhill Redbird" as *rubra*. Finally, Wilson (1808, vol. 1, p. 95) lists Bartram's *Merula flammula* as a synonym of the Summer Redbird. However, this may signify nothing more than that the meanings of the two names had somehow become transposed since the publication of the *Travels*. Linnaeus in 1766 had caused confusion by applying the name *rubra* (in different genera) to both of these tanagers.

Page 290 *bis*. "Lucar lividus, apice nigra, the cat bird, or chicken bird." There is a further account on pages 299–300, including a reference to the *Muscicapa vertice nigro* of Catesby, which forms the basis for the *Muscicapa carolinensis* of Linnaeus (1766). Thus Bartram's validly described species is unmistakably the Catbird, currently known as *Dumetella carolinensis* (Linnaeus). His specific name is antedated by that of Linnaeus, but his generic name has priority over several others proposed for the Catbird, and it must take its place in current nomenclature. The objections to it, as stated in the Eighth Supplement to the A. O. U. Check-List (Auk, vol. 14, p. 134, 1897), simply do not hold water under the International Rules. The genus may be cited as follows: *Lucar* Bartram, Travels, ed. 1, pp. 290 *bis*, 299, 1791; type, by monotypy, *Lucar lividus* Bartram = *Muscicapa carolinensis* Linnaeus (1766). The specific name will stand as *Lucar carolinensis* (Linnaeus).

Page 290 *bis*. "Meleagris Americanus, the wild turkey." The prefixed symbol (¶) indicates birds that "breed and continue the year round in Pennsylvania." The name as here presented can be validated only by some further description. The first whole paragraph on page 14 describes a "large turkey of the native wild breed" seen in McIntosh County, Ga. (The *Meleagris silvestris* of Vieillot (1817) is based primarily upon the description in this paragraph; hence the restriction of the type locality of *silvestris* to "Pennsylvania" (A. O. U. Check-List of 1931, p. 92) is obviously incorrect.) The next paragraph gives a general description of "our turkey of America," and the maximum weight of "near forty" pounds ascribed to it would apply much more probably to northern birds (such as those in Pennsylvania) than to the birds of southeastern Georgia. It thus appears quite justifiable to connect the name on page 290 *bis* with the description in the second paragraph on page 14. Bartram's name becomes validated accordingly, and the Eastern Wild Turkey will be known as *Meleagris gallopavo americana* Bartram (Travels, ed. 1, pp. 290 *bis*, 14 (par. 2), 1791) rather than as *M. g. silvestris* Vieillot. The type locality of Bartram's bird may be restricted to Chester County, Pennsylvania, where it was formerly resident (Burns, 1919, p. 48).

Page 83. "The wild turkey-cock (Meleagris occidentalis)." This name is applied to Wild Turkeys on the St. John's River, Fla., perhaps at the mouth of Clark's Creek, Clay County. Unfortunately Bartram here employs but a single descriptive phrase, "silver bordered train" (p. 84). Moreover, while this description fits the Domestic Turkey, it does not apply to the Florida Wild Turkey (*Meleagris gallopavo osceola* Scott, 1890). Consequently Bartram's name, although having 99 years' priority over Scott's, can scarcely be considered available.

Page 291. "Linaria ciris, the painted finch, or nonpareil," and "L. cyanea, the blue linnet." These names, standing alone without references, would be *nomina nuda*, although identifiable. They are further discussed, however, on page 299, as "Linaria ciris (emberiza ciris Linn.)" and "Linaria cianea (tanagra Linn.)." They thus become new combinations of *Emberiza ciris* Linnaeus (1758) and *Tanagra cyanea* Linnaeus (1766). The generic name is new here in post-Linnaean usage, although it was employed by Catesby (1731–43) in his *Linaria caerulea*, which formed the basis for the *Tanagra cyanea* of Linnaeus. *Linaria* Bartram thus becomes the valid name of the genus to which the Indigo Bunting and the Painted Bunting belong, and it will replace *Passerina* Vieillot (1816), the type of which, by subsequent designation, is *Tanagra cyanea* Linnaeus. The genus may be cited as follows: *Linaria* Bartram, Travels, ed. 1, p. 299, 1791; type, by present designation, *Emberiza ciris* Linnaeus (1758). This change of generic names will involve the following species and subspecies:

Linaria cyanea (*Tanagra cyanea* Linnaeus, 1766). Indigo Bunting.

Linaria amoena (*Emberiza amoena* Say, in Long, 1823). Lazuli Bunting.

Linaria versicolor versicolor (*Spiza versicolor* Bonaparte, 1837). Varied Bunting.

Linaria versicolor pulchra (*Passerina versicolor pulchra* Ridgway, 1887). Beautiful Bunting.

Linaria versicolor dickeyae (*Passerina versicolor dickeyae* van Rossem, 1934). Mrs. Dickey's Bunting.

Linaria versicolor purpurascens (*Passerina versicolor purpurascens* Griscom, 1930). Guatemalan Bunting.

Linaria rositae (*Cyanospiza rositae* Lawrence, 1874). Rosita's Bunting.

Linaria ciris ciris (*Emberiza ciris* Linnaeus, 1758). Eastern Painted Bunting.

Linaria ciris pallidior (*Passerina ciris pallidior* Mearns, 1911). Western Painted Bunting.

Linaria leclancheri leclancheri (*Passerina leclancheri* Lafresnaye, 1840). Leclancher's Bunting.

Linaria leclancheri grandior (*Passerina leclancheri grandior* Griscom, 1934). Oaxaca Bunting.

Page 291. Coues (1875, pp. 350–351) attempts to revive six Bartramian specific names that were published on this page, as follows:

"C[arduelis] pinus, the lesser goldfinch."

"Passer domesticus, the little house sparrow or chipping bird."

"P[asser] palustris, the reed sparrow."

"P[asser] agrestis, the little field sparrow."

"M[otacilla] domestica (regulus rufus) the house wren."

"M[otacilla] palustris, (reg. minor) the marsh wren."

All these names are more or less identifiable by reason of the vernacular names supplied, but they are not thereby validated in a nomenclatural sense, and so they must be discarded as *nomina nuda*.

Page 291. "Calandra pratensis, the May bird." The generic name, although new here, is not available, for the genotype is a *nomen nudum,* despite the fact that it is identifiable as the Dickcissel (*Spiza americana* (Gmelin, 1789)).

Pages 291–292. The case of "Regulus" is so fraught with unfortunate possibilities in the way of transfer and confusion of names that I prefer to pass it by for the present. Much trouble would be saved if *Regulus* Cuvier (1800) could be added to the list of *nomina conservanda.*

Page 292. "Ruticilla Americana, the redstart." *Ruticilla,* although new as a generic name in post-Linnaean usage, is not available, since the genotype is a *nomen nudum.*

Page 292. "Luscinia, s. philomela Americana, the yellow hooded titmouse." If *Philomela* can be construed as a generic name, this is its first occurrence as such in the literature. At best, however, it is no more than a *nomen nudum.*

Page 292. "P[arus] cedrus, uropygio flavo, the yellow rump." Edwards (1758, pt. 1, pp. 97–98, pl. 255) describes, and gives a colored plate of, the "Yellow-rumped Fly-catcher." He had received this bird "from Mr. William Bartram, of Pennsylvania." It is clearly the Magnolia Warbler, currently known as *Dendroica magnolia* (Wilson, 1811). Bartram's present "yellow rump" should naturally be the same species. The only other species to which "Parus cedrus" might apply is the Myrtle Warbler (*Dendroica coronata* (Linnaeus, 1766)), but the latter is accounted for a few lines below as "P[arus] aurio vertice, the golden crown flycatcher." It is evident, however, that Bartram confused these two species over a long period of years. The "Yellow rump Flycatchers" of his manuscript report to Dr. Fothergill (vol. 2, p. 50, 1774?; original in the Brit. Mus.) and the bird represented under this name in one of his drawings (No. 11) at the British Museum are no doubt the Myrtle Warbler. In a letter of March, 1791, to B. S. Barton (original in possession of Mrs. John R. Delafield), he was still quite confused concerning the two species. Finally, on page 298 of the *Travels,* his "yellow rump (parus cedrus)" is obviously the Myrtle Warbler. Apparently Bartram applied this last name to the birds in winter plumage, and the "P. aurio vertice" to adult males in spring plumage. But in that case he did not realize that the "Yellow-rumped Fly-catcher" he had sent to Edwards many years previously was an entirely distinct species, the Magnolia Warbler. Under all these circumstances it is probably best to identify *Parus cedrus* as the Myrtle Warbler in winter plumage; and to consider that Wilson (1810, vol. 2, p. 138) and Bonaparte (1824, p. 193) were correct in placing both of the Bartramian names here discussed in the synonymy of *Dendroica coronata.*

Page 292. The publication, on the same page, of "P[arus] aureus vertice rubro, the yellow red pole," and "P. aureus alis ceruleis. the blue winged yellow bird," together with the omission of the comma after "aureus" in each case, creates such a strong suspicion of polynomialism that perhaps we need not consider these names further at present.

Page 293. "G[rus] pratensis, corpore cinereo, vertice papilloso, the great savanna crane." This bird is further described on pages 146–147 and 220–221, where it is referred to as "grus pratensis" and as "Grus p." These accounts constitute the valid original description of the Florida Sandhill Crane (*Grus canadensis pratensis*). The name *pratensis,* proposed by Bartram, is improperly credited to Meyer (1794) by Peters (1925, p. 12) and by the *A. O. U. Check-List* of 1931 (p. 94). Peters misplaces the type locality in Clay County, Florida. The specimen described by Bartram was not obtained in "the eastern part of the Alachua Savanna"; and this savanna, incidentally, is comprised wholly within Alachua County. The specimen was shot by Bartram's hunter companions within a few miles of the present Bronson, Levy County, Florida, and the type locality must be designated accordingly. The nearest approach to a type specimen (the original having been eaten) is a drawing ("Tab. II") made by Bartram and now preserved in the British Museum.

Page 293. "A[rdea] mugitans, the marsh bitern, or Indian hen." This bird, while identifiable as the American Bittern (*Botaurus lentiginosus* (Montagu, 1813)), is not validly described. Therefore the name *mugitans* cannot be adopted, as Coues suggests (1875, p. 353).

Page 293. "T[antalus] pictus, (Ephouskyka Indian) the crying bird, beautifully speckled." This bird, the Florida Limpkin, is more fully described, under the same name, on pages 147–148. Both the description and the nomenclature are valid, and Bartram, instead of Meyer (1794), must be credited with the authorship. The original reference should be cited as follows: *Tantalus pictus* Bartram, Travels, ed. 1, p. 147, 1791. In future lists the name will stand as *Aramus scolopaceus pictus* (Bartram). In his manuscript report to Dr. Fothergill (vol. 1, p. 95, 1774?; original in Brit. Mus.), Bartram tells of shooting a specimen on the St. John's River in the vicinity of St. Francis, Lake County, Florida. This may be appropriately designated as the restricted type locality. The type specimen was apparently eaten, but it may be represented by a drawing made by Bartram and published by Barton (1818, pl. 1).

Page 294. "A[nser] branta, corpore albo, remigibus nigris, the white brant goose." This name unquestionably applies to either the Lesser Snow Goose (*Chen hyperborea hyperborea* (Pallas, 1769)) or the Greater Snow Goose (*C. h. atlantica* Kennard, 1927). Or, in view of the distribution indicated by the symbol "†," it may apply to both (the latter bird being more usual in Pennsylvania, while the former is the only one of the two that is definitely known to occur in Florida). The description does not differentiate between the two subspecies. There is also at least a slight suspicion of polynomialism, since the next entry (an unmistakable polynomial: "A. branta grisca maculata") duplicates the second term in the name now under consideration. Under all these circumstances it is probably best to consider that *branta* of Bartram is not available, although it has priority over *atlantica* of Kennard.

Page 295. "C[olymbus] Floridanus, the great black cormorant of Florida, having a red beak." The prefixed symbol (||) indicates birds that "are natives of Carolina and Florida, where they breed and continue the year round." This is unmistakably the Florida Cormorant, currently known as *Phalacrocorax auritus floridanus* (*Carbo floridanus* Audubon, 1835). The description may be considered more valid than accurate, for "red beak" might have been better expressed as "orange lores and gular pouch." It seems justifiable to substitute the *floridanus* of Bartram for the later *floridanus* of Audubon. Thus the Florida Cormorant may be known hereafter as *Phalacrocorax auritus floridanus* (Bartram). The type locality may be restricted to Mosquito Lagoon on the east coast of Florida. This locality was visited by Bartram (p. xxv), and it forms one of the breeding areas of the Florida Cormorant (Howell, 1932, p. 92).

Page 295. "Petrella pintada, the pintado bird." This name suggests the Pintado Petrel, currently known as *Daption capense* (Linnaeus, 1758). However, *Petrella pintada* is merely *a nomen nudum* here, since there is no accompanying description. The generic name as well as the specific is new in post-Linnaean usage, but it cannot be validated with a *nomen nudum* as genotype. It is difficult to comprehend the basis of Bartram's name, unless possibly it is the "white and black Spotted Peteril" of Edwards (1747, pt. 2, p. 90, pl. 90, lower fig., and p. 128 (as "Petrella, media, maculata")), who mentions the Portuguese name of "Pantado." However, there is no known record of the Pintado Petrel (a bird of the southern oceans) in North America up to and including Bartram's time.

For a critical reading of the manuscript, either as a whole or in part, I am much indebted to Messrs. James Bond, Ezra T. Cresson, Jr., Henry W. Fowler, H. Radclyffe Roberts, Alexander Wetmore, and John T. Zimmer. While there has been no resulting unanimity of opinion, a decisive majority agrees that the proposals here made are in accordance with the International Rules.

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NEWS AND NOTES

THE PROCEEDINGS

During May of this year, the paper of Dr. Robert B. Simpson entitled: *Studies in the geography of population change, Canandaigua Lake region, New York,* appeared in these *Proceedings* as No. 2 and 3 of Vol. 8. The Council has voted that members of the Academy may receive its current publications free of charge upon request. Such requests should be sent to the Librarian of the Academy, Rhees Library, University of Rochester.

The Council has voted that an effort will be made to assign one-half of all current and future dues towards the financing of *The Proceedings.* Further, the Council has voted not over $500 of capital funds towards publication of *The Proceedings* for the current year. If we are to continue publication additional current income is essential. Increased membership is greatly desired. Those who can make a contribution towards the cost of *The Proceedings* in addition to the $2.00 annual dues are urgently requested to do so.

Missing Numbers: Certain numbers of the *The Proceedings* are either entirely missing from the Academy files offered for sale, or very few copies remain. These numbers are greatly desired so that the Academy may offer complete sets for sale. Will authors or members who have any of these copies, and are willing to part with them, send them to the Librarian of the Academy. The numbers especially desired are:

SARGENT, C. S. Crataegus in Rochester. Vol. 4:93–136, 1903.

BECKWITH, FLORENCE, M. E. MACAULEY, and M. S. BAXTER. Plants of Monroe County, New York, and adjacent territory: supplementary list. Vol. 5:1–38, 1910.

BECKWITH, FLORENCE. Early botanists of Rochester and vicinity, and the Botanical Section. Vol. 5:39–58, 1910.

Biographical memoirs of deceased fellows, title pages, etc. Vol. 5:241–288.

FAIRCHILD, H. L. The Rochester Canyon and the Genesee River base-levels. Vol. 6:1–55, 1919.

GILES, A. W. Minerals in the Niagara limestone of Western New York. Vol. 6:57–72, 1920.

FAIRMAN, E. E. The fungi of our common nuts and pits. Vol. 6:73–115, 1921.

On motion of Dean Gamble the Council elected David R. Goddard as Chairman of the Publications Committee; Dr. Gamble remaining a member of the Committee. Since Dr. Goddard will be out of town from September, 1942, until August, 1943, Dr. S. C. Bishop was elected to serve as Chairman during Dr. Goddard's absence.

D. R. G.

GENERAL MEETINGS

April 28, 1941.—This meeting was held to celebrate the sixtieth anniversary of the founding of the Botanical Section. The Academy welcomed as its speaker Dr. Josiah Lowe of the State College of Forestry at Syracuse. The topic of his lecture was *Lichens.*

Dr. Lowe had collected lichens extensively on Isle Royale in Lake Superior and also in this state. He gave an interesting account of their structure, growth and economic importance.

An unusual feature of this meeting was the presence of Miss Isles, who, fifty-nine years before, had presented before the Academy a paper on the very subject of the evening's discourse, *Lichens!* Her membership in the Academy's Botanical Section began less than a year after its inauguration.

October 27, 1941.—A symposium on *Alaska* was presented by President Floyd C. Fairbanks and Professor F. W. C. Meyer, both of whom had visited there during the summer just past. President Fairbanks showed kodachrome movies which included excellent views taken in the Canadian Rockies. Professor Meyer followed the Lewis and Clarke trail from Chicago to Seattle and made a study of the Indian tribes with whom he came in contact. He was particularly interested in their totems and in the effect of so-called "civilization" on their social and religious life.

November 25, 1941.—A joint meeting with the Rochester Astronomy Club and the Rochester Section of the Optical Society of America was held on the River Campus of the University. The speaker was the distinguished astronomer, Dr. Chandrasekhar, of the Yerkes Observatory—a native of India. His subject was *The Dynamics of Stellar Systems.*

Although using a language foreign to him, Dr. Chandrasekhar succeeded admirably in presenting an abstruse subject in as simple a manner as possible. Our galaxy and the great nebula of Andromeda were the examples to which he chiefly referred. From evidence furnished by the galaxy itself he stated that its age is of the order of three billion years. Its form is that of a flattened disc with more than one-half its mass concentrated in a dense nucleus consisting of between one and ten billion stars. Our sun is at a point about two-thirds of the distance from the center to the edge of the disc, some ten thousand parsecs from the center, around which it is circling at the rate of approximately 250 kilometers per second.

January 26, 1942.—The annual business meeting. The speaker was Dr. Justus F. Mueller of the State College of Forestry at Syracuse, who gave an illustrated lecture on his recent journey across Peru from Lima to Yurimaguas. Much of this dangerous trip was made on rafts or in crude canoes with semi-civilized native boatmen. Dr. Mueller's kodachrome slides were excellent.

February 16, 1942.—This was a joint meeting with the Morgan Chapter of the New York State Archaeological Association and was held in the new building of the Rochester Museum at East Avenue and Goodman Street. It was the first public lecture to be held in this building, which was not yet completed.

The speaker was Dr. Arthur C. Parker, Director of the Rochester Museum of Arts and Sciences. His topic was *Revivals of Material Culture among the Iroquois.* From the time the Indians began to use things they could not make, their life became dependent on the white races and their own arts began to degenerate. In a few generations it became impossible to find even samples of some of the things which were once commonly made. Their ancient religions, and all that was based upon it, was despised.

It was in an effort to revive some of the lost arts of the Iroquois that lead Dr. Parker in 1935 to undertake to interest certain inhabitants of the Tonawanda and Cattaraugus reservations in the old crafts of carving, painting, beadwork, weaving, leatherwork, etc. Much artistic work was done and some worth-while talent was discovered, but the general conclusion reached was that evolution, even under artificial conditions, is not easily reversed. The Indians consistently looked upon their productions as toys and curiosities rather than as patterns for their own lives. Movies were shown and records of Indian music were played.

March 23, 1942.—Dr. David R. Goddard of the Department of Botany, University of Rochester, gave an illustrated lecture on *Light Chemistry and Life,* in which he discussed some of the applications of photochemistry to photosynthesis, in such a way as to clarify them in the minds of those whose previous concepts may have been rather vague.

April 13, 1942.—The Research Section sponsored a general meeting addressed by Dr. Bernard Nebel of the New York State Agricultural Experiment Station, Geneva, on the subject, *Recent Trends in Agricultural Research.* He described the growth of governmental aid to agriculture and mentioned some of the more serious problems of the modern farmer. "To be successful on a farm," he said, "one must have experience, a technical education, and a knack for good business." He briefly outlined the modern research in three fields: the weather, the soil, and the plants, themselves. The Norwegians have made a science of weather forecasting, the Russians have evolved a practical soil classification, and Americans have put both into practice. Dr. Nebel discussed the technical methods of plant breeding by which species are improved and varieties developed, such as the use of x-rays to re-align chromosomes, and the use of colchicine.

May 11, 1942.—Dr. Dudley S. De Groot addressed the Academy on the subject of *Bird Migration.* His talk was not confined by this title but ranged as well over various of his experiences in egg collecting, from Maine to Florida to California. The first nest of the San Benito sparrow ever to be collected is his chief prize. Many times he has visited eagle nests without once being attacked by the birds. In waters filled with alligators he has stalked the sand-hill crane of Florida, and on the isle of Mani he has welcomed the plover migrating from the Aleutians. In due time he hopes to arrange his collection of over ten thousand eggs so that it may be inspected and studied. M. N. S.

MINERALOGY SECTION

The Mineralogy Section of the Rochester Academy of Science meets once each month from October to May inclusive, on the second Thursday of the month. During the 1941–1942 season, the first five indoor meetings were held at Ward's Natural Science Establishment, 302 N. Goodman Street. The sixth and seventh meetings were held in the Eastman Building on the Prince Street Campus of the University of Rochester, and the eighth meeting, preceded by a picnic supper, was held at the Girl Scout's "Little House" at Seneca Park. In addition to the indoor meetings, four field trips were held in 1941. All plans for subsequent trips have been canceled for the duration of the war.

The Indoor Meetings for the year 1941–1942 were as follows:

October 9.—W. McClelland—*An Hour with Gems.*

November 13.—General meeting for members.

December 11.—F. W. C. Meyer—*Glaciers and Water Erosion.*

January 8.—John M. Dowe, Jr.—*Prospecting.*

February 12.—Nelson Secrist—*Minerals in the Arts.*

March 12.—G. E. Houghton—*Asbestos.*

April 9.—Robert C. Vance—*Meteorites.*

May 14.—John E. Hartfelder—*Collecting Experiences.*

Field Trips:

May 24, 1941.—Collecting minerals at limestone quarry southeast of Sodus.

June 14, 1941.—Collecting septaria in Bristol hills.

July 4, 5, 6, 1941.—A three-day trip to mineral localities in eastern Vermont and New Hampshire. At Gassetts, Vt., a quarry in mica schist yielded crude crystals of garnet, kyanite and staurolite. The Golden Keene feldspar mine near East Alstead, New Hampshire, produced large beryl crystals, garnet and tourmaline crystals, quartz, feldspar and mica. A soapstone quarry at Chester, Vt., was the source of choice crystals of pyrite and magnetite, together with ankerite, prochlorite, talc, actinolite and steatite.

September 21, 1941.—A joint field trip with the Geological Section of the Buffalo Society of Natural Sciences to Eighteen-Mile Creek near Buffalo. Led by Mr. Carter, many good Devonian fossils and pyrite nodules were collected.

Officers of the Mineral Section

Robert C. Vance	Chairman
David E. Jensen	Recorder
George R. Costich	Treasurer
Edwin G. Foster	Chairman of the Committee for Recording Mineral Localities of Monroe County.
David E. Jensen	Chairman of the Committee for New York State Mineral Localities
John M. Dowe, Jr.	Chairman of the Field Trip and Program Committees
Charles W. Foster	Chairman of the Summer Activities Committee

R. C. V.

RESEARCH SECTION

May 15, 1941.—Dr. Robert B. Simpson of the Department of Geology of the University was the speaker. His title was: *Why is the Canandaigua area becoming depopulated?* His talk was based on the material used in writing his paper since published in the Proc. Rochester Acad. Sci. 8:49–121 (1942).

The first three of the following meetings were designed to discuss various aspects of the general subject of macro-molecules.

November 17, 1941.—The speakers were Mr. Arthur Schoen and Dr. Maurice L. Huggins of the Research Laboratories, Eastman Kodak Company. Dr. Schoen discussed the *Design and use of the electron microscope* and reported on some of the results obtained in the examination of photographic emulsions. Dr. Huggins spoke on the *Chemistry of macro-molecules.*

December 8, 1941.—The speaker was Dr. Robert Ramsey, of the Department of Physiology, University of Rochester School of Medicine and his title was *Myosin and the molecular theory of muscle contraction.*

January 19, 1942.—Dr. Curt Stern and Dr. John B. Buck, of the Department of Zoology, University of Rochester, participated in a symposium entitled *Chromosomes, genes, and proteins.*

February 16, 1942.—Dr. Arthur C. Parker, Director, Rochester Museum of Arts and Sciences, spoke on the subject, *Revivals of material culture among the Iroquois.* (See notes on General Meetings.)

March 9, 1942.—Dr. Henrik Dam, Research Associate, Department of Biochemistry, University of Rochester School of Medicine, and the discoverer of Vitamin K, told of some of his work in a talk under the following title: *Biological significance of vitamin K.*

April 13, 1942.—Dr. Bernard R. Nebel, of the New York State Agricultural Experiment Station, Geneva, N. Y., was the speaker and his title was, *Recent trends in agriculture research.* (See notes on General Meetings.)

At the Meeting of April 13, 1942, the Executive Committee nominated the following officers, who were elected, for the current year:

CHAIRMAN - - - - - Dr. Richard H. Goodwin

RECORDER - - - - - - Dr. William S. Cornwell

MEMBERS OF THE EXECUTIVE COMMITTEE

Professor Sherman C. Bishop
Dr. Dean L. Gamble
Dr. Robert L. Roudabush

The Research Section abolished its special dues; membership is now open to all Members of the Academy for the usual Academy dues. W. S. C.

THE HERBARIUM OF THE ROCHESTER ACADEMY OF SCIENCE

Through the activity of the members of the Botanical Section of the Academy the excellent herbarium of the Rochester Academy of Science has been built up during the past sixty years. A history of the Botanical Section and the lives of many of its members have been written up in these Proceedings (Proc. Roch. Acad. Sci. 5:39–58, 1912; 8:122–149, 1942). Among the principal early collectors whose mounted specimens are now housed in the herbarium were Mr. George T. Fish, Mr. Joseph B. Fuller, Mr. Edward L. Hankenson, Mr. Charles W. Seelye, and Miss Florence Beckwith. Many others who have made smaller contributions could be listed. In 1939 title to two collections previously on deposit in the herbarium came to the Academy, those of Mr. Milton S. Baxter and of Mr. Ellsworth P. Killip. These collections are notable both for their size and their scientific value, Mr. Baxter's consisting chiefly of plants native to western New York and Mr. Killip's containing a large percentage of plants collected in the West Indies and Central and South America.

In 1930 the Rochester Academy of Science placed its herbarium on deposit with the University of Rochester. The specimens were housed in steel cabinets on the ground floor of the Dewey Building on the River Campus, under the supervision of the Botany Department. Mr. Milton S. Baxter served as curator of the combined herbaria of the Academy and of the University until the time of his death in 1938. Since then I have served in this capacity. In 1941 a new, well-lighted room on the ground floor of Dewey Building was made available for the herbarium and it is to be hoped that in these convenient and attractive quarters the collections will grow and continue to serve a useful purpose for many years to come.

The mounted specimens in the combined collections of the University and of the Academy have been estimated at between 40,000 and 45,000 sheets. Of these, by far the greater part belong to the Academy. Specimens in the Academy herbarium have been marked with the following stamp: *Herbarium of the Rochester Academy of*

Science on deposit with the University of Rochester. The herbaria of the Academy and of the University are now combined into a single unit. A small reference collection of representative specimens of species to be found in New York State has been kept separate as a means of reducing the handling particularly of old and fragile specimens. All other specimens have been placed in the main herbarium. The families have been arranged according to the system of Engler and Prantl—a system adopted by many of the larger herbaria. The genera and species are in alphabetical sequence under the families.

A large quantity of additional unmounted material belonging to the Academy is also stored at the University. These specimens are not arranged and will not be readily available for study until they can be labelled and mounted.

Since 1938 the following accessions numbering 1228 mounted sheets can be reported in addition to the collections of Mr. Baxter and Mr. Killip previously mentioned. Many of these are University accessions, but they have been included here since the usefulness of the collection should be measured by the amount and nature of the material available for study. Mr. Ellsworth P. Killip, 191 specimens; the U. S. National Museum, 180 specimens; Dr. Edgar Anderson of the Missouri Botanical Gardens, 25 specimens; Dr. Royal E. Shanks, 25 specimens; Mr. Warren Matthew, 5 specimens; Dr. R. H. Goodwin, 702 specimens; students in the Botany Department of the University, about 100 specimens.

Richard H. Goodwin, *Curator.*

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* Indicates Life Members.
† Indicates Fellows.

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THE FLORA OF MENDON PONDS PARK[1]

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DESCRIPTION OF THE AREA

The Mendon Ponds are situated in the southeastern part of Monroe County, New York. For at least seventy years they have been a Mecca for botanists and during this period many rare and interesting species of plants have been collected in their vicinity. Since its dedication in 1930, Mendon Ponds Park has become one of the most-used recreation centers within the county and now thousands of people visit it every year. With the exploitation of the area, however, profound changes in the vegetation are being brought about. The purpose of the present paper is to describe as accurately as possible certain interesting botanical features of the area as they appear today. It is hoped that a description of the remarkably rich vegetation of this small tract will provide a valuable historical record in the years to come. Furthermore, it should serve as a useful supplement to the recent, comprehensive ecological survey of the vegetation of Monroe County by Shanks (1943).

The paper has been divided into two sections: first, a description of the physical and ecological features of the area; and second, an annotated list of the species and varieties of vascular plants which have been found therein.

PHYSICAL FEATURES

The area under consideration is situated about three miles northwest of Mendon and is shown in the accompanying map, fig. 1. It is bounded on the east by the Pittsford-Mendon Center Road, on the south by the Mendon Road, on the west by State Highway 65 or the southward continuation of Clover Street, and on the north by the eastward continuation of Reeves Road. The area includes the whole of Mendon Ponds Park and a certain amount of privately-owned adjacent farm land.

The broken topography is of considerable interest to the glacial geologist. The area is enclosed by two long steep-sided, sinuous ridges running in a generally north-south direction. Fairchild (1926) has pointed out that these are eskers, water-laid sand and gravel deposits formed by

[1] Received for publication December 10, 1942.

The author wishes to thank Dr. Royal E. Shanks for assistance in the field and for going over the first portion of the manuscript. He is indebted to Mr. J. Franklin Bonner of the Monroe County Division of Regional Planning for making available aerial photographs and ecological data on file with the Division of Regional Planning. He is also grateful to his wife, Esther B. Goodwin, Mr. Warren A. Matthews, Mr. William Stepka and others for assistance in various ways. For the determination of specimens in certain groups, acknowledgment is made in footnotes to the annotated list under the particular family involved.

subglacial rivers under the receding Wisconsin ice sheet.[2] In the depression between them lie five little lakes known as Hundred Acre (or Big) Pond, Deep Pond, Lost Pond, Round (or Harris) Pond and Quaker (or Mud) Pond, all of which drain southward into the headwaters of Irondequoit Creek. In addition to the eskers are a number of small, rounded, sandy hills or kames—outwash deposits laid down at the edge of the ice sheet in the waters of ancient Lake Warren which extended from the edge of the ice south to the Allegany upland. Among these glacial sand and gravel deposits are a number of steep-walled depressions known as kettles. These are thought to mark the former location of buried fragments of glacial ice. The bottoms of some of the kettles are above the water table, and hence are dry. Others are below the water table and are occupied by lakes, as in the case of the Devil's Bathtub, or by bogs, such as Kennedy's Bog. Owing partly to the sandy nature of the underlying deposits of the area, the bodies of water are fed by springs, and their level, being dependent on the water table, is extremely constant. This is very important from a botanical standpoint.

The soil types found within the area have been well studied in detail. Fig. 2 shows a soil map of the area adapted from the soil survey of Monroe County by Sweet, *et al.* (1938). The soil types fall into three major categories on the basis of their mode of origin. (1) Those of the higher land to the east and west, indicated by diagonal cross-hatching, are characterized by water-worn sands and gravels and are plainly derived from water-laid, stratified deposits. The Groton series, the most extensive in this category, is found on the kames and eskers. (2) To the north are areas characterized by unassorted glacial till, indicated by stippling. These deposits have developed for the most part into the somewhat acid loams of the Ontario series. (3) In the depressions are found peat and muck deposits up to eleven feet or more in thickness. These are composed chiefly of decomposed organic material representing the accumulation of plant remains for thousands of years. The muck is sometimes underlaid by a fine, whitish marl which was formed by aquatic plants when the ponds were more extensive and covered these areas. Such calcareous deposition is certainly taking place now along the moderately steep banks of Deep Pond where masses of the alga *Chara* are thriving to the virtual exclusion of other types of aquatic vegetation. The dark poorly-drained soils at the margin of the muck deposits are usually underlaid with marl and have been classified as the Colwood loam.

The Vegetation

The post-Pleistocene vegetation of the Mendon Ponds area must have first become established subsequent to the draining of glacial Lakes Warren and Dana (Fairchild, 1926). An analysis of pollen distribution

[2] See also Fairchild (1896), and Giles (1918).

FIG. 1. A topographic map of the Mendon Ponds reproduced from the 1935 edition of the Mendon Ponds quadrangle (U.S.G.S.). The contour interval is five feet.

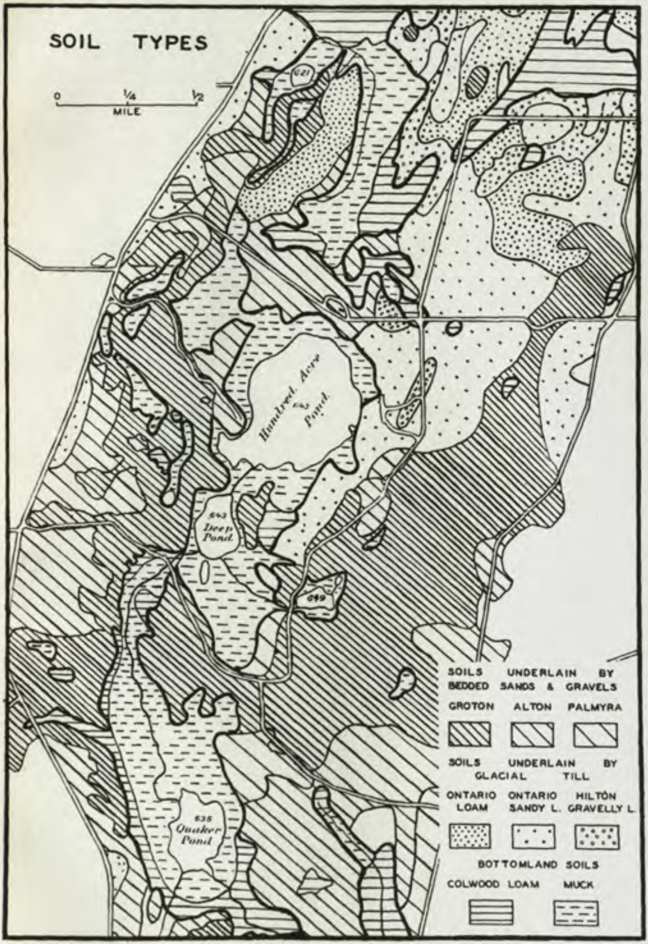

FIG. 2. A map of soil types adapted from the soil survey of Monroe County (Sweet, *et al.*, 1938).

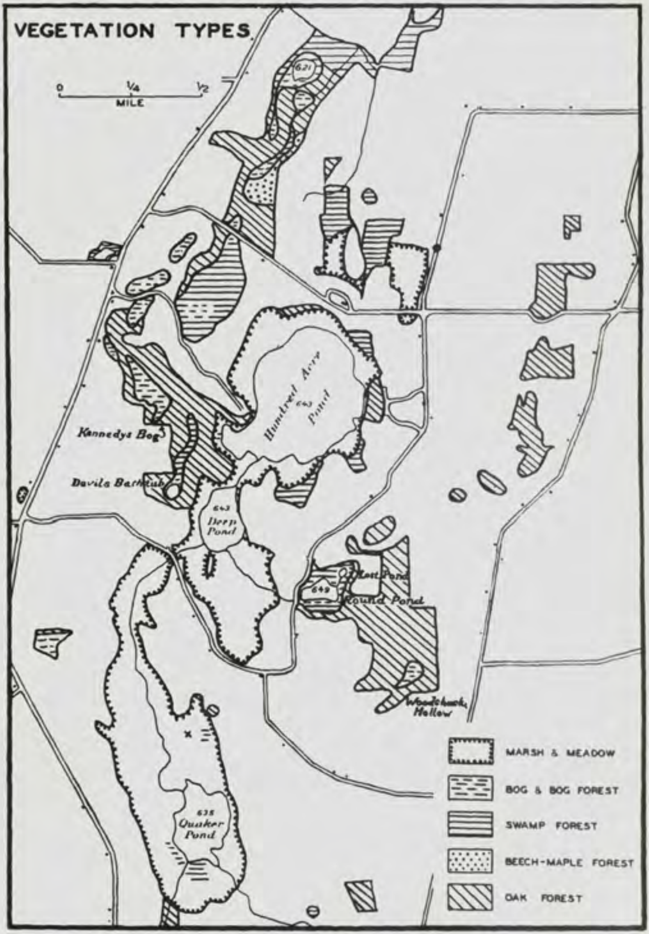

FIG. 3. A map of the remnants of the original vegetation compiled with the aid of aerial photographs loaned by the Monroe County Division of Regional Planning. The various vegetation types recognized by Shanks (1943) are shown.

in the local peat bogs should reveal the vegetational succession which must have taken place. From the results of such analyses made in neighboring states which have a similar climate, such as Pennsylvania, Ohio, and Indiana (Sears, 1935), it can be surmised that the sandy and gravelly slopes were clothed first by spruce and fir, then by white pine and later by hardwoods similar to those found in the region today. Lakes must have occupied the intervening depressions which gradually became filled in by marshes and bogs, an encroachment still in progress at the present time.

From a recent ecological survey of the remaining woodlots in Monroe County and from available historical sources, Shanks (1943) has reconstructed the probable distribution of the vegetation types within the region as they occurred before white settlement. He has distinguished eight different types: marshes and marsh meadows; bogs and bog forest; deciduous swamp forest; hemlock-northern hardwood forest; beech-maple forest; oak forest; oak-chestnut-pine forest; and oak openings. It is beyond the scope of this paper to discuss these generalized vegetation types at length. As Shanks points out, there are innumerable variations in their composition, and transitions frequently occur between them. Each type is easily recognized, however, by the spectrum of its dominant species, and each type fits into a definite ecological niche which is locally conditioned in large part by the water supply and the nature of the soil. All but two of these types, the hemlock-northern hardwood forest, and the oak-chestnut-pine forest, occur within the tract under consideration, reflecting the great diversity of habitat conditions within this small area, which accounts in part for the diversity of the flora.

The distribution of these vegetation types in the relatively undisturbed portions of the area is shown in fig. 3. A comparison of this map with that of fig. 1 will show the close correlation between the location of the remnants of the original vegetation and the topography. Marshes, marsh meadows, bogs and bog forest occupy the low, poorly-drained areas, which, for the most part, are covered with deposits of muck or peat (see fig. 2); while upland oak and beech-maple woods are found chiefly on slopes too steep to be suitable for agriculture. The rest of the land has been cleared for the better part of a century, the first man to clear land in the area having settled in Mendon prior to 1817 (Foreman, 1930). In describing the area in 1896, Fairchild wrote that "much of the valley bottom between the lakes is tilled land. The kame hills are mostly pasture land or under cultivation."

In the following pages a description is given of the various vegetation types which are found in the vicinity of Mendon Ponds. Emphasis has been placed on botanical features of particular interest—the marshes and meadows, the bogs, and the oak openings—while the woodlots and cleared areas which are very similar to those elsewhere in the county have been treated very briefly.

Aquatics. The shallow ponds and sluggish streams (see figs. 4 and 5) are rich in species of flowering plants. The pondweeds, belonging to the genus *Potamogeton*, are particularly abundant with ten species, two of which, *P. praelongus* and *P. strictifolius* var. *rutiloides*, have not been reported elsewhere in the county. The duckweed family is represented by two species of *Lemna*, two species of *Wolffia* and *Spirodela polyrhiza*. Other aquatics include two species of naiad (*Najas*), waterweed (*Anacharis canadensis*), eel grass (*Vallisneria americana*), water stargrass (*Heteranthera dubia*), cow lily (*Nuphar variegata*) (fig. 4), sweet white water lily (*Nymphaea odorata*), hornwort (*Ceratophyllum demersum*), two species of water milfoil (*Myriophyllum*), and the great bladderwort (*Utricularia vulgaris* var. *americana*). For further details the reader is referred to the annotated list.

Marsh and marsh meadow. The marshes and marsh meadows have been formed as a result of the invasion of the open water of the ponds by a marsh vegetation. This invasion is still in progress and all stages of transition between the pioneer species at the water's edge and well-developed natural meadows may still be found. The endless variation in the composition of these marshes and meadows baffles description. However, certain representative and interesting communities will be described in detail.

The invasion of open water by the marsh has reached an advanced stage particularly around Hundred Acre and Quaker Ponds. A dominant pioneer of this zone is the water willow (*Decodon verticillatus*) (see fig. 5). The immersed tips of the recurved branches of this shrub develop a very spongy cortical tissue which gives buoyancy to the floating mass of vegetation. The following species are commonly found growing in this community: the marsh fern (*Dryopteris Thelypteris* var. *pubescens*), the great bulrush (*Scirpus validus*) (fig. 4), arrow arum (*Peltandra virginica*), false nettle (*Boehmeria cylindrica* var. *Drummondiana*), spotted touch-me-not (*Impatiens biflora*), marsh St. John's-wort (*Hypericum virginicum*), marsh skullcap (*Scutellaria galericulata*), bugle weed (*Lycopus uniflorus*), and blue nightshade (*Solanum Dulcamara*). In the very wet marshes behind this outer fringe of vegetation additional species occur, including the cattails, *Typha latifolia* and *T. angustifolia* var. *elongata*, water plantain (*Alisma Plantago-aquatica*), great water dock (*Rumex Britannica*), swamp milkweed (*Asclepias incarnata*), dodder (*Cuscuta Gronovii*), button-bush (*Cephalanthus occidentalis*), *Aster junceus*, and *A. lateriflorus*.

North of Quaker Pond the *Decodon* community gives way to an extensive marsh. Conspicuous and dominant species are the great bulrush (*Scirpus validus*) and reed grass (*Phragmites communis*), but a number of other species are important components of the mat of vegetation which is virtually floating on unconsolidated peat—*Eleocharis rostellata*, its long recurved culms frequently rooting at the tips, *Calamagrostis canadensis*, *C. inexpansa*, *Muhlenbergia racemosa*, *M. sylvatica*, and *Cladium mariscoides*. Near the border of the pond and along sluggish streams which are frequently completely overgrown, may be found pools varying from six inches to six feet or more in depth. These pools are often choked with the sweet white water lily (*Nymphaea odorata*) or may contain *Chara* and *Utricularia intermedia*, and at their margins have been collected such unusual species as *Eleocharis pauciflora* and *Carex limosa*. Other species with a scattered but more general distribution in the marsh are the grass pink (*Calopogon pulchellus*), pitcher plant (*Sarracenia purpurea*), shrubby cinquefoil (*Potentilla fruticosa*), marsh cinquefoil (*P. palustris*), *Galium labradoricum*, marsh bellflower (*Campanula uliginosa*), goldenrod (*Solidago uniligulata*), *Aster junceus* and *A. lateriflorus*.

As one approaches firmer ground to the north, the marsh gradually becomes a wet meadow. A boring made at the point marked *x* in fig. 3 showed that there an eight foot layer of well-preserved peat was underlaid by twenty feet of pure marl. The calcareous nature of the underlying deposits and of the springs feeding the meadow is indicated by the vegetation, which shows a great similarity to the floras of the marl beds in Bergen Swamp (Stewart and Merrell, 1937) and of the marly region around the Junius ponds (Wiegand and Eames, 1926). A list of species characteristic of marly habitats which have been found in this meadow are given in table 1. Dense mixed stands of *Eleocharis rostellata*, *Carex Buxbaumii*, and *Juncus balticus* var. *littoralis* are interspersed with *Scirpus validus*, *Carex exilis*, clumps of *Sorghastrum nutans*, and other species (fig. 6). In the marginal portions of this meadow grow mixed stands of *Bromus ciliatus*, *Rynchospora alba*, *Smilacina stellata*, *Thalictrum polygamum*, *Pycnanthemum virginianum*, *Valeriana uliginosa*, *Campanula uliginosa*, *Eupatorium maculatum*, *E. perfoliatum*, *Solidago ohioensis*, *S. uniligulata*, *Aster umbellatus*, and *Cirsium muticum*, and in local depressions among the above-mentioned species may be found the following rare or unusual plants characteristic of marl beds: *Triglochin palustris*, *Rynchospora capillacea*, *Scleria verticillata*, *Juncus brachycephalus*, *Spiranthes cernua*, *Liparis Loeselii*, *Parnassia glauca*, and *Lobelia Kalmii*. Mounds of sphagnum in this zone are covered with sundew (*Drosera rotundifolia*) and occasional pitcher plants.

Islands of shrubs may be found scattered about in this marsh meadow. These include the willows, *Salix Bebbiana*, *S. candida*, *S. discolor*, and other species, bayberry (*Myrica carolinensis*) (fig. 6), speckled alder (*Alnus incana* var. *americana*), shrubby cinquefoil (*Potentilla fruticosa*), swamp rose (*Rosa palustris*), poison sumac (*Rhus Vernix*), and swamp fly honeysuckle (*Lonicera oblongifolia*).

TABLE 1

Characteristic species of marly habitats found in the meadows north of Quaker Pond, on the marl beds of Bergen Swamp (Stewart and Merrell, 1937), and around the Junius Ponds (Wiegand and Eames, 1926).

	Quaker Pond meadows	Bergen Swamp marl beds	Junius Ponds
Triglochin palustris	+*	+	+
Phragmites communis	+	+	
Sorghastrum nutans	+	+	
Eleocharis pauciflora	+**	+	
Eleocharis rostellata	+**	+	+
Cladium mariscoides	+**	+	+
Rynchospora capillacea	+*	+	+
Scleria verticillata	+**	+	+
Carex Buxbaumii	+**	+	+
C. Sartwellii	+**	+	+
Juncus balticus var. littoralis	+	+	+
J. brachycephalus	+*	+	+
Spiranthes cernua	+	+	
Liparis Loeselii	+*	+	+
Salix candida	+*	+	
Parnassia glauca	+	+	+
Potentilla fructicosa	+	+	+
Pycnanthemum virginianum	+		+
Utricularia gibba	+**		+
Lonicera oblongifolia	+*	+	+
Valeriana uliginosa	+*	+	+
Lobelia Kalmii	+	+	+
Solidago ohioensis	+*	+	+
S. uniligulata	+**	+	+

* Rare elsewhere in Monroe County.
** Only station reported for Monroe County.

Bogs and bog forest. The development of bog vegetation takes place where poor drainage conditions prevail. "This results in deficient aeration and the concomitant conditions of a poor bacterial and fungus flora and, often, of acidity."[3] Excellent examples of bogs and bog forest in various stages of development occur within the Mendon Ponds area. Bog vegetation as indicated by the presence of sphagnum and a number of characteristic species of vascular plants such as cranberry (*Vaccinium macrocarpon*), pitcher plant (*Sarracenia purpurea*), and sundew (*Drosera rotundifolia*) may be found in the marshes around Quaker Pond. A patch of bog forest composed chiefly of tamarack (*Larix laricina*) and poison sumac (*Rhus Vernix*) has become established on the west side of the pond (fig. 7). Elsewhere in these marshes the few scattered tamarack trees, some of them now dead, attest the failure of a bog vegetation to become well developed.

Situations more favorable for bog formation are the deeper of the undrained kettles. These were probably originally occupied by lakes similar to the Devil's Bathtub and subsequently became filled in. Kennedy's Bog, the largest and best-preserved sphagnum bog within the county (Bray, 1915; Merrell, 1930; Shanks, 1943), is one of this type.

[3] Weaver and Clements (1938), p. 76.

It is about five acres in extent and is situated to the west of the ponds in an undrained depression, bounded on the north by the steep slopes of an esker and on the south by kame deposits. The surrounding upland is heavily wooded with oak and hickory but near the margins of the bog may be found a fringe of trees including black ash (*Fraxinus nigra*), red maple (*Acer rubrum*), yellow birch (*Betula lutea*) and two species which are relatively rare in the county, black gum (*Nyssa sylvatica* var. *caroliniana*), and balsam poplar (*Populus Tacamahacca*).

Surrounding the bog is a very wet zone often with a foot or more of standing water. In places this zone is a slough choked with wild calla (*Calla palustris*) and various other species including *Cicuta bulbifera*, *Impatiens biflora*, *Lycopus uniflorus*, *Circaea quadrisulcata* var. *canadensis*, and *Bidens frondosa*. Occasional specimens of tufted loosestrife (*Lysimachia thyrsiflora*), buckbean (*Menyanthes trifoliata* var. *minor*), *Carex comosa*, *Eleocharis obtusa*, and *Glyceria grandis* may also be found. Elsewhere the margin of the bog is filled with a dense growth of tall shrubs, including black chokeberry (*Aronia melanocarpa*), mountain holly (*Nemopanthus mucronata*), winterberry (*Ilex verticillata*), speckled alder (*Alnus incana* var. *americana*), highbush blueberry (*Vaccinium corymbosum*), button-bush (*Cephalanthus occidentalis*), with occasional specimens of bog willow (*Salix pedicellaris* var. *hypoglauca*), shining willow (*S. lucida*), poison sumac (*Rhus Vernix*), and withe-rod (*Viburnum cassinoides*).

Beyond this marginal zone lies the open bog which is covered with low ericaceous shrubs growing in a bed of sphagnum. The bog heath has a number of sharply-defined communities, each dominated by characteristic species. Portions of the bog toward the southeast are covered with large bushes of leatherleaf (*Chamaedaphne calyculata*), to the exclusion of all other shrubs. The western end has been taken over by luxuriant stands of the handsome Virginia chain fern (*Woodwardia virginica*), growing four to five feet tall (fig. 9). In the central section a considerable area is covered with a mixed and stunted growth of *Chamaedaphne*, bog rosemary (*Andromeda glaucophylla*), and Labrador tea (*Ledum groenlandicum*) (fig. 8). In a few places, where the cranberries (*Vaccinium Oxycoccos* and *V. macrocarpon*) become the dominant heaths, stands of *Rynchospora alba* give the bog the appearance of a grassy swale, and the following species are also found in abundance: pitcher plant (*Sarracenia purpurea*), the sundews (*Drosera rotundifolia* and *D. intermedia*), cotton grass (*Eriophorum virginicum*), rose pogonia (*Pogonia ophioglossoides*) and very stunted specimens of *Chamaedaphne* and *Andromeda*.

Quite a number of other species have been found in the sphagnum of the bog heath, among them *Dryopteris Thelypteris* var. *pubescens*, *Scheuchzeria palustris*, *Eriophorum gracile*, *E. viridi-carinatum*, *Scirpus* *cyperinus*, *Dulichium arundinaceum*, *Carex canescens* and its varieties *disjuncta* and *subloliacea*, *C. interior*, *C. limosa*, *C. trisperma* and its variety *Billingsii*, *Juncus canadensis*, *Boehmeria cylindrica* var. *Drummondiana*, *Hypericum virginicum*, *Decodon verticillatus*, and *Solanum Dulcamara*.

The present bog heath is broken here and there by islands of taller shrubs, especially highbush blueberry (*Vaccinium corymbosum*), black huckleberry (*Gaylussacia baccata*) and the bog conifers—tamarack (*Larix laricina*) and black spruce (*Picea mariana*), the latter species having been reported from only one other station within the county (fig. 8). Toward the west end, the bog is being invaded by clumps of *Aronia melanocarpa;* and scattered individuals of red maple (fig. 9), sweet birch (*Betula lenta*), and poison sumac are also becoming established. It is clear that the invasion of the bog by the bog forest has well begun. Botanists who have been visiting this area for many years comment on the increasing dryness and solidity of the heath. It is very probable that desiccation has been hastened by the destruction of adjacent woodlands and by subsequent farming operations.

Bog forest may be found at the bottoms of wooded kettles such as Woodchuck Hollow and at the margins of Round Pond and the Devil's Bathtub. In such habitats grow species not found elsewhere in the area—e.g., pink ladyslipper (*Cypripedium acaule*), goldthread (*Coptis groenlandica*), bunchberry (*Cornus canadensis*), and shinleaf (*Pyrola asarifolia* var. *incarnata*). Forty years ago a more extensive bog forest containing a considerable stand of tamarack occurred west of Hundred Acre Pond, and was known as a "huckleberry swamp." Although draining, cutting, peat removal and various other activities of man have greatly altered the flora so that it now appears as swamp forest dominated by red maple and blackberries, black spruce and a few other interesting bog forest species still persist in this woodlot.

Swamp forest. The most extensive swamp forests in Monroe County occupied low ground along the streams. Alluvial deposits characteristic of such habitats are almost absent around the Mendon Ponds, and the swamp-forest vegetation, where present (see fig. 3), has probably been derived secondarily from bog forest, as in the case mentioned in the preceding paragraph. Dominant trees of this secondary swamp forest community are red maple, American elm (*Ulmus americana*), basswood (*Tilia americana*), white ash (*Fraxinus americana*), and red ash (*F. pennsylvanica*). In this habitat several conspicuous species of ferns are usually abundant, cinnamon fern (*Osmunda cinnamomea*), interrupted fern (*O. Claytoniana*), and ostrich fern (*Pteretis nodulosa*).

Beech-maple forest. This forest type occurs on rich, well-drained soils and is considered to be a climax association. It is characterized in this area by three dominant species, sugar maple (*Acer saccharum*), beech

FIG. 4. The sluggish outlet to Quaker Pond, lined by the great bulrush (*Scirpus validus*) and choked with cow lily (*Nuphar variegata*). The edge of an extensive alder thicket may be seen at the right.

FIG. 5. A view looking north along the western shore of Quaker Pond. Here, the water willow (*Decodon verticillatus*) is invading the open water of the pond. The conifers at the left, which are also shown in the distance in figure 7, are tamarack (*Larix laricina*).

FIG. 6. A portion of the marly meadow north of Quaker Pond looking north from the point marked *x* in figure 3. The dominant species in the foreground are *Eleocharis rostellata*, with the recurved culms, *Juncus balticus* var. *littoralis*, and *Carex Buxbaumii*. The dark patches are shrubs of bayberry (*Myrica carolinensis*). In the background to the right is a young grove of aspen (*Populus tremuloides*).

FIG. 7. A view looking eastward toward Quaker Pond across a marsh meadow in which the dominant species are bluejoint (*Calamagrostis canadensis*) and sedges (particularly *Carex strictior*). The patch of bog conifers in the background are tamarack (*Larix laricina*) growing at the margin of the pond. In front of them may be seen a zone of shrubs composed of alder (*Alnus incana* var. *americana*) and various species of willow (including *Salix candida*, *S. Bebbiana*, and *S. discolor*).

(*Fagus grandifolia*) and basswood (*Tilia americana*). Associated with these are American elm, white ash, red maple, red oak (*Quercus borealis* var. *maxima*), shagbark hickory (*Carya ovata*), hop hornbeam (*Ostrya virginiana*), tulip tree (*Liriodendron Tulipifera*), wild black cherry (*Prunus serotina*), hornbeam (*Carpinus caroliniana* var. *virginiana*), witch hazel (*Hamamelis virginiana*), flowering dogwood (*Cornus florida*), and alternate-leaved dogwood (*Cornus alternifolia*). The ground cover includes a wide variety of woodland species, many of them vernal wildflowers. A small patch of beech-maple woods may be found north of Canfield Road (see fig. 3).

Upland oak forest. This is the most generally-distributed vegetation type within the Mendon Ponds area, occupying the well-drained sands and gravels of the kames and eskers. Formerly it must have been much more extensive, occupying most of the cleared land which has been pastured or under cultivation until recent years.

The dominant species are white oak (*Quercus alba*), red oak (*Q. borealis* var. *maxima*), black oak (*Q. velutina*), and shagbark hickory (*Carya ovata*). Numerous other tree species are also found in this association, including various other hickories (*Carya spp.*), white ash, red maple, wild black cherry, sassafras (*Sassafras albidum*), hop hornbeam (*Ostrya virginiana*), butternut (*Juglans cinerea*), slippery elm (*Ulmus fulva*), basswood, tulip tree, bur oak (*Quercus macrocarpa*), and chestnut (*Castanea dentata*). Smaller trees and shrubs include witch hazel (*Hamamelis virginiana*), choke cherry (*Prunus virginiana*), flowering dogwood, arrowwood (*Viburnum affine* var. *hypomalacum* and *V. acerifolium*), various species of shadbush (*Amelanchier*), and staghorn sumac (*Rhus typhina*).

Oak openings. In very dry situations on the over-drained, sandy glacial deposits and on the limestone outcrops, openings occurred in the original oak forests of the county. Shanks (1943) has assembled a considerable body of evidence derived from historical records and from recent vegetation studies to demonstrate the nature and extent of these so-called oak openings, a very good undisturbed example of which may still be found a short distance west of Five Points in the town of Rush.[4] The openings apparently represent a remnant of a more generally-distributed prairie vegetation which extended far eastward of its present range (Transeau, 1935; Gordon, 1940) and which flourished during the "xerothermic phase" of the post-glacial period (Sears, 1932, 1942). Dryness of the habitat and occasional fires were probably major factors in maintaining these openings.

The sandy kame deposits in the vicinity of Mendon Ponds were a favorable place for the survival of these prairie plants, many of which may still be found within the area. These species must have originally

[4] For maps indicating the sites of oak openings see Shanks and Goodwin (1943), figs. 9, 10, 11, and 12.


FIGS. 8 and 9. Views of the heath in Kennedy's Bog. The undulating wooded crest of the western esker is shown in the background. Fig. 8. (Left) A stand of leatherleaf (*Chamaedaphne calyculata*) and bog rosemary (*Andromeda glaucophylla*). The white tufts are the fruiting heads of cotton grass (chiefly *Eriophorum virginicum*). The island of shrubs is composed chiefly of highbush blueberry (*Vaccinium corymbosum*) with some marginal specimens of black huckleberry (*Gaylussacia baccata*). The tree in the center is tamarack (*Larix laricina*), and black spruce (*Picea mariana*) may be seen in the background, to the right. Fig. 9. A luxuriant stand of the Virginia chain fern (*Woodwardia virginica*) about five feet high. Red maple (*Acer rubrum*) and tamarack are shown invading the bog. The man standing near the center of the picture is Dr. Royal E. Shanks.

occupied dry sterile sites on the tops and slopes of the kames and eskers, particularly along trails and about camp sites of the Indians (see Parker, 1920 and 1926), but it is almost certain that openings in these situations were not extensive. Due to the drastic changes which have taken place since white settlement, very few actual oak openings remain intact. In the Mendon Ponds area only a few square yards of this original vegetation have been found on a knoll northeast of Quaker Pond in an open stand of black oak and pignut hickory (*Carya glabra*). Here were found a considerable number of characteristic prairie species in an unbroken association. The turf was composed of **Andropogon scoparius*, **A. furcatus*, **Sorghastrum nutans*, **Poa compressa*, *Danthonia spicata*, **Panicum sphaerocarpon*, **Carex pennsylvanica*, *Juncus macer*, and *Luzula multiflora*. Among these were scattered plants of *Pteridium latiusculum*, **Lilium philadelphicum*, **Hypoxis hirsuta*, **Comandra umbellata*, **Fragaria virginiana*, **Desmodium canadense*, *Helianthemum canadense*, **Zizia aurea*, *Gaultheria procumbens*, *Vaccinium angustifolium*, **Pycnanthemum flexuosum*, *Areolaria pedicularia*, **Galium boreale*, *Campanula rotundifolia*, *Solidago bicolor*, *S. juncea*, **S. nemoralis*, **Aster laevis*, *Sericocarpus asteroides*, and **Antennaria plantaginifolia*. Numerous additional prairie species not necessarily confined to prairie habitats are found within the area, even though the original plant associations have been disturbed or even completely disrupted. Of the 273 species listed by Shimek (1911) from typical prairie habitats in Iowa, at least 91 (or 33 per cent) have been collected around the Mendon Ponds.

Cleared land and park policies. Since the formation of the Park in 1930 some of the cleared land has begun to revert to forest. The early stages of such a succession are best seen on some of the steep slopes of the eskers, where pastures and fields of golden rod (*Solidago* spp.) have been invaded first by brambles (*Rubus* spp.) and subsequently by sumac (*Rhus typhina* and *R. glabra*), hawthorn (*Crataegus* spp.), *Sassafras*, or willow (*Salix humilis* and other species).

Numerous sections have been extensively planted with various conifers, of which the only native species are white pine (*Pinus Strobus*) and arbor vitae (*Thuja occidentalis*). Some of the introduced species may be found in the annotated list. The groves which are developing from these plantings will be relatively sterile and uninteresting from a botanical standpoint, at least until such time as they may be invaded by the native vegetation.

From the preceding description of the vegetation of the area and from the annotated list of species which follows, it should be clear that within the boundaries of the Park may still be found many fascinating botanical and ecological features. The preservation of these features is, in the writer's opinion, compatible with the best interests of the many people

* Typical prairie species (see Shimek, 1911; Weaver and Fitzpatrick, 1934).

who use the Park as a recreation center. Roads, parking areas, picnic facilities, bathing beach, bridle paths, trails, etc., have already been adequately developed. Further encroachment of civilization would threaten the survival of those plant communities which contribute the most toward the natural beauty and scientific interest of the area. Inasmuch as some of these associations are virtually unique within the county, no adequate substitute could be found once they became destroyed.

Those who are interested in conservation should keep themselves informed as to developments in County Park policies in order to safeguard this fragment of our vanishing heritage. Recent lumbering, excavation of peat and gravel pit operations which have been carried out within the Park can scarcely net the county budgetary saving commensurate with the violence done to the natural features and should be stopped. Moreover, further landscaping of the roadsides with cultivated plants seems scarcely appropriate in an area so well known for its natural botanical attractions.

AN ANNOTATED LIST OF THE SPECIES OF VASCULAR PLANTS

In the following list the results of a large number of collecting trips to the vicinity of Mendon Ponds made during the past eighty years have been brought together. Among the botanists who have made substantial contributions to our knowledge of the flora of this area previous to 1938 should be mentioned Mr. George T. Fish, Mr. Joseph B. Fuller, Mr. Milton S. Baxter, Mr. Ellsworth P. Killip, Dr. Karl M. Wiegand, Mr. Warren A. Matthews, and Dr. Homer D. House. During the past five years the vegetation of the area has been surveyed by W. P. A. workers under the supervision of Dr. Royal E. Shanks as part of an ecological study of the vegetation of Monroe County sponsored jointly by the New York State Museum and the Monroe County Division of Regional Planning (Shanks, 1943). In 1939, Dr. Robert T. Clausen and Mr. W. A. Hinkey studied the aquatics in conjunction with the biological survey of the Ontario watershed (Clausen, 1940). The writer, accompanied on various occasions by Dr. Royal E. Shanks, Mr. Warren A. Matthews, Mr. William Stepka and others, has attempted to round out the record by adding and supplementing common species and recent introductions, by verifying earlier reports, and by noting the distribution and relative abundance of the various components of the flora. Although the list is still incomplete, it seems advisable to bring together the material available at the present time.

Certain conventions have been followed in the annotated list. Scientific names of native plants are printed in **bold face** type. Those of introduced species and common names are printed in SMALL CAPITALS. Nomenclature conforms insofar as possible with the International Rules. Wherever the scientific names differ from those of *Gray's Manual*, edition 7, of the *Annotated List of the Ferns and Flowering Plants of New York State* (House, 1924), or of the previously published lists of the flora of Monroe County, New York (Beckwith *et al.*, 1896, 1910, 1917), the synonyms are given in *italics*.

The sequence of the families and genera follows that of the *Genera Siphonogamarum* (Dalle Torre and Harms, 1907), an arrangement in use in most of our manuals. The only exception to this will be found in the *Gramineae* which follow Hitchcock (1935). Students will find excellent up-to-date keys for the identification of our native plants in the *Flora of the Cayuga Lake Basin, New York* (Wiegand and Eames, 1926) and in the *Flora of Indiana* (Deam, 1940). Most of the species listed will be found in either of these publications.

Information concerning specimens and literature reports is given in condensed form within brackets following the names. Letters refer to herbaria in which specimens are deposited. Numbers refer to published reports fully cited in the bibliography (page 297). Other literature references are cited by author and date. An index to the symbols and abbreviations used is given below.

*	Collected or seen by the author within the last five years.
C	Herbarium of Cornell University, College of Agriculture, Ithaca.
HP	Herbarium at Highland Park, Rochester.
NYS	Herbarium of the New York State Museum, Albany.
R	Herbarium of the University of Rochester. (Most of the specimens collected previous to 1930 are in the Herbarium of the Rochester Academy of Science, now on deposit with the University of Rochester.)
USNM	Herbarium of the United States National Museum, Washington, D. C.
WAM	Herbarium of Warren A. Matthews, Rochester.
1.	Beckwith and Macauley (1896).
2.	Beckwith, Macauley and Baxter (1910).
3.	Beckwith, Macauley and Baxter (1917).
4.	Clausen (1940).
5.	Shanks and Goodwin (1943).

OPHIOGLOSSACEAE

Botrychium matricariaefolium A. Br. (*B. ramosum* of Gray's Man., ed. 7; *B. neglectum* of House.) [1, p. 9] Reported only once from the area. No confirming specimens have been found.

Botrychium virginianum (L.) Sw. RATTLESNAKE FERN. [*R] Wooded portions of the area; occasional.

Ophioglossum vulgatum L. COMMON ADDER'S TONGUE. [2, R, WAM] Apparently rare. Last collected by *M. S. Baxter* in 1919.

OSMUNDACEAE

Osmunda cinnamomea L. CINNAMON FERN. [*] Swamp forest, throughout the area; common.

Osmunda Claytoniana L. INTERRUPTED FERN. [*] Similar habitats; not nearly as common as the preceding species.

Osmunda regalis L. var. **spectabilis** (Willd.) Gray. (Rhodora 21: 179. 1919.) (*O. regalis* L. of Gray's Man., ed. 7, and of Monroe Co. List.) ROYAL FERN. [*] Wet situations in open woods or at the edges of thickets around the ponds; frequent.

POLYPODIACEAE

Cystopteris fragilis (L.) Bernh. (*Felix fragilis* of House.) FRAGILE BLADDER FERN. [*R] Moist humus of the swamp forest; frequent.

Pteretis nodulosa (Michx.) Nieuwl. (Rhodora 21: 178. 1919.) (*Onoclea Struthiopteris* of Gray's Man., ed. 7, and of Monroe Co. List.) OSTRICH FERN. [*] Moist humus of the swamp forest, often in standing water; infrequent.

Onoclea sensibilis L. SENSITIVE FERN. [*R] Low ground in open woods, at the edges of marshes, along roadsides, etc.; abundant.

Dryopteris cristata (L.) Gray var. **Clintoniana** (D. C. Eaton) Underw. (*Aspidium cristatum* var. *Clintonianum* of Gray's Man., ed. 7, and of Monroe Co. List; *Thelypteris Clintoniana* of House.) CLINTON'S WOODFERN. [R]

Dryopteris hexagonoptera (Michx.) C. Chr. (*Phegopteris hexagonoptera* of Gray's Man., ed. 7, and of Monroe Co. List; *Thelypteris hexagonoptera* of House.) BROAD BEECH FERN. [*] In beech-maple woods; infrequent.

Dryopteris Linnaeana C. Chr. (*Phegopteris Dryopteris* of Gray's Man., ed. 7, and of Monroe Co. List; *Thelypteris Dryopteris* of House.) OAK FERN. [1]

Dryopteris marginalis (L.) Gray. (*Aspidium marginale* of Gray's Man., ed. 7, and of Monroe Co. List; *Thelypteris marginalis* of House.) MARGINAL SHIELD FERN. [*] Moist slopes among mixed hardwoods; occasional.

Dryopteris noveboracensis (L.) Gray. (*Aspidium noveboracense* of Gray's Man., ed. 7, and of Monroe Co. List; *Thelypteris noveboracensis* of House.) NEW YORK FERN. [*]

Dryopteris spinulosa (O. F. Müller) Ktze. (*Aspidium spinulosum* of Gray's Man., ed. 7, and of Monroe Co. List; *Thelypteris spinulosa* of House.) SPINULOSE SHIELD FERN. [*R] Moist humus of the swamp forest.

Dryopteris spinulosa var. **intermedia** (Muhl.) Underw. (Rhodora 21: 178. 1919; 22: 196. 1920.) (*Thelypteris intermedia* of House.) [*R] Habitat the same as that of the species.

Dryopteris Thelypteris (L.) Gray var. **pubescens** (Lawson) A. R. Prince. (*Aspidium Thelypteris* of Gray's Man., ed. 7, and of Monroe Co. List; *Thelypteris Thelypteris* of House.) MARSH FERN. [*R] Marshes surrounding the ponds; abundant.

Polystichum acrostichoides (Michx.) Schott. (*Aspidium acrostichoides* of Monroe Co. List.) CHRISTMAS FERN. [*R] Wooded slopes of the eskers; frequent.

Athyrium angustum (Willd.) Presl. (Rhodora 19: 190–197. 1917.) (*Asplenium Felix-femina* of Gray's Man., ed. 7, and of Monroe Co. List.) LADY FERN. [Edson, 1928] Dry woods.

Asplenium platyneuron (L.) Oakes. (*A. ebeneum* of Monroe Co. List.) EBONY SPLEENWORT. [1, R] One specimen was collected by *M. S. Baxter* in a "huckleberry swamp" in 1896. This species apparently has never been found since.

Woodwardia virginica (L.) Sm. (*Anchistea virginica* of House.) VIRGINIA CHAIN FERN. [*R, 1] In the sphagnum of Kennedy's Bog (see fig. 9); a dominant species in this habitat, but not found elsewhere.

Adiantum pedatum L. MAIDENHAIR FERN. [*] Moist slopes in beech-maple woods or under mixed hardwoods; infrequent.

Pteridium latiusculum (Desv.) Hieronymus. (*Pteris aquilina* of Gray's Man., ed. 7, and of Monroe Co. List.) BRACKEN. [*] Dry open woods and abandoned pastures on the slopes of the kames and eskers; common.

EQUISETACEAE

Equisetum arvense L. FIELD HORSETAIL. [*] Moist sandy soil in fields and along roadsides; common.

Equisetum fluviatile L. (*E. limosum* of Monroe Co. List.) WATER HORSETAIL. [*R, 5] In standing water at the edge of Hundred Acre Pond; rare.

Equisetum praealtum Raf. (*E. hyemale* var. *affine* of Gray's Man., ed. 7; *E. hyemale* of Monroe Co. List.) TALL SCOURING-RUSH. [*R] Shaded or open, moist sandy slopes; occasional.

Equisetum sylvaticum L. [*] Wet shady places; infrequent.

LYCOPODIACEAE

Lycopodium flabelliforme (Fern.) Blanchard. (Rhodora 13: 168–171. 1911.) (*L. complanatum* L. var. *flabelliforme* Fern.) [*]

Lycopodium lucidulum Michx. SHINING CLUBMOSS. [*R] Only one locality in the swamp forest; scarce.

Lycopodium obscurum L. GROUNDPINE. [*R] Found only with the preceding species; scarce.

PINACEAE

PINUS NIGRA Arnold var. AUSTRIACA Aschers. & Graebn. AUSTRIAN PINE. [*] Planted.

PINUS RESINOSA Ait. RED PINE. [*] Planted.

Pinus Strobus L. WHITE PINE. [*5] Planted extensively. A natural station may be found in a boggy depression just west of Clover Street.

PINUS SYLVESTRIS L. SCOTCH PINE. [*] Planted.

Larix laricina (DuRoi) Koch. (*L. americana* of Monroe Co. List.) LARCH. TAMARACK. [*5] Sphagnum bogs, wet marly meadows and various places near the margins of the ponds (see figs. 7 and 8). This species is still frequent but was formerly more abundant.

PICEA ABIES (L.) Karst. NORWAY SPRUCE. [*R] Planted.

PICEA CANADENSIS (Mill.) BSP. (*P. glauca* of House.) WHITE SPRUCE. [*R] Planted.

Picea mariana (Mill.) BSP. (*P. nigra* of Monroe Co. List.) BLACK SPRUCE. [*R, 1] In Kennedy's Bog, abundant; also found as scattered trees in two or three other localities in remnants of the bog forest. This species has been reported from only one other station in the county.

Thuja occidentalis L. (*Thuya* of Monroe Co. List.) ARBOR VITAE. WHITE CEDAR. [*5] In a small sphagnum bog beside the western esker; also planted in several places.

TYPHACEAE

Typha angustifolia L. var. **elongata** (Dudley) Wieg. (Rhodora 26: 1. 1924.) (*T. latifolia* var. *elongata* of Monroe Co. List.) NARROW-LEAVED CATTAIL. [*] Marshes; not nearly as common as *T. latifolia*.

Typha latifolia L. BROAD-LEAVED CATTAIL. [*] Marshes; frequent, but nowhere forming extensive stands.

NAJADACEAE[5]

Potamogeton. PONDWEED.

Potamogeton americanus Cham. & Schlecht. (*P. lonchitis* of House; *P. fluitans* of Monroe Co. List.) [*R, 4, 5] In Hundred Acre, Deep, and Quaker Ponds; common to frequent.

Potamogeton amplifolius Tuckerm. [NYS, 5]

Potamogeton angustifolius Berch. & Presl. [*R, 4, 5] In Hundred Acre, Deep, and Quaker Ponds; abundant to frequent.

Potamogeton Berchtoldi Fieb. (Rhodora 42: 246. 1940.) (*P. pusillus* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [*4, 5] In Hundred Acre Pond; frequent.

Potamogeton compressus L. (*P. zosterifolius* of Gray's Man., ed. 7, and of Monroe Co. List; *P. zosteriformis* Fern.) [*R, 4, 5] In Quaker Pond; common.

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[5] Notes on distribution have been taken from Clausen (1940). I am indebted to Dr. W. C. Muenscher for determinations of the specimens of *Potamogeton* in the Herbarium of the University of Rochester.

Potamogeton gramineus L. var. **graminifolius** Fries. (*P. heterophyllus* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R, 4, 5] In Hundred Acre Pond; common.

Potamogeton natans L. [*R, 4, 5] In Hundred Acre and Quaker Ponds; frequent.

Potamogeton pectinatus L. [*R, 4, 5] In Hundred Acre, Deep, and Quaker Ponds; abundant to common.

Potamogeton praelongus Wulf. [*R, 4, 5] In Hundred Acre Pond; common. In Deep Pond; rare. This is a rare species not reported elsewhere within the county.

Potamogeton strictifolius Benn. var. **rutiloides** Fern. (Memoirs Gray Herb. 3: 57–60. 1932.) [*R, NYS, 4, 5] In 2–4 feet of water in Hundred Acre, Deep, and Quaker Ponds; abundant to frequent. This is the only station for this species within the county.

Najas flexilis (Willd.) Rostk. & Schmidt. NAIAD. [*R, C, 4, 5] A submerged aquatic. Hundred Acre Pond; abundant. Deep Pond; rare.

Najas marina L. LARGE NAIAD. [*C, 4, 5] In three feet of water, Hundred Acre Pond; frequent.

JUNCAGINACEAE

Triglochin palustris L. ARROW-GRASS. [*R, 5] In wet depressions in the marly meadows north of Quaker Pond, associated with *Rynchospora capillacea* and *Scleria verticillata;* rare.

Scheuchzeria palustris L. var. **americana** Fern. (Rhodora 25: 177–179. 1923.) (*S. palustris* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R, C, 1] In sphagnum, Kennedy's Bog; rare.

ALISMACEAE

Alisma Plantago-aquatica L. (*A. subcordatum* of House; *A. Plantago* of Monroe Co. List.) WATER PLANTAIN. [*R] In mucky soil at the edges of the ponds; frequent. This is the species with large achenes. One shallow slough just west of Clover Street has been completely covered by it.

Alisma Plantago-aquatica var. **parviflorum** (Pursh) Farwell. [*R, 5] Margin of Quaker Pond outlet, in a wet muddy pasture.

Sagittaria latifolia Willd. (*S. variabilis* of Monroe Co. List.) ARROWHEAD. [*R] Muddy borders of the streams and ponds; frequent. Specimens of **S. latifolia** forma **hastata** (Pursh) Robinson have also been collected [*R].

HYDROCHARITACEAE

Anacharis canadensis (Michx.) Planch. (*Elodea canadensis* of Gray's Man., ed. 7, and of Monroe Co. List; *Philotria canadensis* of House.) WATERWEED. [*R, 4] A submerged aquatic of the ponds; common.

Vallisneria americana Michx. (Rhodora 20: 108–110. 1918.) (*V. spiralis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) EEL GRASS. WILD CELERY. [*R, 4] A submerged aquatic; frequent in Hundred Acre Pond.

GRAMINEAE[6]

Bromus ciliatus L. FRINGED BROME. [*R] Wet marly meadows; infrequent.

BROMUS COMMUTATUS Schrad. HAIRY CHESS. [*R, 5] A roadside adventive.

Bromus Kalmii Gray. [R, 1]

BROMUS SECALINUS L. CHESS. [*R] A weed of cultivated fields and roadsides.

BROMUS TECTORUM L. DOWNY CHESS. [*R] A weed of roadsides and waste places; frequent.

FESTUCA ELATIOR L. MEADOW FESCUE. [*R] A weed of meadows and roadsides; frequent.

Festuca obtusa Spreng. (*F. nutans* of Gray's Man., ed. 7, and of Monroe Co. List.) NODDING FESCUE. [R] Open woods. Collected by *E. P. Killip* in 1919.

Glyceria grandis Wats. (*Panicularia grandis* of House.) AMERICAN MANNAGRASS. [*R] Wet soil in marshes.

Glyceria striata (Lam.) Hitchc. (*G. nervata* of Gray's Man., ed. 7, and of Monroe Co. List; *Panicularia striata* of House.) FOWL MANNAGRASS. [*R] Wet mud in shady places.

Poa alsodes Gray. [*R] Moist woods.

POA ANNUA L. ANNUAL BLUEGRASS. [*] Lawns and cultivated ground; common.

POA COMPRESSA L. CANADA BLUEGRASS. [*R] Dry open hillsides; abundant.

Poa languida Hitchc. (*P. debilis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [3]

POA PRATENSIS L. KENTUCKY BLUEGRASS. [*] Open woods, fields and open ground; abundant.

DACTYLIS GLOMERATA L. ORCHARD GRASS. [*R] Fields, meadows and roadsides; common.

Phragmites communis Trin. (*Phragmites Phragmites* of House.) REED GRASS. [*R, 1] A conspicuous grass in portions of the wet marshes around Quaker Pond; infrequent.

Schizachne purpurascens (Torr.) Swallen. (*Melica striata* of Gray's Man., ed. 7; *Melica purpurascens* of House; *Avena striata* of Monroe Co. List.) [2]

[6] In this family the sequence of genera and the nomenclature of Hitchcock (1935) have been followed. I am indebted to Mrs. Agnes Chase of the U. S. National Museum for identification of critical material including all specimens of the genus *Panicum*.

AGROPYRON REPENS (L.) Beauv. QUACKGRASS. [*R] A weed of roadsides and cultivated ground; abundant.

Agropyron subsecundum (Link) Hitchc. (Amer. Jour. Bot. 21: 131. 1934.) (*A. caninum* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) BEARDED WHEATGRASS. [R, 5]

TRITICUM AESTIVUM L. WHEAT. [*R] An occasional escape.

Hystrix patula Moench. (*H. Hystrix* of House; *Asprella Hystrix* of Monroe Co. List.) BOTTLEBRUSH. [R] Collected by *E. P. Killip* in 1915.

Sphenopholis intermedia (Rydb.) Rydb. (*S. pallens* of Gray's Man., ed. 7, and of House; probably *Eatonia pennsylvanica* of Monroe Co. List.) SLENDER WEDGEGRASS. [R, 5]

Sphenopholis nitida (Spreng.) Scribn. (*Eatonia Dudleyi* of Monroe Co. List.) WEDGEGRASS. [*R, 5] Dry wooded hillsides.

ARRHENATHERUM ELATIUS (L.) Mert. & Koch. (*A. avenaceum* of Monroe Co. List.) TALL OATGRASS. [R, 5] A roadside weed.

HOLCUS LANATUS L. (*Notholcus lanatus* of House.) VELVET GRASS. [*R, 5] A roadside adventive; scarce.

Danthonia spicata (L.) Beauv. POVERTY OATGRASS. [*R] A grass of openings and open woods especially on the crests and slopes of the eskers; common.

Calamagrostis canadensis (Michx.) Beauv. BLUEJOINT. [*R, C] In the marshes, particularly around Quaker Pond, where it is a dominant species over considerable areas (see fig. 7).

Calamagrostis inexpansa Gray. NORTHERN REEDGRASS. [*R, 5] Marly marsh meadows north of Quaker Pond; apparently much less frequent than *C. canadensis.*

AGROSTIS ALBA L. (*A. palustris* of House.) REDTOP. [*R] Meadows and pastures; abundant.

AGROSTIS PALUSTRIS Huds. (*A. alba* var. *maritima* of Gray's Man., ed. 7; *A. maritima* of House.) CREEPING BENT. [R] Collected by *M. S. Baxter*, 1917.

Agrostis perennans (Walt.) Tuckerm. AUTUMN BENT. [R, C] Sandy woods.

Alopecurus aequalis Sobol. (*A. geniculatus* var. *aristulatus* of Gray's Man., ed. 7, and of Monroe Co. List.) SHORT-AWN FOXTAIL. [*R] In the shallow water of depressions which usually dry up in the summer and fall.

PHLEUM PRATENSE L. TIMOTHY. [*R] A common escape along roadsides and in fields.

Muhlenbergia foliosa (Roem. & Schult.) Trin. [*R] Marshes and wet thickets.

Muhlenbergia racemosa (Michx.) BSP. (*M. glomerata* of Monroe Co. List.) MARSH MUHLY. [*R] Marshes north of Quaker Pond; frequent.

Muhlenbergia tenuiflora (Willd.) BSP. (*M. Willdenowii* of Monroe Co. List.) [1] Reported as growing on sandy knolls.

Sporobolus vaginiflorus (Torr.) Wood. [*R] In rock fill along roadsides.

Oryzopsis asperifolia Michx. [R] Collected by *E. P. Killip* in 1921.

Hierochloë odorata (L.) Beauv. (*Torresia odorata* of House; *H. borealis* of Monroe Co. List.) SWEETGRASS. [*R, 3] Open marshes and moist stream banks.

ANTHOXANTHUM ODORATUM L. SWEET VERNALGRASS. [R] Collected by *E. P. Killip* in 1916.

Phalaris arundinacea L. REED CANARY GRASS. [*R] Marshes around the ponds; infrequent.

Leersia oryzoides (L.) Swartz. (*Homalocenchrus oryzoides* of House.) RICE CUTGRASS. [*R] Wet places particularly at or near the edges of the marshes; frequent.

DIGITARIA ISCHAEMUM (Schreb.) Muhl. (*D. humifusa* of Gray's Man., ed. 7; *Syntherisma Ischaemum* of House; *Panicum glabrum* of Monroe Co. List.) SMOOTH CRABGRASS. [*R] A weed of fields and farmyards.

DIGITARIA SANGUINALIS (L.) Scop. (*Syntherisma sanguinalis* of House; *Panicum sanguinale* of Monroe Co. List.) CRABGRASS. [*R] A weed of fields and abandoned farmyards; common.

Paspalum pubescens Muhl. (*P. Muhlenbergii* of Monroe Co. List.) [*R] Sandy hillsides.

Panicum barbulatum Michx. [*USNM, 5] Dry wooded slopes of an esker.

Panicum boreale Nash. [C, 5] Sandy fields.

Panicum capillare L. WITCHGRASS. [*R] A weed of dry sandy fields; common.

Panicum dichotomum L. [*R, 5] Dry fields.

Panicum huachucae var. **fasciculatum** (Torr.) F. T. Hubb. (*P. huachucae* var. *silvicola* of Gray's Man., ed. 7, and of House.) [C, 5] Dry sandy fields.

Panicum latifolium L. (*P. macrocarpon* of Monroe Co. List.) [*USNM, 5] Dry wooded slopes of an esker.

Panicum linearifolium Scribn. [*USNM, 5] Dry wooded slopes of an esker.

Panicum Scribnerianum Nash. [3, 5]

Panicum sphaerocarpon Ell. [*R, 5] Dry slopes of the eskers; common. Depauperate specimens were also collected in wet marly meadows.

Panicum subvillosum Ashe. [R, 5] Dry sandy soil.

Panicum tsugetorum Nash. [R, 5]

Echinochloa crusgalli (L.) Beauv. (*Panicum crusgalli* of Monroe Co. List.) BARNYARD GRASS. [*R] A weed of fields and roadsides and many other habitats; common.

SETARIA LUTESCENS (Weigel) F. T. Hubb. (*S. glauca* of Gray's Man., ed. 7, and of Monroe Co. List; *Chaetochloa lutescens* of House.) YELLOW BRISTLEGRASS. YELLOW FOXTAIL. [R, 5] Fields, roadsides and waste ground; common.

SETARIA VIRIDIS (L.) Beauv. (*Chaetochloa viridis* of House.) GREEN BRISTLEGRASS. GREEN FOXTAIL. [*R] A weed of roadsides and cultivated ground; common.

Andropogon furcatus Muhl. TALL BLUESTEM. [*R, 5] In the remnants of oak openings; infrequent.

Andropogon scoparius Michx. LITTLE BLUESTEM. [*R, 5] Dry sandy soils, on the slopes of the eskers, and in oak openings where disturbances of the vegetation have not been too recent; common.

Sorghastrum nutans (L.) Nash. (*Chrysopogon nutans* of Monroe Co. List.) INDIAN GRASS. [*R, 5] In the remnants of oak openings and in the dryer portions of the marly marsh meadows; occasional.

CYPERACEAE[7]

Cyperus diandrus Torr. [*R] Muddy margins of ponds and streams; infrequent.

Cyperus filiculmis Vahl. var. **macilentus** Fern. (Rhodora 37: 153–154. 1935.) [*R, C, 5] Dry soil on the open tops of the kames and eskers; infrequent.

Cyperus rivularis Kunth. [*R, C, 5] Muddy margins of Quaker Pond; infrequent.

Cyperus strigosus L. [*R] On the muddy banks of ditches, etc.

Dulichium arundinaceum (L.) Britt. (*D. spathaceum* of Monroe Co. List.) [*R, 1] In sphagnum in Kennedy's Bog; rare.

Eriophorum. COTTON GRASS.

Eriophorum angustifolium Roth. (*E. polystachyon*, in part, of Monroe Co. List.) [R] Collected by *G. T. Fish* in 1867.

Eriophorum gracile Koch. [*R, 1] In sphagnum in Kennedy's Bog; rare.

Eriophorum virginicum L. (Including *E. virginicum* var. *album* Gray.) [*R, 1] In sphagnum, particularly in Kennedy's Bog, where locally abundant (see fig. 8).

Eriophorum viridi-carinatum (Engelm.) Fern. (*E. polystachyon*, in part, of Monroe Co. List.) [R] In the marshes around Quaker Pond. Collected by *E. P. Killip* in 1919.

Scirpus acutus Muhl. (*S. occidentalis* of Gray's Man., ed. 7, and of Monroe Co. List.) BULRUSH. [*R, 5] In water along the margin of ponds; common.

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[7] I am indebted to Dr. Henry K. Svenson for the determination of specimens of *Scirpus*, *Cyperus*, and *Eleocharis;* to Dr. Royal E. Shanks and Dr. Frederick J. Hermann for assistance in the identification of specimens of *Carex* and *Eriophorum*. The nomenclature of the genus *Carex* is that of K. K. Mackenzie (North American Flora 18: 1–478. 1931–1935.) unless otherwise indicated.

Scirpus atrovirens Muhl. [*R] Along the shores of the ponds; frequent.

Scirpus atrovirens var. **georgianus** (Harper) Fern. (Rhodora 23: 134. 1921.) (*S. georgianus* of Gray's Man., ed. 7.) [5] No specimens of this variety have been seen.

Scirpus cyperinus (L.) Kunth. (*Eriophorum cyperinum* of Monroe Co. List.) WOOL GRASS. [*R] In wet swales and marshes; common.

Scirpus cyperinus var. **pelius** Fern. [*R] Habitat same as that of the species. This variety has not previously been recorded for the county.

Scirpus lineatus Michx. [*R] On the dryer, undisturbed banks of the ponds; scarce.

Scirpus pedicellatus Fern. [*R, 5] Found in a wet depression; scarce.

Scirpus planifolius Muhl. [*R, 5] Oak woods on the dry slopes of the eskers; frequent.

Scirpus polyphyllus Vahl. [*R, 5] Boggy woods.

Scirpus validus Vahl. (*S. lacustris* of Monroe Co. List.) GREAT BULRUSH. [*R, 5] In the marshes around the ponds; abundant (see fig. 4).

Eleocharis. SPIKERUSH.

Eleocharis calva Torr. (*E. palustris*, in part, of recent authors.) [*R, 5] At the muddy margins of the ponds; frequent.

Eleocharis elliptica Kunth. (Rhodora 41: 65. 1939.) [R, 5]

Eleocharis equisetoides (Ell.) Torr. (*E. interstincta* of Gray's Man., ed. 7, and of House.) [R, 5] This is the only record for the species within the state. It was reported by *W. A. Matthews* in 1920 as growing in standing water at the edge of Hundred Acre Pond. It apparently no longer occurs at this station.

Eleocharis intermedia (Muhl.) Schultes. (*E. reclinata* of House.) (Rhodora 41: 67. 1939.) [*R] On exposed mud at the edges of ponds and streams. *H. K. Svenson* has reported this station (Rhodora 39: 263. 1937.).

Eleocharis obtusa (Willd.) Schultes. (*E. ovata* of Monroe Co. List.) [*R] On the muddy shores of ponds and sloughs; frequent.

Eleocharis olivacea Torr. [R, 2] Collected on a floating island by *M. S. Baxter* in 1897 and again in 1907.

Eleocharis pauciflora (Lightf.) Link. (*Scirpus pauciflorus* of Gray's Man., ed. 7, and of House.) [*R, 5] At the edge of muddy pools in the marsh meadow north of Quaker Pond; rare. This is the first record for this species within the county.

Eleocharis rostellata Torr. [*R, 5] In the marly meadows north of Quaker Pond; abundant in this habitat (see fig. 6). This is the first authentic record for this species from the county.

Cladium mariscoides (Muhl.) Torr. TWIGRUSH. [*R, 1] Marly meadows and at the margins of ponds; infrequent.

Rynchospora alba (L.) Vahl. BEAKRUSH. [*R, 1] In sphagnum bogs and marly meadows; frequent.

Rynchospora capillacea Torr. BEAKRUSH. [*R, C, 5] Marly springy places; scarce.

Scleria verticillata Muhl. NUTRUSH. [*R, 1] Growing in marly springy places with *Rynchospora capillacea;* rare.

Carex. SEDGE.

Carex albursina Sheldon. (*C. laxiflora* var. *latifolia* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R, 5] On the steep slopes of the eskers in oak woods; frequent.

Carex angustior Mack. (*C. stellulata* var. *angustata* of Gray's Man., ed. 7, and of Monroe Co. List.) [R, 3] Listed as scarce by *M. S. Baxter.*

Carex artitecta Mack. (*C. varia*, including var. *colorata*, of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [*R] In oak woods on the slopes of the eskers. A specimen referred to the variety was collected by *E. P. Killip* in 1919.

Carex atlantica Bailey. (See note on *C. sterilis*.)

Carex aurea Nutt. [R] Collected by *E. P. Killip* in 1915.

Carex Bebbii Olney. (*C. tribuloides* var. *Bebbii* of Monroe Co. List.) [*R] Marshes.

Carex blanda Dewey. (*Carex laxiflora* var. *blanda* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R, 3, 5] Dry wooded slopes of the eskers; frequent.

Carex bromoides Schk. [*R] Wet woods.

Carex Buxbaumii Wahl. (*C. polygama* of Gray's Man., ed. 7; *C. fusca* of Monroe Co. List.) [*R, 5] In the marly meadows and marshes around Quaker Pond; frequent in this habitat (see fig. 6).

Carex canescens L. [*R, 5] In sphagnum bogs.

Carex canescens var. **disjuncta** Fern. [*R, 5] In sphagnum in Kennedy's Bog.

Carex canescens var. **subloliacea** Laest. [*R, 5] In sphagnum in Kennedy's Bog.

Carex Careyana Torr. [2]

Carex castanea Wahl. [R, 5] Sphagnum bogs. Collected by *E. P. Killip* and later by *M. S. Baxter* between 1917 and 1918.

Carex cephalophora Muhl. [*R] In the dryer wooded areas; common.

Carex communis Bailey. [*R] In oak woods on the slopes of the eskers; common.

Carex comosa Boott. (*C. Pseudo-Cyperus* var. *americana* of Monroe Co. List.) [*R] In marshes around the ponds, often in shallow water; common.

Carex comosa × C. retrorsa. [R, 5] One plant of this hybrid was collected by *M. S. Baxter* in 1911. No other collections have been seen.

Carex conoidea Schk. [R, 5] Collected by *M. S. Baxter* near Quaker Pond in 1917.

Carex convoluta Mack. (Bull. Torrey Bot. Club 43: 428. 1916.) [*R, 5] Dry woods.

Carex cristatella Britt. (*C. cristata* of Gray's Man., ed. 7; *C. tribuloides* var. *cristata* of Monroe Co. List.) [*R] Moist oak woods.

Carex cryptolepis Mack. (Torreya 14: 156. 1914.) (*C. flava*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) [*R, 5] Marshes and wet meadows; infrequent.

Carex diandra Schrank. (*C. teretiuscula* of Monroe Co. List.) [*R, USNM] At the marly margin of Round Pond.

Carex digitalis Willd. [*R] On dry slopes in oak woods.

Carex exilis Dewey. [*R, 5] Marly marsh meadows around Quaker Pond.

Carex flava L. [*R] In marly marshes south of Quaker Pond.

Carex gracillima Schwein. [*R] Moist woods.

Carex granularis Muhl. [R] Collected by *E. P. Killip* near Quaker Pond in 1919.

Carex Grayii Carey. (*C. Asa-grayi* of House.) [5] At the edge of swampy woods north of Hundred Acre Pond.

Carex Haleana Olney. (*C. granularis* var. *Haleana* of Gray's Man., ed. 7, and of Monroe Co. List; *C. Shriveri* of House.) [*R, 5] Moist woods.

Carex Howei Mack. (Bull. Torrey Bot. Club 37: 245. 1910.) (*C. scirpoides* var. *capillacea* of Gray's Man., ed. 7.) [*R, 5] On mossy hummocks in wet boggy woods.

Carex hystricina Muhl. [*R] Swamps and boggy places.

Carex interior Bailey. (*C. scirpoides* of Gray's Man., ed. 7.) [R, 2]

Carex intumescens Rudge. [R] Collected by *M. S. Baxter* in 1895.

Carex lacustris Willd. (*C. riparia* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R] In the marshes around the ponds; common.

Carex laevivaginata (Kükenth.) Mack. (Rhodora 17: 231. 1915.) (*C. stipata*, in part, of Gray's Man., ed. 7.) [*R, 5] Boggy woods.

Carex lanuginosa Michx. (*C. filiformis* var. *latifolia* of Monroe Co. List.) [*R] In marshy places.

Carex lasiocarpa Ehrh. (*C. filiformis* of Gray's Man., ed. 7, and of Monroe Co. List.) [R, 5] In the marshes around Quaker Pond.

Carex laxiflora Lam. (Including *C. laxiflora* var. *patulifolia*.) [*R, 5] Dry oak woods.

Carex leptalea Wahl. (*C. polytrichoides* of Monroe Co. List.) [*R] In sphagnum bogs; where abundant.

Carex limosa L. [*R, C, 1] In sphagnum in the marsh meadow north of Quaker Pond and in Kennedy's Bog; scarce.

Carex livida (Wahl.) Willd. [R, 5] Collected by *M. S. Baxter* in 1917 and 1919.

Carex lupulina Muhl. (Including *C. lupulina* var. *pedunculata*.) [*R] Wet swales; infrequent.

Carex lurida Wahl. [*R] In wet places around the ponds; common.

Carex Muhlenbergii Schk. [R, 1] On sandy knolls.

Carex Muhlenbergii var. **enervis** Boott. (*C. plana* of House.) [*R, 5] On the open crests of the dry gravelly eskers; infrequent.

Carex normalis Mack. (*C. mirabilis* of Gray's Man., ed. 7; *C. straminea* var. *mirabilis* of Monroe Co. List.) [*R] Dry open woods.

Carex pallescens L. [R, 5] Moist meadows.

Carex pennsylvanica Lam. [*R] In oak woods on the dry slopes of the eskers.

Carex plantaginea Lam. [*] In moist beech-maple woods.

Carex prairea Dewey. (*C. diandra* var. *ramosa* of Gray's Man., ed. 7; *C. teretiuscula* var. *ramosa* of Monroe Co. List.) [*R] In marsh meadows.

Carex Pseudo-Cyperus L. [*R] In the marshes around the ponds; common.

Carex radiata (Wahl.) Dewey. (*C. rosea* var. *radiata* of Gray's Man., ed. 7, and of Monroe Co. List.) [R] Collected by *M. S. Baxter* in 1918.

Carex retrorsa Schwein. [*R] In wet places; infrequent.

Carex rosea Schk. [*R] Moist woods; frequent.

Carex Sartwellii Dewey. [*R, 5] Wet marshy meadows; rare.

Carex siccata Dewey. [R, 5] Dry kames southeast of Round Pond.

Carex sterilis Willd. (*C. echinata* var. *microstachys* and *C. atlantica* of Monroe Co. Lists.) [*R] Marly marsh meadows. This species was collected by *H. D. House* (N. Y. State Mus. Bull. 254: 166. 1924.), and a collection by *E. P. Killip* was erroneously listed as *C. atlantica* [3].

Carex stipata Muhl. [*R] In wet places; common.

Carex stricta Lam. [R] Quaker Pond marsh. Collected by *E. P. Killip*, 1917.

Carex strictior Dewey. (Mackenzie, North Amer. Flora 18: 404. 1935.) (Probably *C. stricta*, in part, of Monroe Co. List.) [*R, 5] Extensive stands of this and the following species may be found in the marshes and marsh meadows, particularly south of Deep Pond and south of Quaker Pond (see fig. 7). These sedges form dense beds or may be found invading the shallow water of Deep Pond as tussocks.

Carex substricta (Kükenth.) Mack. (Rydberg, Flora Rocky Mts., 139. 1917.) (*C. aquatilis*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) [*R, 5] Habitat same as for the preceding species. Previously listed from the area as *C. aquatilis* [1].

Carex tetanica Schk. [*R, 5] Marly marsh meadows north of Quaker Pond.

Carex tribuloides Wahl. [*R] In wet swales.

Carex trisperma Dewey. [*R, 1] In the sphagnum bogs; abundant.

Carex trisperma var. **Billingsii** Knight. [*R, 5] In sphagnum in Kennedy's Bog.

Carex umbellata Schk. [*R] The specimens upon which this report is based are rather immature and should possibly be referred to *C. rugosperma*. Dry sandy soil on the open crests of the eskers.

Carex vulpinoidea Michx. [*R] In wet places; common.

ARACEAE

Acorus Calamus L. Sweet Flag. [*R] Alluvial bottom land east of the Pittsford-Mendon Center Road; scarce.

Symplocarpus foetidus (L.) Nutt. (*Spathyema foetida* of House.) Skunk Cabbage. [*] Shady springy places growing in wet muck; common.

Calla palustris L. Wild Calla. [*R, 1] Shady places at the mucky borders of the ponds and in the sphagnum of Kennedy's Bog; locally abundant in these habitats.

Peltandra virginica (L.) Kunth. Arrow Arum. [*R, C, 4] In wet muck or shallow water along streams or at the borders of the ponds; frequent.

Arisaema atrorubens (Ait.) Blume. (Rhodora 42: 252. 1940.) (*A. triphyllum* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) Jack-in-the-Pulpit. [*] In damp mucky soil in low woodlands; infrequent.

Arisaema Stewardsonii Britt. (Britton & Brown, Ill. Flora, ed. 2, 1: 443. 1913; Rhodora 42: 250. 1940; Proc. Roch. Acad. Sci. 8: 316. 1943.) [*R, 5] This species grows in wetter, more boggy habitats than *A. atrorubens*.

LEMNACEAE

Spirodela polyrhiza (L.) Schleid. Greater Duckweed. [*R] In the marshes and sluggish streams; common.

Lemna minor L. Lesser Duckweed. [*R] This is the commonest species of duckweed and may be found in almost every sheltered body of water in the area.

Lemna trisulca L. Submerged Duckweed [*R] Floating underneath other species of aquatics in the shallow water of the ponds; common.

Wolffia columbiana Karst. (*Bruniera columbiana* of House.) COMMON WOLFFIA. [*R, 5] Floating in more or less stagnant water in the streams and in the shallow bays of the ponds; abundant.

Wolffia punctata Griseb. (*Bruniera punctata* of House; *W. brasiliensis* of Monroe Co. List.) DOTTED WOLFFIA. [*5] Habitat the same as for the preceding species; much less common.

PONTEDERIACEAE

Heteranthera dubia (Jacq.) MacM. (*Zosterella dubia* of House; *H. graminea* of Monroe Co. List.) WATER STARGRASS. [*R, 3, 4] A submerged aquatic in the shallow water of the ponds; common.

JUNCACEAE[8]

Juncus. RUSH.

Juncus articulatus L. [R, C, 5] Gravelly shore of Hundred Acre Pond; infrequent.

Juncus balticus Willd. var. **littoralis** Engelm. [*R, 5] Wet marly meadows north of Quaker Pond; frequent in this habitat (see fig. 6).

Juncus brachycephalus (Engelm.) Buch. [*R, 5] Marly meadows; scarce.

Juncus bufonius L. [*R] In sand or clay, in roadbeds, trails and ditches; frequent.

Juncus canadensis J. Gay. (*J. canadensis* var. *longicaudatus* of Monroe Co. List.) [*R] In sphagnum bogs; infrequent.

Juncus Dudleyi Wieg. [*R, 5] Wet shores and meadows; infrequent.

Juncus effusus L. var. **solutus** Fern. & Wieg. (Rhodora 12: 90. 1910.) (*J. effusus* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R] Along the shores of the ponds and in wet meadows; frequent.

Juncus macer S. F. Gray. (Jour. Bot. 68: 364–367. 1930.) (*J. tenuis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [*R] Fields, pastures, paths and roadsides; common.

Juncus nodosus L. [*R] At the sandy edges of the marshes; infrequent.

Luzula carolinae S. Wats. var. **saltuensis** (Fern.) Fern. (Rhodora 40: 404. 1938.) (*L. saltuensis* of Gray's Man., ed. 7; *Juncoides carolinae* of House; *L. vernalis* of Monroe Co. List.) WOOD RUSH. [*R] Oak woods, particularly on the slopes of the eskers; common.

Luzula multiflora (Ehrh.) Lejeune. (*L. campestris* var. *multiflora* of Gray's Man., ed. 7; *Juncoides intermedium* of House; *L. campestris* of Monroe Co. List.) WOOD RUSH. [*R] Oak woods, particularly on the slopes of the eskers; common.

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[8] I am indebted to Dr. Royal E. Shanks for checking the determinations of all specimens within this family.

LILIACEAE

Chamaelirium luteum (L.) Gray. (*C. carolinianum* of Monroe Co. List.) DEVIL'S BIT. BLAZING STAR. [*R, 5] Beech woods on steep gravelly slopes; rare.

Uvularia perfoliata L. BELLWORT. [*R] Rich wet woods; frequent.

Uvularia sessilifolia L. (*Oakesia sessilifolia* of Gray's Man., ed. 7, and of Monroe Co. List; *Oakesiella sessilifolia* of House.) SESSILE BELLWORT. [*R] Rich wet woods; frequent.

HEMEROCALLIS FULVA L. COMMON DAYLILY. [*] This ornamental species has become established along roadsides where it was probably originally planted.

Allium tricoccum Ait. WOOD LEEK. [*] Woods, in deep leaf mold; infrequent.

Lilium canadense L. MEADOW LILY. CANADA LILY. [*R] Moist meadows and boggy places; scarce.

Lilium philadelphicum L. WOOD LILY. [*R] Dry sandy soil in open oak woods; infrequent.

Erythronium americanum Ker. YELLOW ADDER'S-TONGUE. [*] Moist woods; common.

ASPARAGUS OFFICINALIS L. GARDEN ASPARAGUS. [*] A sporadic escape in open places.

Smilacina racemosa (L.) Desf. (*Vagnera racemosa* of House.) FALSE SOLOMON'S-SEAL. [*] Rich wet woods; common.

Smilacina stellata (L.) Desf. (*Vagnera stellata* of House.) [*R] Moist woods and also in open marly meadows; frequent.

Maianthemum canadense Desf. (*Unifolium canadense* of House.) TWO-LEAVED FALSE SOLOMON'S-SEAL. [*R] Moist woods; abundant.

Disporum lanuginosum (Michx.) Nichols. [WAM, 3] Woodlot on the crest of a drumlin about half a mile north of the Park; rare.

Polygonatum biflorum (Walt.) Ell. (Complex). (*P. commutatum* of Gray's Man., ed. 7, and of House.) SMALL SOLOMON'S-SEAL. [*R] Rich woods; common.

Medeola virginiana L. INDIAN CUCUMBER-ROOT. [*] Rich wet woods; infrequent.

Trillium erectum L. WAKE ROBIN. BIRTHROOT. [*] Moist woods; common.

Trillium grandiflorum (Michx.) Salisb. LARGE WHITE TRILLIUM. [*] Moist woods; common.

Smilax herbacea L. CARRION-FLOWER. [*R] A climbing species of moist woods and thickets; frequent.

Smilax hispida Muhl. GREEN BRIER. [*] Rich wet woods; infrequent.

AMARYLLIDACEAE

Hypoxis hirsuta (L.) Coville. (*H. erecta* of Monroe Co. List.) Star Grass. [*R] Dry sandy soil in an oak opening; scarce.

IRIDACEAE

Iris versicolor L. Blue Flag. [*R] Wet meadows and pastures; infrequent.

ORCHIDACEAE

Cypripedium acaule Ait. Pink or Stemless Ladyslipper. [*R, 1] This ladyslipper was reported in 1894 as "abundant in a swamp." It is certainly scarce now, although a few plants have been found in the rich wet woods of the swamp forest.

Cypripedium Calceolus L. var. **pubescens** (Willd.) Correll. (Bot. Mus. Leafl. Harvard Univ. 7: 1–18. 1938.) (Including *C. parviflorum* Salisb., and *C. parviflorum* var. *pubescens* (Willd.) Knight or *C. pubescens* Willd.) Yellow Ladyslipper. [*R, 1] Correll has recently lumped the large and small yellow ladyslippers into one polymorphic variety of the Eurasian species, *C. Calceolus* L. Both the large and small-flowered forms have been reported from the Mendon area, but I have seen no specimens of the small-flowered form. One of the three stations which I have found was destroyed in 1940 by some vandal who discarded the plants within a few feet of the place where he had pulled them up. Dry wooded slopes; scarce.

Cypripedium reginae Walt. (*C. hirsutum* of Gray's Man., ed. 7; *C. spectabile* of Monroe Co. List.) Showy Ladyslipper. [R, 1] The most recent collection of this species was made by *M. S. Baxter* in a tamarack swamp in 1922. It probably no longer occurs within this area.

Habenaria blephariglottis (Willd.) Torr. (*Blephariglottis Blephariglottis* of House.) White Fringed Orchid. [R, 1] Reported as growing in sphagnum.

Habenaria clavellata (Michx.) Spreng. (*Gymnadeniopsis clavellata* of House; *H. tridentata* of Monroe Co. List.) Small Green Wood Orchid. [R] Collected by *F. Beckwith* in 1920.

Habenaria Hookeri Torr. (*Lysias Hookeriana* of House.) Hooker's Orchid. [1]

Habenaria hyperborea (L.) R. Br. (*Limnorchis hyperborea* of House.) Northern Green Orchid. [*R] Wet marly meadow; rare.

Habenaria lacera (Michx.) Lodd. (*Blephariglottis lacera* of House.) Green Fringed Orchid. [*R, 1] Wet swampy woods; rare.

Pogonia ophioglossoides (L.) Ker. Rose Pogonia. [*R, 1] Sphagnum bogs and boggy meadows; formerly frequent but now scarce.

SERAPIAS HELLEBORINE L. (*Epipactis Helleborine* of Monroe Co. List.) [*5] Shady places throughout the area; frequent. This is our only weedy orchid.

Spiranthes cernua (L.) Richard. (*Ibidium cernuum* of House.) NODDING LADIES' TRESSES. [*R] Wet marly meadows; scarce. Specimens have been found in bloom as early as August 3rd.

Goodyera repens (L.) R. Br. var. **ophioides** Fern. (*Epipactis repens* var. *ophioides* of Gray's Man., ed. 7; *Peramium secundum* of House; *Goodyera repens* of Monroe Co. List.) RATTLESNAKE PLANTAIN. Reported by *M. S. Baxter* in 1895 (Proc. Roch. Acad. Sci. 3: 160. 1896.) as *Epipactis repens*. No confirming specimen has been found and the species identification is uncertain.

Calopogon pulchellus (Salisb.) R. Br. (*Cathea pulchella* of House.) GRASS-PINK ORCHID. [*R, 1] Wet marly meadows and marshes; scarce.

Corallorrhiza odontorhiza Nutt. LATE CORALROOT. [R, 1]

Liparis Loeselii (L.) Richard. LOESEL'S TWAYBLADE. [*R, 1] Boggy tussocks at the edge of one of the ponds and in open springy places; scarce.

SALICACEAE [9]

POPULUS ALBA L. WHITE POPLAR. [*] Established in abandoned pastures where it is spreading rapidly.

Populus deltoides Marsh. (*P. monilifera* of Monroe Co. List.) COTTONWOOD. [*] Low ground around the ponds and along the streams; frequent.

Populus grandidentata Michx. LARGE-TOOTHED ASPEN. [*R] Dry slopes; less frequent.

Populus Tacamahacca Mill. (*P. balsamifera* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) BALSAM POPLAR. [*R] Low ground north of Hundred Acre Pond; scarce.

Populus tremuloides Michx. ASPEN. [*] Hills, abandoned fields and low ground at the edge of fields and meadows; common (see fig. 6).

SALIX ALBA L. var. VITELLINA (L.) Koch. WHITE WILLOW. [*] Low ground along roadsides.

Salix amygdaloides Anders. PEACH-LEAVED WILLOW. [*R] Stream margin.

Salix Bebbiana Sarg. (Jour. Arnold Arboretum 2: 68. 1920.) (*S. rostrata* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R] A low shrub in the marshes, particularly around Quaker Pond; frequent (see fig. 7).

[9] Mr. R. E. Horsey, in the course of a survey of the woody plants of the Monroe County Parks, reported two more species of *Salix* from Mendon Ponds, *S. longifolia* Muhl., the sand-bar willow, and *S. purpurea* L., the purple willow, but no specimens were collected. Although all but two of the species of *Salix* previously listed from Monroe County have been reported from Mendon, this technical group needs further study, particularly in the area south of Deep Pond.

SALIX BLANDA Anders. (Bailey, Man. Cult. Plants: 225. 1924.) WISCONSIN WEEPING WILLOW. [*R] Low ground.

Salix candida Flügge. HOARY WILLOW. SAGE WILLOW. [*R, C, 1] A low shrub in the marshes around Quaker Pond; frequent (see fig. 7).

Salix cordata Muhl. HEART-LEAVED WILLOW. [*R] Wet marshes and meadows and along streams; common.

Salix discolor Muhl. PUSSY WILLOW. GLAUCOUS WILLOW. [*R] In marshy places; frequent.

SALIX FRAGILIS L. CRACK WILLOW. [*R] Low ground along roadsides; frequent, often becoming a large tree.

Salix humilis Marsh. PRAIRIE WILLOW. [*R] Dry sandy hillsides; infrequent.

Salix lucida Muhl. SHINING WILLOW. [*R] A shrub of the marshes and bogs; infrequent.

Salix nigra Marsh. BLACK WILLOW. [*R] A shrub or tree in wet places along streams and at the edges of the ponds and bogs; common.

Salix pedicellaris Pursh var. **hypoglauca** Fern. (Rhodora 11: 161. 1909.) (*S. pedicellaris*, in part, of Gray's Man., ed. 7; *S. myrtilloides* of Monroe Co. Lists.) BOG WILLOW. [*R, 1] Kennedy's Bog; rare.

Salix petiolaris J. E. Smith. [*R, C, 5] A shrub of the marsh meadows around Quaker Pond; infrequent.

Salix serissima (Bailey) Fern. AUTUMN WILLOW. [*R, C, 5] A late-flowering shrub of marshy and boggy places; infrequent.

MYRICACEAE

Myrica carolinensis Mill. (*M. cerifera* of Monroe Co. List.) BAYBERRY. [*R, 5] Marly meadows usually associated with *Potentilla fruticosa* (see fig. 6), rarely on upland cites; infrequent.

JUGLANDACEAE

Juglans cinerea L. BUTTERNUT. [*] Oak-hickory woods on the slopes of the kames and eskers; frequent.

Carya cordiformis (Wang.) K. Koch. (*Hicoria cordiformis* of House; *C. amara* of Monroe Co. List.) BITTERNUT. [*] Oak-hickory woods on the slopes of the eskers; frequent.

Carya glabra (Mill.) Sweet. (*Hicoria glabra* of House; *C. porcina*, including var. *acuta*, of Monroe Co. Lists.) PIGNUT. [*HP, 3] Oak-hickory woods on the slopes of the eskers.

Carya ovalis (Wang.) Sarg. (*C. microcarpa*, in part, of Gray's Man., ed. 7, and of Monroe Co. List; *Hicoria ovalis* of House.) [*] Oak-hickory woods; scarce.

Carya ovalis var. **obovalis** Sarg. [*R]

Carya ovalis var. **odorata** (Marsh.) Sarg. [HP] Collected by *C. C. Laney* and *R. E. Horsey*, 1911.

Carya ovata (Mill.) K. Koch. (*Hicoria ovata* of House; *C. alba* of Monroe Co. List.) SHAGBARK HICKORY. [*R] Oak-hickory woods throughout the area; the commonest species of the genus.

Carya tomentosa (Lam.) Nutt. (*C. alba* of Gray's Man., ed. 7; *Hicoria tomentosa* of House.) MOCKERNUT. [1] Extended search by J. Dunbar, B. H. Slavin, and R. E. Horsey has failed to reveal this species within the county.

BETULACEAE

Carpinus caroliniana Walt. var. **virginiana** (Marsh.) Fern. (Rhodora **37**: 425. 1935.) (*C. caroliniana* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) HORNBEAM. BLUE BEECH. WATER BEECH. [*] Moist woods throughout the area; common.

Ostrya virginiana (Mill.) K. Koch. (*O. virginica* of Monroe Co. List.) HOP HORNBEAM. IRONWOOD. [*] Woods, usually in dryer, better-drained soil than the preceding species.

Corylus americana Walt. AMERICAN HAZELNUT. [*R, 1] Moist thickets; scarce.

Corylus cornuta Marsh. (*C. rostrata* of Gray's Man., ed. 7, and of Monroe Co. List.) BEAKED HAZELNUT. [*] Woods and thickets; more frequent than the preceding species.

Betula lenta L. SWEET BIRCH. BLACK BIRCH. [*5] Becoming established in Kennedy's Bog.

Betula lutea Michx. f. YELLOW BIRCH. [*5] Moist wooded slopes and bottomlands; frequent.

Alnus incana (L.) Moench. var. **americana** Regel. (*A. incana* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) SPECKLED ALDER. [*R] Forming thickets at the borders of the streams and ponds; common (see fig. 4).

FAGACEAE

Fagus grandifolia Ehrh. (*F. ferruginea* of Monroe Co. List.) AMERICAN BEECH. [*] Confined chiefly to the northern portion of the area where found for the most part on the glacial till; frequent.

Castanea dentata (Marsh.) Borkh. (*C. sativa* var. *americana* of Monroe Co. List.) CHESTNUT. [*R, 5] The chestnut blight has eliminated this species as a forest tree. Suckers growing from old stumps may be found in various places.

Quercus alba L. WHITE OAK. [*R] In practically every woodlot in this area; one of the three dominant oaks of the oak and oak-hickory forests.

Quercus bicolor Willd. SWAMP WHITE OAK. [*R, 5] Wet oak woods; locally abundant.

Quercus borealis Michx. var. **maxima** (Marsh.) Ashe. (*Q. rubra* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) RED OAK. [*R] In the oak and oak-hickory woods; one of the three dominant species.

Quercus macrocarpa Michx. BUR OAK. MOSSYCUP OAK. [*5] Wet woods near the ponds and streams; infrequent.

Quercus velutina Lam. (*Q. coccinea* var. *tinctoria* of Monroe Co. List.) BLACK OAK. [*R] In the oak and oak-hickory woods; one of the three dominant species.

ULMACEAE

Ulmus americana L. AMERICAN ELM. WHITE ELM. [*] A dominant species of the swamp forest; abundant.

Ulmus fulva Michx. SLIPPERY ELM. RED ELM. [*] Usually in wet woods; frequent.

MORACEAE

MORUS ALBA L. WHITE MULBERRY. [R] Collected by *E. P. Killip* in 1915.

URTICACEAE

URTICA DIOICA L. STINGING NETTLE. [*R] A roadside weed.

Urtica procera Muhl. in Willd. (Rhodora 28: 195. 1926.) (*U. gracilis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) TALL NETTLE. [*R] Damp roadsides and low ground; frequent.

Pilea pumila (L.) Gray. RICHWEED. CLEARWEED. [*R] Moist shaded soil and springy places; frequent.

Boehmeria cylindrica (L.) Sw. FALSE NETTLE. [*R] Thickets and wet woods and occasionally in open marshes; frequent.

Boehmeria cylindrica var. **Drummondiana** Wedd. (Rhodora 12: 10. 1910.) (*B. cylindrica* var. *scabra* of Gray's Man. ed. 7.) [*R, 5] In open marshes around the ponds; common.

LORANTHACEAE

Arceuthobium pusillum Peck. (*Razoumofskya pusilla* of House.) DWARF MISTLETOE. [R, C, 1] Parasitic on the branches of *Picea mariana* in Kennedy's Bog; rare.

SANTALACEAE

Comandra umbellata (L.) Nutt. BASTARD TOADFLAX. [*R] Dry sandy soil in an oak opening; scarce. A semi-parasite associated with *Gaylussacia* and *Helianthemum*.

ARISTOLOCHIACEAE

Asarum canadense L. var. **acuminatum** Ashe. (*A. acuminatum* of House; *A. canadense*, in part, of Monroe Co. List.) WILD GINGER. [*] Found in beech-maple woods just west of Clover Street, but not elsewhere.

POLYGONACEAE

RUMEX ACETOSELLA L. SHEEP SORREL. FIELD SORREL. [*] A weed of sandy fields and roadsides; common.

Rumex Britannica L. GREAT WATER DOCK. [*] Marshes around the ponds; frequent.

RUMEX CRISPUS L. (Including *R. elongatus* Guss.) CURLY OR YELLOW DOCK. [*R] A weed of roadsides and waste ground; common.

RUMEX OBTUSIFOLIUS L. BLUNT-LEAVED DOCK. [*R] Moist ground; frequent.

POLYGONUM CONVOLVULUS L. BLACK BINDWEED. [*R] Fields, roadsides, and waste ground; common.

Polygonum lapathifolium L. (*P. lapathifolium* var. *incarnatum* of Monroe Co. List.) [*R] Shores of Quaker Pond.

Polygonum natans A. Eaton f. **genuinum** Stanford. (Rhodora 27: 156–166. 1925.) (*P. amphibium* of Gray's Man., ed. 7, and of Monroe Co. List; *P. fluitans* of House.) [R]

Polygonum natans A. Eaton f. **Hartwrightii** (Gray) Stanford. (*P. amphibium* var. *Hartwrightii* of Gray's Man., ed. 7; *P. Hartwrightii* of House, and of Monroe Co. List.) [*R] Marshes around the ponds; infrequent.

POLYGONUM NEGLECTUM Besser. (*P. aviculare* var. *angustissimum* of Gray's Man., ed. 7; *P. aviculare* of Monroe Co. List.) [*R] A roadside weed.

Polygonum pennsylvanicum L. var. **laevigatum** Fern. (Rhodora 19: 73. 1917.) (*P. pennsylvanicum*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) [*R] Low ground, particularly in wet places.

POLYGONUM PERSICARIA L. LADY'S THUMB. [*] A weed of fields and roadsides; common.

Polygonum punctatum Ell. (Rhodora 29: 77–87. 1927.) (Including var. *leptostachyum*. *P. acre* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R, C] Marshy places; frequent.

CHENOPODIACEAE

Chenopodium album L. PIGWEED. LAMB'S QUARTERS. GOOSEFOOT. [*R] A weed, particularly of cultivated fields.

CHENOPODIUM URBICUM L. (*C. urbicum* var. *rhombifolium* of Monroe Co. List.) UPRIGHT GOOSEFOOT. [*R] A weed of cultivated fields.

SALSOLA PESTIFER A. Nels. (*S. Kali* var. *tenuifolia* of Gray's Man., ed. 7, and of Monroe Co. List.) RUSSIAN THISTLE. [*R] An adventive in waste ground; infrequent.

AMARANTHACEAE

AMARANTHUS GRAECIZANS L. (*A. albus* of Monroe Co. List.) TUMBLEWEED. [*R] A weed of cultivated fields and roadsides; common.

AMARANTHUS RETROFLEXUS L. GREEN AMARANTH. PIGWEED. [*R] A weed of cultivated fields and roadsides; common.

PHYTOLACCACEAE

Phytolacca americana L. (*P. decandra* of Gray's Man., ed. 7, and of Monroe Co. List.) POKEWEED. SCOKE. GARGET. [*R] Rich moist soil in thickets and woods; frequent.

PORTULACACEAE

Claytonia virginica L. VIRGINIA SPRING BEAUTY. [*] Rich moist woods; frequent.

PORTULACA OLERACEA L. COMMON PURSLANE. [*] A weed of cultivated ground; common.

CARYOPHYLLACEAE

STELLARIA GRAMINEA L. [*] A weed of roadsides and fields.

STELLARIA MEDIA (L.) Cyril. COMMON CHICKWEED. [*R] A weed of cultivated ground and sometimes of woodlands; common.

CERASTIUM VULGATUM L. MOUSE-EAR CHICKWEED. [*] A weed of cultivated ground; common.

Arenaria lateriflora L. (*Moehringia lateriflora* of House.) SANDWORT. [*R, 1] In undisturbed meadows and in association with *Potentilla fruticosa;* infrequent.

ARENARIA SERPYLLIFOLIA L. THYME-LEAVED SANDWORT. [*R] A weed of dry sandy fields and banks; common.

SILENE LATIFOLIA (Mill.) Britten & Rendle. (*S. Cucubalus* of Monroe Co. Lists.) BLADDER CAMPION. [*] A weed of dry sandy fields and roadsides.

LYCHNIS ALBA Mill. (*L. vespertina* of Monroe Co. List.) WHITE CAMPION. [*R] A roadside adventive.

DIANTHUS ARMERIA L. DEPTFORD PINK. [*R, 5] A roadside escape.

SAPONARIA OFFICINALIS L. BOUNCING BET. SOAPWORT. [*R] A roadside weed; common.

NYMPHAEACEAE

Nymphaea odorata Ait. (Rhodora 18: 161. 1916.) (*Castalia odorata* of Gray's Man., ed. 7, and of House; *N. odorata*, including var. *minor*, of Monroe Co. List.) SWEET WHITE WATER LILY. [*R, 1, 4] In shallow water of the ponds; abundant. Specimens with flowers only 4 cm. in diameter may be found in very shallow pools in the marshes.

Nuphar variegata Engelm. (*Nymphaea advena* var. *variegata* of Gray's Man., ed. 7, and of House; *Nuphar advena* of Monroe Co. List.) COW LILY. SPATTERDOCK. YELLOW POND LILY. [*4] In shallow water in the ponds and sluggish streams; frequent (see fig. 4).

CERATOPHYLLACEAE

Ceratophyllum demersum L. HORNWORT. [*R, 4] A submerged aquatic in the ponds; common.

RANUNCULACEAE

Caltha palustris L. MARSH MARIGOLD. [*R] In springy places and along streams in or near running water; common.

Coptis groenlandica (Oeder) Fern. (Rhodora 31: 136–142. 1929.) (*C. trifolia* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) GOLDTHREAD. [*R] Swampy and boggy woods; frequent.

Actaea alba (L.) Mill. WHITE BANEBERRY. [*] Rich woods; frequent.

Actaea rubra (Ait.) Willd. (*A. spicata* var. *rubra* of Monroe Co. List.) RED BANEBERRY. [*R] Rich woods; frequent.

Aquilegia canadensis L. WILD COLUMBINE. [*R] In gravelly soil on the dry wooded slopes of the eskers; frequent.

Anemone cylindrica Gray. LONG-FRUITED ANEMONE. [*] In sandy soil on the dry open slopes of the eskers; frequent.

Anemone virginiana L. TALL ANEMONE. [*R] Dry thickets and open woods; frequent.

Anemonella thalictroides (L.) Spach. (*Syndesmon thalictroides* of House.) RUE ANEMONE. [*R] Dry wooded slopes and crests of the eskers; frequent.

Hepatica acutiloba DC. HEPATICA. [*] Dry open woods; frequent.

Hepatica americana (DC.) Ker. (*H. triloba* of Gray's Man., ed. 7, and of Monroe Co. List.) HEPATICA. [*R] Dry open woods; common.

Clematis virginiana L. VIRGIN'S BOWER. WHITE CLEMATIS. [*R] Thickets and fence rows; infrequent.

Ranunculus abortivus L. SMALL-FLOWERED BUTTERCUP. [*] Wet woods and springy places; common.

RANUNCULUS ACRIS L. TALL BUTTERCUP. [*R] Fields and roadsides; frequent.

Ranunculus hispidus Michx. (Including var. *falsus* Fern., Rhodora 22: 30. 1920.) BRISTLY BUTTERCUP. [*R, 5] Oak woods; frequent.

Thalictrum dioicum L. EARLY MEADOW RUE. [*] On the steep wooded slopes of the eskers; frequent.

Thalictrum polygamum Muhl. (*T. canadense* of House.) TALL MEADOW RUE. [*R] Meadows and marsh meadows; common.

BERBERIDACEAE

Podophyllum peltatum L. MAYAPPLE. [*] Moist woods; frequent.

Jeffersonia diphylla (L.) Pers. TWINLEAF. [3, WAM] In woods on the crest of a drumlin about half a mile north of the park area and also just east of the Pittsford-Mendon Center Road; rare.

Caulophyllum thalictroides (L.) Michx. BLUE COHOSH. [*] Rich woods; frequent.

BERBERIS THUNBERGII DC. JAPANESE BARBERRY. [*] An occasional escape.

BERBERIS VULGARIS L. EUROPEAN BARBERRY. [*R] An occasional escape.

MENISPERMACEAE

Menispermum canadense L. MOONSEED. [*] Thickets and banks; infrequent.

MAGNOLIACEAE

Liriodendron Tulipifera L. TULIP TREE. TULIP POPLAR. [*5] Particularly on glacial till, and often associated with beech; frequent.

LAURACEAE

Sassafras albidum (Nutt.) Nees. (*S. variifolium* of Gray's Man., ed. 7; *S. sassafras* of House; *S. officinale* of Monroe Co. List.) SASSAFRAS. [*R] Dry woods; common. Forming fairly extensive thickets on some of the cut-over sandy slopes.

Benzoin aestivale (L.) Nees. (*B. Benzoin* of Monroe Co. List.) SPICE-BUSH. [*R] Low swampy woods; common.

PAPAVERACEAE

Sanguinaria canadensis L. BLOODROOT. [*] Rich woods; occasional.

CRUCIFERAE

LEPIDIUM CAMPESTRE (L.) R. Br. DOWNY PEPPERGRASS. [*R, 1] A weed of roadsides and fields; frequent.

LEPIDIUM DENSIFLORUM Schrad. var. TYPICUM Thellung. (*L. apetalum* of Gray's Man., ed. 7; *L. intermedium* of Monroe Co. List.) [*R] A weed of roadsides and sandy fields; common.

Lepidium virginicum L. var. **typicum** C. L. Hitchcock. PEPPERGRASS. [*] A weed of roadsides and sandy fields; common.

SISYMBRIUM OFFICINALE (L.) Scop. (*Erysimum officinale* of House.) HEDGE MUSTARD. [*R] A weed of waste places; frequent.

SISYMBRIUM THALIANUM (L.) J. Gay. (*Arabidiopsis Thaliana* of House; *S. Thaliana* of Monroe Co. Lists.) MOUSE-EAR CRESS. [*R] A weed of sandy fields and waste grounds; frequent.

BARBAREA VULGARIS R. Br. (*Campe Barbarea* of House.) COMMON WINTER CRESS. YELLOW ROCKET. [*] A weed of damp cultivated fields and roadsides; common.

ARMORACIA LAPATHIFOLIA Gilib. (Bot. Mus. Leafl. Harvard Univ. 10: 144. 1942.) (*Radicula Armoracia* of Gray's Man., ed. 7; *A. Armoracia* of House; *Nasturtium Armoracia* of Monroe Co. List.) HORSERADISH. [*R] Escaping in wet places; infrequent.

Cardamine bulbosa (Schreb.) BSP. var. **purpurea** (Torr.) BSP. (*C. Douglassii* of Gray's Man., ed. 7, and of House; *C. rhomboidea* var. *purpurea* of Monroe Co. List.) SPRING CRESS. [*R] Swampy woods; common.

Cardamine pratensis L. var. **palustris** Wimm. & Grab. (Rhodora 22: 14. 1920.) (*C. pratensis* of Gray's Man., ed. 7, and of Monroe Co. List.) CUCKOO FLOWER. [*R, 3] Marshes around Quaker Pond and elsewhere; infrequent.

Dentaria diphylla Michx. CRINKLEROOT. TOOTHWORT. PEPPERROOT. [*] Rich woods in moist humus; frequent.

Dentaria laciniata Muhl. CUT-LEAVED TOOTHWORT OR PEPPERROOT. [*R] Rich wet woods in deep humus; infrequent.

CAPSELLA BURSA-PASTORIS (L.) Medic. (*Bursa Bursa-pastoris* of House.) SHEPHERD'S PURSE. [*R] A weed of fields, lawns and roadsides; common.

CAMELINA MICROCARPA Andrz. FALSE FLAX. [*R, 5] Roadside adventive; scarce.

Arabis canadensis L. SICKLE-POD. [R] Dry sandy soil on the wooded eskers. Collected by *G. T. Fish*, 1865, and by *E. P. Killip*, 1919.

Erysimum cheiranthoides L. (*Cheirinia cheiranthoides* of House.) WORM-SEED MUSTARD. [*R] In sandy loam or sandy muck, particularly in disturbed areas, such as the banks of ditches; common.

SARRACENIACEAE

Sarracenia purpurea L. PITCHER PLANT. [*R, 1] In sphagnum in the bogs and marshes; locally abundant.

DROSERACEAE

Drosera intermedia Hayne. (*D. longifolia* of Gray's Man., ed. 7; *D. intermedia* var. *americana* of Monroe Co. List.) SPATULATE-LEAVED SUNDEW. [*R, C, 1] In sphagnum. Only found in the eastern portion of Kennedy's Bog, where abundant.

Drosera rotundifolia L. ROUND-LEAVED SUNDEW. [*R, 1] In sphagnum in the bogs and marshes; locally abundant.

CRASSULACEAE

Penthorum sedoides L. DITCH STONECROP. [*R] In wet mucky soil in open places; frequent.

SAXIFRAGACEAE

Saxifraga pennsylvanica L. SWAMP SAXIFRAGE. [*1, 2] In wet springy places; scarce.

Saxifraga virginiensis Michx. EARLY ROCK SAXIFRAGE. [*R] Dry gravelly banks; common.

Tiarella cordifolia L. FALSE MITERWORT. [*] Wooded slopes; common.

Mitella diphylla L. MITERWORT. BISHOP'S CAP. [*] Moist woods; common.

Parnassia glauca Raf. (Bartonia 17: 18. 1935.) (*P. caroliniana* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) GRASS OF PARNASSUS. [*R, 1] In wet marly places in the marsh-meadows and around the ponds; infrequent.

Ribes americanum Mill. (Rhodora 11: 46. 1909.) (*R. floridum* of Gray's Man., ed. 7, and of Monroe Co. List.) WILD BLACK CURRANT. [*R] Swampy woods; frequent.

RIBES SATIVUM (Reichenb.) Syme. (*R. vulgare* of Gray's Man., ed. 7, and of House; *R. rubrum* of Monroe Co. List.) RED CURRANT. [*R] Moist woods.

Ribes triste Pall. var. **albinervium** (Michx.) Fern. (*R. rubrum* var. *subglandulosum* of Monroe Co. List.) WILD RED CURRANT. [*] Boggy woods.

HAMAMELIDACEAE

Hamamelis virginiana L. WITCH-HAZEL. [*] On the wooded slopes; common throughout the area.

ROSACEAE

Spiraea alba DuRoi. (*S. salicifolia*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) MEADOW-SWEET. [*R, 1] Marly marsh meadows; scarce.

PYRUS COMMUNIS L. COMMON PEAR. [*] Abandoned farmyards.

MALUS PUMILA Mill. (*Pyrus Malus* of Gray's Man., ed. 7, and of Monroe Co. List; *Malus Malus* of House.) COMMON APPLE. [*] Abandoned farmyards and orchards, possibly escaping.

SORBUS DECORA (Sarg.) Schneid. (Jour. Arnold Arboretum 20: 1–43. 1939.) (*Pyrus sitchensis* of Gray's Man., ed. 7; *S. dumosa* of House.) SHOWY MOUNTAIN-ASH. [*R] Probably introduced. It has been found growing along roadsides.

Aronia melanocarpa (Michx.) Ell. (*Pyrus melanocarpa* of Gray's Man., ed. 7; *Pyrus arbutifolia* var. *melanocarpa* of Monroe Co. List.) BLACK CHOKEBERRY. [*R, HP, 1] Acid peat bogs; frequent.

Aronia prunifolia (Marsh.) Rehder. (Jour. Arnold Arboretum 19: 74. 1938.) (*Pyrus arbutifolia* var. *atropurpurea* of Gray's Man., ed. 7, and of Monroe Co. List; *A. atropurpurea* of House.) PURPLE CHOKEBERRY. [HP, 2]

Amelanchier amabilis Wieg. (Wiegand & Eames, Flora Cayuga Lake basin, 1926: 247.) (*A. canadensis* var. *rotundifolia*, in part, of Monroe Co. List; *A. grandifolia* Wieg.) [*R, 5] Dry wooded crest of an esker.

Amelanchier canadensis (L.) Medic. (*A. canadensis* var. *Botryapium* of Gray's Man., ed. 7; *A. canadensis* var. *oblongifolia* of Monroe Co. List.) SHADBUSH. [*R] Dry woods; common.

Amelanchier intermedia Spach. (Rhodora 22: 147. 1920.) [*R, C, 5] Marshes and boggy margins of the ponds; scarce.

Amelanchier laevis Wieg. (*A. canadensis* of Gray's Man., ed. 7, and of Monroe Co. List.) SHADBUSH. JUNE BERRY. SERVICEBERRY. [*R] Dry wooded slopes of the eskers; frequent.

Amelanchier sanguinea (Pursh) DC. (Rhodora 14: 138. 1912.) (*A. spicata* of Gray's Man., ed. 7; *A. canadensis* var. *rotundifolia*, in part, of Monroe Co. List.) [*R, C, HP, 5] Swamps and gravelly soil on the dry open crests of the eskers; frequent.

Amelanchier stolonifera Wieg. (Rhodora 14: 144. 1912.) [3]

Crataegus. HAWTHORN. This difficult genus has been inadequately collected and studied. Specimens may be found in a number of places in thickets and along fencerows in low ground and particularly on the dry open slopes of the eastern esker.

Crataegus pruinosa (Wendl.) K. Koch. (For synonymy see N. Y. State Mus. Bull. 254: 421. 1924.) [*R] The specimens collected have been tentatively referred to this species.

Rubus allegheniensis Porter. (*R. villosus* of Monroe Co. List.) COMMON HIGH BLACKBERRY. [*R] Forming thickets on dry open slopes; common.

Rubus canadensis L. [*] Dry slopes and thickets; frequent.

Rubus flagellaris Willd. (*R. villosus* of Gray's Man., ed. 7.) DEWBERRY. [*R] Dry open slopes and crests of the eskers; common.

Rubus hispidus L. [*C] Borders of swamps and in dry sandy woods; infrequent.

Rubus idaeus L. var. **strigosus** (Michx.) Maxim. (Rhodora 21: 96. 1919.) (*R. idaeus* var. *aculeatissimus* of Gray's Man., ed. 7; *R. strigosus* of House, and of Monroe Co. List.) WILD RED RASPBERRY. [*] At the edges of thickets; abundant.

Rubus occidentalis L. BLACK RASPBERRY. [*] Dry thickets and open slopes of the eskers; abundant.

Rubus odoratus L. PURPLE FLOWERING RASPBERRY. [*] Gravelly banks and thickets; infrequent.

Rubus pubescens Raf. (Rhodora 11: 236. 1909.) (*R. triflorus* of Gray's Man., ed. 7, and of Monroe Co. List.) [*R] Swampy woods; infrequent.

Fragaria virginiana Duchesne. WILD STRAWBERRY. [*] Gravelly and sandy fields; common.

Potentilla argentea L. SILVERY CINQUEFOIL. [*] Fields, lawns and roadsides; common.

Potentilla arguta Pursh. [*] Dry sandy fields; frequent.

Potentilla fruticosa L. SHRUBBY CINQUEFOIL. [*R, 1, 5] Borders of marly meadows where it frequently forms extensive stands; abundant. Individuals with nearly white flowers have been found.

Potentilla palustris (L.) Scop. (*Comarum palustre* of House.) MARSH CINQUEFOIL. [*R, 1] Marshes around Quaker Pond; infrequent.

POTENTILLA RECTA L. [*R] A weed of dry sandy fields and roadsides; common.

Potentilla simplex Michx. var. **typica** Fern. (Rhodora 33: 180–191. 1931.) (*P. canadensis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) COMMON CINQUEFOIL. [*R] Dry sandy fields and roadsides; frequent.

Waldsteinia fragarioides (Michx.) Tratt. BARREN STRAWBERRY. [*] Dry woods; infrequent.

Geum aleppicum Jacq. var. **strictum** (Ait.) Fern. (Rhodora 37: 294. 1935.) (*G. strictum* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) YELLOW AVENS. [*R] Moist thickets; frequent.

Geum canadense Jacq. WHITE AVENS. [*R] Moist thickets; frequent.

Geum rivale L. WATER OR PURPLE AVENS. [*R] Edges of wet meadows and swampy woods; infrequent.

Agrimonia gryposepala Wallr. (*A. Eupatoria*, in part, of Monroe Co. List.) AGRIMONY. [*R] Thickets and banks; common.

Agrimonia striata Michx. AGRIMONY. [*R, 3] Dry thickets and open woods.

Sanguisorba canadensis L. (*Poterium canadense* of Monroe Co. List.) CANADIAN BURNET. [*R, 5] At the edge of a wet alder thicket near Quaker Pond; scarce.

Rosa carolina L. (Rhodora 20: 91. 1918.) (*R. humilis* of Gray's Man., ed. 7, and of Monroe Co. List.) DWARF ROSE. [*R] Dry open slopes of the eskers. The specimens examined appear to belong to var. **glandulosa** (Crep.) Farw.

Rosa palustris Marsh. (*R. carolina* of Gray's Man., ed. 7, and of Monroe Co. List.) SWAMP ROSE. [*R] Swamps and wet meadows around the ponds; common.

ROSA RUBIGINOSA L. SWEETBRIER. [*R] Dry open slopes of the eskers.

PRUNUS AVIUM L. SWEET CHERRY. MAZZARD. [*R] Thickets, fence-rows and the edges of woods; a frequent escape.

PRUNUS DOMESTICA L. GARDEN PLUM. [*] Abandoned farmyards.

Prunus nigra Ait. WILD PLUM. [*R] Forming roadside thickets.

Prunus pennsylvanica L. f. WILD RED CHERRY. PIN CHERRY. [*R] Thickets and wet woods; scarce.

Prunus serotina Ehrh. WILD BLACK CHERRY. [*] Open woods and clearings; common.

Prunus virginiana L. CHOKE CHERRY. [*R] Thickets, fencerows and open woods; common.

LEGUMINOSAE

CERCIS CANADENSIS L. REDBUD. [*R] Roadside plantings.

GLEDITSIA TRIACANTHOS L. (*Gleditschia* of Monroe Co. List.) HONEY LOCUST. [1]

Lupinus perennis L. WILD LUPINE. [*R] Dry sandy slopes; infrequent.

CYTISUS SCOPARIUS (L.) Link. (*Sarothamnus scoparius* of House.) SCOTCH BROOM. [*R, 5] Well established in a sandy field.

MEDICAGO LUPULINA L. BLACK MEDICK. NONESUCH. [*R] A weed of fields, roadsides and lawns; common.

MEDICAGO SATIVA L. ALFALFA. LUCERNE. [*R] A weed of fields and roadsides, commonly escaping from cultivation.

MELILOTUS ALBA Desr. WHITE SWEET CLOVER. WHITE MELILOT. [*] A weed of gravelly roadsides and waste places; common.

MELILOTUS OFFICINALIS (L.) Lam. YELLOW SWEET CLOVER. YELLOW MELILOT. [*R] A weed of fields, roadsides, and waste places; common.

TRIFOLIUM AGRARIUM L. YELLOW OR HOP CLOVER. [*] Dry gravelly fields and roadsides; frequent.

TRIFOLIUM HYBRIDUM L. ALSIKE CLOVER. [*R] Fields and roadsides; common.

TRIFOLIUM PRATENSE L. RED CLOVER. [*R] Fields and roadsides; common.

TRIFOLIUM REPENS L. CREEPING WHITE CLOVER. [*R] Lawns and roadsides; common.

ROBINIA PSEUDO-ACACIA L. COMMON OR BLACK LOCUST. [*] Planted and freely escaping at several places.

Astragalus neglectus (T. & G.) Sheldon. (*Phaca neglecta* of House; *A. Cooperi* of Monroe Co. List.) [*R, 5] Open oak woods on the gravelly crests of the eskers; rare.

Desmodium acuminatum (Michx.) DC. (*D. grandiflorum* of Gray's Man., ed. 7; *Meibomia grandiflora* of House.) POINTED-LEAVED TICK TREFOIL. [*] Dry open woods; frequent.

Desmodium bracteosum (Michx.) DC. (*Meibomia bracteosa* of House; *D. cuspidatum* of Monroe Co. List.) LARGE-BRACTED TICK TREFOIL. [*R, C] Dry open woods; infrequent.

Desmodium canadense (L.) DC. (*Meibomia canadensis* of House.) CANADA TICK TREFOIL. [*R] Open slopes; common.

Desmodium ciliare DC. (*D. obtusum* of Gray's Man., ed. 7; *Meibomia obtusa* of House.) [R, 1] Previously listed as rare.

Desmodium nudiflorum (L.) DC. (*Meibomia nudiflora* of House.) NAKED-FLOWERED TICK TREFOIL. [*R] Dry sandy woods; frequent.

Desmodium paniculatum (L.) DC. (*Meibomia paniculata* of House.) PANICLED TICK TREFOIL. [*R] Dry sandy woods; frequent.

Desmodium rotundifolium (Michx.) DC. (*Meibomia Michauxii* of House.) PROSTRATE TICK TREFOIL. [*R] Dry sandy woods; rare.

Lespedeza hirta (L.) Hornem. (*L. polystachya* of Monroe Co. List.) HAIRY BUSH CLOVER. [*R] Dry sandy woods and open slopes; common.

Lespedeza intermedia (Wats.) Britt. (Rhodora 26: 31. 1924.) (*L. frutescens* of Gray's Man., ed. 7; *L. Stuvei* var. *intermedia* of Monroe Co. List.) WANDLIKE BUSH CLOVER. [*R] Dry open woods; scarce.

VICIA CRACCA L. WILD VETCH. [*R] Fields and roadsides.

VICIA VILLOSA Roth. HAIRY VETCH. WINTER VETCH. [*R, 5] A roadside escape; frequent.

Amphicarpa bracteata (L.) Fern. (*A. monoica* of Gray's Man., ed. 7, and of Monroe Co. List; *Falcata comosa* of House.) HOG PEANUT. [*R] Woods and thickets; frequent.

Apios americana Medic. (*A. tuberosa* of Gray's Man., ed. 7, and of Monroe Co. List; *Glycine Apios* of House.) GROUNDNUT. [*R] Thickets and wet woods; frequent.

GERANIACEAE

Geranium carolinianum L. [3]

Geranium maculatum L. WILD GERANIUM. WILD CRANESBILL. [*R] Dry wooded slopes of the eskers; common.

OXALIDACEAE

Oxalis stricta L. (*O. corniculata* var. *stricta* of Monroe Co. List.) YELLOW WOOD SORREL. [*R] Roadsides and fallow fields; frequent.

OXALIS EUROPAEA Jordan. (Rhodora 27: 134. 1925.) (*O. corniculata* of Gray's Man., ed. 7, and of Monroe Co. List.) YELLOW WOOD SORREL. [*R] Roadsides and cultivated ground; common.

LINACEAE

Linum virginianum L. YELLOW FLAX. [1] Previously reported as scarce in dry sandy woods.

RUTACEAE

Zanthoxylum americanum Mill. (*Xanthoxylum* of Monroe Co. List.) NORTHERN PRICKLY ASH. [*] Low ground along fencerows; infrequent.

SIMARUBACEAE

AILANTHUS ALTISSIMA (Mill.) Swingle. (*A. glandulosus* of Gray's Man., ed. 7, and of Monroe Co. List.) TREE OF HEAVEN. AILANTHUS. [*] A roadside escape; infrequent.

POLYGALACEAE

Polygala paucifolia Willd. FRINGED POLYGALA. FLOWERING WINTERGREEN. [*] In marly places under dense stands of *Potentilla fruticosa;* rare. This is an unreported station in the county.

Polygala Senega L. SENECA SNAKEROOT. [*R] Steep wooded slopes of the eskers; scarce.

Polygala verticillata L. [*R, C] Dry open slopes of the eskers; frequent.

Polygala verticillata var. **ambigua** (Nutt.) Wood. [*R] Habitat similar to that of the species.

EUPHORBIACEAE

Euphorbia maculata L. (Contr. Gray Herb. 127: 74. 1939.) (*E. Preslii* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) SPURGE. [*R] A weed of roadsides, particularly on rock fill; frequent.

ANACARDIACEAE

RHUS AROMATICA Air. (*R. canadensis* of Gray's Man., ed. 7, and of Monroe Co. List.) FRAGRANT SUMAC. [*R] This small shrub has been planted along certain of the graded roadsides, from which it is sparingly escaping.

Rhus glabra L. SMOOTH SUMAC. [*R] Forming thickets on the dry open slopes of the eskers; occasional.

Rhus radicans L. (*R. Toxicodendron* L.) POISON IVY. [*] Along roadsides and stone walls and in thickets; abundant.

Rhus typhina L. STAGHORN SUMAC. [*] The most common of the pioneer shrubs invading the dry open slopes. It forms extensive stands in numerous places, particularly near the crests of the eskers.

Rhus Vernix L. (*R. venenata* of Monroe Co. List.) POISON SUMAC. [*R, 1, 5] In the marshes around the ponds but more often in bogs and boggy woods; frequent.

AQUIFOLIACEAE

Ilex verticillata (L.) Gray. WINTERBERRY. BLACK ALDER. [*R, 1] In swampy or boggy places around the bogs and ponds; frequent.

Nemopanthus mucronata (L.) Trel. (*Nemopanthes fascicularis* of Monroe Co. List.) MOUNTAIN HOLLY. [*R, 1, 5] Habitats similar to the preceding species; somewhat less frequent.

CELASTRACEAE

Celastrus scandens L. AMERICAN BITTERSWEET. [*R] Thickets and open woods; frequent.

ACERACEAE

Acer rubrum L. RED MAPLE. [*R] A dominant tree of the swamp forest, but also found in moist situations throughout the area.

Acer saccharinum L. (*A. dasycarpum* of Monroe Co. List.) SILVER MAPLE. [*] Occasional.

Acer saccharum Marsh. (*A. saccharinum* of Monroe Co. List.) SUGAR MAPLE. [*R] A common hardwood especially in the northern portion of the area where it is associated with beech.

BALSAMINACEAE

Impatiens biflora Walt. (*I. fulva* of Monroe Co. List.) SPOTTED TOUCH-ME-NOT. [*] In mucky soil in wet woods and in the bogs and marshes; abundant.

RHAMNACEAE

Rhamnus alnifolia L'Hér. ALDER-LEAVED BUCKTHORN. [*R, 5] In sphagnum bogs and wet marly meadows; scarce.

Ceanothus americanus L. NEW JERSEY TEA. [*R] On the dry slopes and crests of the eskers, usually in open woods; common.

VITACEAE

Vitis aestivalis Michx. SUMMER GRAPE. [*R] Dry thickets; frequent.

Vitis riparia Michx. (Rhodora 41: 431–434. 1939.) (*V. vulpina* of Gray's Man., ed. 7, and of House.) FROST GRAPE. RIVERBANK GRAPE. [*R] Moist thickets; common.

Parthenocissus inserta (Kerner) Fritsch. (Jour. Arnold Arboretum 20: 419. 1939.) (*Psedera vitacea* of Gray's Man., ed. 7, and of House; *Ampelopsis quinquefolia*, in part, of Monroe Co. List.) [*R, C, 5] Roadside fencerows and banks; common.

Parthenocissus quinquefolia (L.) Planch. (*Psedera quinquefolia* of Gray's Man., ed. 7, and of House; *Ampelopsis quinquefolia*, in part, of Monroe Co. List.) VIRGINIA CREEPER. WOODBINE. [*R] Low woods and moist slopes; common.

TILIACEAE

Tilia americana L. BASSWOOD. LINDEN. [*] Moist woodlands, particularly in the northern portion of the area; common.

MALVACEAE

ALTHAEA ROSEA (L.) Cav. HOLLYHOCK. [*] A roadside escape; occasional.

MALVA NEGLECTA Wallr. (*M. rotundifolia*, in part, of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [*R] COMMON MALLOW. CHEESES. A weed of cultivated ground and waste places; common.

HYPERICACEAE

Hypericum Ascyron L. GREAT ST. JOHN'S-WORT. [1] Previously reported as scarce.

Hypericum majus (Gray) Britt. (*H. canadense* var. *majus* of Monroe Co. List.) [C, 5] Low pasture.

HYPERICUM PERFORATUM L. COMMON ST. JOHN'S-WORT. [*R] A weed of dry fields and roadsides; common.

Hypericum punctatum Lam. (*H. maculatum* of Monroe Co. List.) [*R] Moist thickets; frequent.

Hypericum virginicum L. (*Triadenum virginicum* of House; *Elodes campanulata* of Monroe Co. List.) MARSH ST. JOHN'S-WORT. [*R] In bogs and in marshes around the ponds; frequent.

CISTACEAE

Helianthemum canadense (L.) Michx. FROSTWEED. [*R, C, 5] In dry sandy soil in the remnants of an oak opening; rare.

VIOLACEAE

VIOLA ARVENSIS Murr. (*V. tricolor* var. *arvensis* of Monroe Co. List.) FIELD PANSY. [*R, 1] Fallow fields and roadsides; infrequent.

Viola blanda Willd. WHITE VIOLET. [*R] Boggy woods; infrequent.

Viola canadensis L. CANADA VIOLET. [*] Found in beech-maple woods just west of Clover Street, but not elsewhere.

Viola cucullata Ait. (*V. palmata* var. *cucullata* of Monroe Co. List.) MARSH BLUE VIOLET. [*R] Marshy meadows and woodlands; common.

Viola incognita Brainerd var. **Forbesii** Brainerd. WHITE VIOLET. [*R] Boggy woods; infrequent.

Viola pallens (Banks) Brainerd. WHITE VIOLET. [*] Wet meadows; frequent.

Viola palmata L. PALMATE VIOLET. [*R] Dry wooded slopes; frequent.

Viola papilionacea Pursh. [WAM] Collected by *W. A. Matthews*, 1915. Deam (1940) states that this species should probably be considered a form of *V. sororia.*

Viola pubescens Ait. DOWNY YELLOW VIOLET. [*R] Wooded slopes of the eskers; common.

Viola sagittata Ait. var. **ovata** (Nutt.) T. & G. (*V. fimbriatula* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) OVATE-LEAVED BLUE VIOLET. [*R] Dry sandy pastures on the slopes of the kames and eskers; frequent.

Viola sororia Willd. [WAM] Collected by *W. A. Matthews*, 1915.

Viola triloba Schw. THREE-LOBED VIOLET. [5]

LYTHRACEAE

CUPHEA PETIOLATA (L.) Koehne. (*Parsonsia petiolata* of House.) CLAMMY CUPHEA. [R, 5] Growing at the edge of a field, probably adventive.

Decodon verticillatus (L.) Ell. WATER WILLOW. SWAMP LOOSESTRIFE. [R; 1, p. 9] In the marshes around all the ponds and also in Kennedy's Bog. Particularly abundant on the south and west sides of Quaker Pond (see fig. 5) and in the Quaker Pond outlet.

ONAGRACEAE

Ludwigia palustris (L.) Ell. var. **americana** (DC.) Fern. & Grisc. (Rhodora 37: 176–177. 1935.) (*Ludvigia palustris*, in part, of Gray's Man., ed. 7; *Ludwigia palustris* of House, and of Monroe Co. List.) WATER PURSLANE. [*R] In ditches and streams; frequent.

Epilobium coloratum Muhl. WILLOW HERB. [*R] Ditches and marshy places; frequent.

Epilobium densum Raf. (*E. lineare* of House, and of Monroe Co. List.) [*R, 5] Marly marsh meadows around Quaker Pond; scarce.

Epilobium glandulosum Lehm. var. **adenocaulon** (Haussk.) Fern. (Rhodora 20: 34. 1918.) (*E. adenocaulon* of Monroe Co. Lists.) [*R] WILLOW HERB. Ditches and marshy places; frequent.

EPILOBIUM HIRSUTUM L. [*C, 3] Low ground in fields and partially-drained swamps; common.

Epilobium strictum Muhl. (*E. molle* of Gray's Man., ed. 7.) [*R, C, 1] Marly marsh meadows around Quaker Pond; frequent in this habitat.

Oenothera biennis L. var. **pycnocarpa** (Atkins. & Bart.) Wieg. (Rhodora 15: 83. 1913; 26: 3. 1924.) (*O. biennis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) EVENING PRIMROSE. [*R, C] Roadside weed; common.

Circaea alpina L. [*] Boggy woods; scarce.

Circaea quadrisulcata (Maxim.) Franch. & Sav. var. **canadensis** (L.) Hara. (Rhodora 41: 386–387. 1939.) (*C. lutetiana* of Gray's

Man., ed. 7, and of Monroe Co. List; *C. latifolia* of House.) ENCHANTER'S NIGHTSHADE. [*R] Rich moist woods; common.

HALORAGIDACEAE

Myriophyllum exalbescens Fern. (Rhodora 21: 120. 1919.) (*M. spicatum* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) WATER MILFOIL. [*R, 4, 5] In Hundred Acre and Deep Ponds; common.

Myriophyllum verticillatum L. var. **pectinatum** Wallr. (*M. verticillatum* of House, and of Monroe Co. List.) [R, 5] Collected by *M. S. Baxter* in 1922 in one of the ponds.

ARALIACEAE

Aralia hispida Vent. BRISTLY SARSAPARILLA. [1] Previously listed as "abundant in some of the marshes." I have seen no specimens of this species.

Aralia nudicaulis L. WILD SARSAPARILLA. [*] Rich woods; common.

ARALIA SPINOSA L. HERCULES' CLUB. [*R] Recently introduced in an ornamental planting.

UMBELLIFERAE

Hydrocotyle americana L. WATER PENNYWORT. [*R, C, 1] Boggy and marshy margins of the ponds; frequent.

Sanicula canadensis L. [*] Dry woods; infrequent.

Sanicula marilandica L. (*S. marylandica* of House, and of Monroe Co. List.) SANICLE. BLACK SNAKEROOT. [*R] Rich moist woods; frequent.

Osmorhiza Claytoni (Michx.) Clarke. (*Washingtonia Claytoni* of House; *O. brevistylis* of Monroe Co. List.) SWEET CICELY. [*R] Moist wooded slopes of the eskers; frequent.

Zizia aurea (L.) Koch. GOLDEN ALEXANDERS. [*R] Moist meadows and roadsides; frequent.

Cicuta bulbifera L. [*R] Swamps, marshes and sloughs, usually in standing water; common.

Cicuta maculata L. WATER HEMLOCK. [*R] Swamps and marshes; frequent.

Cryptotaenia canadensis (L.) DC. (*Deringa canadensis* of House.) HONEWORT. [*] Rich woods; infrequent.

CARUM CARVI L. CARAWAY. [*] A roadside escape.

Taenidia integerrima (L.) Drude. (*Pimpinella integerrima* of Monroe Co. List.) [*R] In open oak woods on the dry slopes and crests of the eskers; infrequent.

Angelica atropurpurea L. PURPLE-STEMMED ANGELICA. [*] Marshy meadows; infrequent.

Angelica villosa (Walt.) BSP. (*A. hirsuta* of Monroe Co. List.) [*R] Dry open woodlands; infrequent.

DAUCUS CAROTA L. WILD CARROT. [*R] A weed of fields, roadsides and waste places; common.

CORNACEAE

Nyssa sylvatica Marsh. var. **caroliniana** (Poir.) Fern. (Rhodora 37: 433–437. 1935.) SOUR GUM. BLACK GUM. PEPPERIDGE. [*R, 1, 5] In rich wet woods around Kennedy's Bog and the Devil's Bathtub; rare.

Cornus alternifolia L. f. ALTERNATE-LEAVED DOGWOOD. [*R] Moist woods; frequent.

Cornus Amomum Mill. (*C. sericea* of Monroe Co. List.) SILKY DOGWOOD. KINNIKINNIK. [*] Low ground about the margins of the ponds and bogs; common.

Cornus canadensis L. DWARF CORNEL. BUNCHBERRY. [*R] Boggy woods; scarce.

Cornus racemosa Lam. (*C. paniculata* of Gray's Man., ed. 7, and of Monroe Co. List; *C. femina* of House.) GRAY DOGWOOD. [*R] Forming thickets along roadsides and fencerows and in low ground at the edges of the marshes; abundant.

Cornus florida L. FLOWERING DOGWOOD. [*] Dry woods, especially on the slopes of the eskers; frequent.

Cornus rugosa Lam. (*C. circinata* of Gray's Man., ed. 7, and of Monroe Co. List.) ROUND-LEAVED DOGWOOD. [*R] On the dry wooded slopes of the eskers; frequent.

Cornus sericea L. ssp. and f. **stolonifera** (Michx.) Fosberg. (Bull. Torrey Bot. Club 69: 583–589. 1942.) (*C. stolonifera* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) RED-OSIER DOGWOOD. [*] Forming thickets in low ground around the ponds and in open woods; very common.

ERICACEAE

Monotropa uniflora L. INDIAN PIPE. [*R] A saprophyte of woodlands in moist humus; frequent.

Monotropa Hypopitys L. (*Hypopitys americana* of House.) PINESAP. [*R] Saprophytic in humus on the wooded slopes of the eskers; scarce.

Chimaphila umbellata (L.) Bart. var. **cisatlantica** Blake. (Rhodora 19: 241. 1917.) (*C. umbellata* of authors, in part.) PIPSISSIWA. PRINCE'S PINE. [*R] Moist oak woods; rare. Only three plants have been found.

Pyrola asarifolia Michx. var. **incarnata** (Fisch.) Fern. (*P. uliginosa* of House; *P. incarnata* of Monroe Co. List.) SHINLEAF. [*R, 3] Boggy forest; scarce.

Pyrola elliptica Nutt. SHINLEAF. [*R] At or near the base of moist wooded slopes; infrequent.

Pyrola rotundifolia L. var. **americana** (Sweet) Fern. (Rhodora 22: 122. 1920.) (*P. americana* of Gray's Man., ed. 7, and of House; *P. rotundifolia* of Monroe Co. List.) ROUND-LEAVED SHINLEAF. [*]

Pyrola secunda L. [R] Collected on a dry hillside by *M. S. Baxter* in 1894.

Ledum groenlandicum Oeder. (*L. latifolium* of Monroe Co. List.) LABRADOR TEA. [*R, 1] In sphagnum bogs; scarce.

Rhododendron maximum L. GREAT LAUREL. [*R] Quite a number of small plants of this species have been found growing along a ditch in the mucky peat of a patch of swamp forest. It is possible that these plants have been introduced. If the species is native to the area it is surprising that it has not been previously reported.

Rhododendron nudiflorum (L.) Torr. var. **roseum** (Loisel.) Wieg. (Rhodora 26: 4. 1924.) (*R. canescens* of Gray's Man., ed. 7; *Azalea periclymenoides* of House; *R. nudiflorum* of Monroe Co. List.) PINK AZALEA. PINXTER FLOWER. [*R, C, 5] Open oak woods on the dry sandy or gravelly slopes of the eskers and often at the margins of the swamps and bogs; frequent.

Andromeda glaucophylla Link. (*A. Polifolia* of Monroe Co. List.) ANDROMEDA. BOG ROSEMARY. [*R, 1] In sphagnum bogs; abundant in Kennedy's Bog (see fig. 8).

Chamaedaphne calyculata (L.) Moench. (*Cassandra calyculata* of Monroe Co. List.) LEATHERLEAF. [*R, 1] In sphagnum in the bogs and marshes; dominant species in a number of the bogs (see fig. 8).

Epigaea repens L. TRAILING ARBUTUS. MAYFLOWER. [*R, 5] Growing in open oak woods on the sandy and gravelly slopes of the eskers; now scarce except in a few places.

Gaultheria procumbens L. WINTERGREEN. CHECKERBERRY. [*] Moist woods; frequent.

Gaylussacia baccata (Wang.) K. Koch. (*G. resinosa* of Monroe Co. List.) BLACK HUCKLEBERRY. [*R, 1] Occasionally growing in dry open woods; common in the sphagnum of Kennedy's Bog.

Vaccinium angustifolium Ait. (*V. pennsylvanicum* of Gray's Man., ed. 7, and of Monroe Co. List.) EARLY UPLAND BLUEBERRY. [*R] In oak woods on dry sandy and gravelly slopes; common.

Vaccinium corymbosum L. SWAMP OR HIGHBUSH BLUEBERRY. [*R, 1] In the sphagnum bogs; very abundant in Kennedy's Bog, where it forms shrubby islands (see fig. 8) and a marginal fringe.

Vaccinium corymbosum var. **atrococcum** Gray. (*V. atrococcum* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [2] Wiegand and Eames (1926) question the distinctness of this variety in central N. Y.

Vaccinium corymbosum var. **glabrum** Gray. (*V. caesariense* of House.) [C, 5] Sphagnum bog.

Vaccinium macrocarpon Ait. (*Oxycoccus macrocarpus* of House.) LARGE CRANBERRY. [*R, 1] In sphagnum in Kennedy's Bog and in the marshes around Quaker Pond.

Vaccinium Oxycoccos L. (*Oxycoccus Oxycoccus* of House.) SMALL CRANBERRY. [*R] In sphagnum; abundant in Kennedy's Bog.

Vaccinium stamineum L. (*Polycodium stamineum* of House.) DEERBERRY. [*R] Habitat the same as that of the preceding species; frequent.

Vaccinium vacillans Kalm. LATE UPLAND BLUEBERRY. [*R] Habitat the same as that of the preceding species; common.

PRIMULACEAE

LYSIMACHIA NUMMULARIA L. MONEYWORT. [*R] In low ground and on moist banks; established at several places.

Lysimachia quadrifolia L. WHORLED LOOSESTRIFE. [*R] Dry oak woods; infrequent.

Lysimachia terrestris (L.) BSP. (*L. stricta* of Monroe Co. List.) [*] Marshes south of Quaker Pond; scarce.

Lysimachia thyrsiflora L. TUFTED LOOSESTRIFE. [*R] Wet meadows and marshes; infrequent.

Steironema ciliatum (L.) Raf. FRINGED LOOSESTRIFE. [*R] Borders of marshes and low thickets; common.

Trientalis borealis Raf. (Rhodora 11: 236. 1909.) (*T. americana* of Gray's Man., ed. 7, and of Monroe Co. List.) STAR FLOWER. [*] Moist or boggy woods; infrequent.

OLEACEAE

Fraxinus americana L. WHITE ASH. [*] Upland woods; common.

Fraxinus nigra L. (*F. sambucifolia* of Monroe Co. List.) BLACK ASH. [*] Wet and swampy woods; infrequent.

Fraxinus pennsylvanica Marsh. (*F. pubescens* of Monroe Co. List.) RED ASH. [*R] Wet swampy woods, particularly near the shores of the ponds; frequent.

GENTIANACEAE

Gentiana Andrewsii Griseb. (*G. clausa* of House.) CLOSED GENTIAN. [*R] Moist undisturbed meadows; scarce.

Gentiana crinita Froel. FRINGED GENTIAN. [*R] Moist undisturbed meadows; scarce.

Gentiana quinquefolia L. (*G. quinqueflora* of Monroe Co. List.) [R] Collected in 1866 and again in 1894 by *G. T. Fish.*

Menyanthes trifoliata L. var. **minor** Michx. (Rhodora 31: 195–198. 1929.) (*M. trifoliata* L. of Gray's Man., ed. 7, of House, and of Monroe Co. List.) BUCKBEAN. [*R, 1] Bogs and boggy marshes; scarce.

APOCYNACEAE[10]

VINCA MINOR L. PERIWINKLE. [*] Banks and roadsides; an occasional escape.

Apocynum androsaemifolium L. var. **incanum** A. DC. (*A. androsaemifolium* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) SPREADING DOGBANE. [*R] Dry thickets and open woods; common.

Apocynum cannabinum L. var. **glaberrimum** A. DC. (*A. cannabinum*, in part, of Gray's Man., ed. 7, of House, and of Monroe Co. List.) INDIAN HEMP. [*R] Marshy meadows around the ponds.

Apocynum cannabinum var. **pubescens** (Mitchell) A. DC. (*A. pubescens* of House.) INDIAN HEMP. [*R, 5] Wet meadows.

Apocynum hypericifolium Ait. (*A. cannabinum* var. *hypericifolium* of Gray's Man., ed. 7; *A. sibericum* of House.) [C, 5] Margin of a bog.

Apocynum medium Greene. [R, 5] Dry fields. A recent investigation by Anderson (1936) has shown that the various forms of this "species" are in reality derived from crosses between *A. androsaemifolium* and *A. cannabinum*.

ASCLEPIADACEAE

Asclepias incarnata L. SWAMP MILKWEED. [*R] Marshes; common.

Asclepias quadrifolia Jacq. FOUR-LEAVED MILKWEED. [*R] Dry open woods along the crests of the eskers; scarce.

Asclepias syricaca L. (*A. cornuti* of Monroe Co. List.) COMMON MILKWEED. [*] Fields and roadsides; frequent.

Asclepias tuberosa L. BUTTERFLY-WEED. PLEURISY-ROOT. [*R] Dry sandy slopes of the kames and eskers; common.

CONVOLVULACEAE

Cuscuta Gronovii Willd. COMMON DODDER. [*R] Marshes around the ponds; frequent.

Convolvulus sepium L. HEDGE BINDWEED. [*R] A weed of roadsides and cultivated ground; frequent.

HYDROPHYLLACEAE

Hydrophyllum canadense L. WATER-LEAF. [R, 1] Rich woods.

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[10] The treatment of the genus *Apocynum* follows the monograph of Woodson (Ann. Missouri Bot. Gard. 17: 1–212. 1930.).

BORAGINACEAE

Cynoglossum boreale Fern. (*C. virginicum* of Monroe Co. List.) WILD COMFREY. [2]

CYNOGLOSSUM OFFICINALE L. HOUND'S TONGUE. [*R] Abandoned farmyards and at the edges of the thickets; frequent.

Hackelia virginiana (L.) I. M. Johnston. (*Lappula virginiana* of Gray's Man., ed. 7, and of House; *Echinospermum virginicum* of Monroe Co. List.) BEGGAR'S LICE. [*] Woodlands and thickets; frequent.

ECHIUM VULGARE L. BLUE WEED. BLUE DEVIL. [*R, 5] A weed on the dry open gravelly slopes and crests of the eskers; infrequent.

VERBENACEAE

Verbena hastata L. BLUE VERVAIN. [*R] Low ground in fields and meadows; frequent.

Verbena urticaefolia L. WHITE VERVAIN. [*R] Roadsides, fields and fencerows; frequent.

LABIATAE

Scutellaria galericulata L. (*S. epilobiifolia* Hamil.; Rhodora 23: 85–86. 1921.) MARSH SKULLCAP. [*R] Marshes and along streams; common.

NEPETA CATARIA L. CATNIP. [*R] Roadsides and waste places; common.

GLECOMA HEDERACEA L. (*Nepeta hederacea* of Gray's Man., ed. 7; *N. Glechoma* of Monroe Co. List.) GROUND IVY. GILL-OVER-THE-GROUND. [*] Roadsides and waste places.

Prunella vulgaris L. (*Brunella* of Monroe Co. List.) (See note in Wiegand and Eames, Flora Cayuga Lake Basin, p. 358. 1926.) HEAL-ALL. SELF-HEAL. [*R] Rich soil in fields and meadows, and at the borders of swamps; common.

LEONURUS CARDIACA L. MOTHERWORT. [*R] Roadsides and waste places; common.

STACHYS LANATA Jacq. [R, 1] A roadside escape which did not become established.

SALVIA SYLVESTRIS L. SAGE. [*R, USNM, 5] A conspicuous escape, well established at one place on the dry open slopes of an esker.

Monarda clinopodia L. BALM. [3]

Monarda fistulosa L. WILD BERGAMOT. [*R] Dry open hillsides; frequent.

Monarda fistulosa var. **mollis** (L.) Benth. (*M. mollis* of Gray's Man., ed. 7, and of House.) [*R] Habitat similar to that of the typical form; common.

Satureja vulgaris (L.) Fritsch. (*Clinopodium vulgare* of House; *Calamintha Clinopodium* of Monroe Co. List.) BASIL. [*R] Moist fields and roadsides; frequent.

Pycnanthemum flexuosum (Walt.) BSP. (*Koellia flexuosa* of House.) MOUNTAIN MINT. [3]

Pycnanthemum muticum (Michx.) Pers. (See note on *P. virginianum.*)

Pycnanthemum virginianum (L.) Durand & Jackson. (*Koellia virginiana* of House; *P. lanceolatum* of Monroe Co. List.) MOUNTAIN MINT. [*R, 2] Open sandy soil at the edge of an oak opening; scarce. A report of *P. muticum* [1] from Mendon was apparently based on a misidentification of a specimen of this species collected by *G. T. Fish.*

Lycopus americanus Muhl. (*L. sinuatus* of Monroe Co. List.) WATER HOREHOUND. [*R] Marshy places; frequent.

Lycopus americanus var. **Longii** Benner. (Bartonia 16: 46–47. 1935.) [*R] Habitats similar to that of the species.

Lycopus uniflorus Michx. (Apparently *L. virginicus* of Monroe Co. List.) BUGLE WEED. [*R, 5] Marshes, frequently with *Decodon verticillatus;* common.

Mentha arvensis L. var. **canadensis** (L.) Briq. (*M. canadensis* of House, and of Monroe Co. List.) WILD MINT. [*R] Wet places at the borders of swamps and along roadsides; frequent.

MENTHA PIPERITA L. PEPPERMINT. [*R] Wet meadows.

MENTHA SPICATA L. (*M. viridis* of House, and of Monroe Co. List.) SPEARMINT. [*R] Wet places along Clover Street.

Collinsonia canadensis L. HORSE BALM. RICHWEED. [*] Rich moist woods; frequent.

SOLANACEAE

LYCIUM HALIMIFOLIUM Mill. (*L. vulgare* of Monroe Co. List.) MATRIMONY-VINE. [*R] Cultivated and persisting in abandoned farmyards.

Physalis heterophylla Nees. (*P. virginiana* of Monroe Co. List, at least in part.) GROUND CHERRY. [*R] Dry open sandy places; frequent.

Solanum Dulcamara L. BITTERSWEET. BLUE NIGHTSHADE. [*] Low ground and marshes; abundant.

SCROPHULARIACEAE

VERBASCUM BLATTARIA L. MOTH MULLEIN. [*R] Fallow fields and dry sandy slopes; common. Both the typical yellow-flowered form and the white-flowered form, f. **albiflora** (G. Don) House, occur.

VERBASCUM THAPSUS L. COMMON MULLEIN. [*R] Dry fields; common.

LINARIA VULGARIS Hill. (*L. linaria* of House.) BUTTER-AND-EGGS. YELLOW TOADFLAX. [*R] Roadside weed; common.

Scrophularia lanceolata Pursh. (*S. leporella* of Gray's Man., ed. 7, and of Monroe Co. List.) FIGWORT. [*R] Thickets and open fields; scarce.

Chelone glabra L. var. **typica** Pennell. TURTLEHEAD. [*R] Wet meadows and thickets; frequent.

PENSTEMON DIGITALIS Nutt. (*P. laevigatus* var. *Digitalis* of Gray's Man., ed. 7, and of Monroe Co. List.) FOXGLOVE PENSTEMON. BEARDTONGUE. [*R, 5] Adventive; rare.

Mimulus ringens L. MONKEY FLOWER. [*R] Wet meadows and pastures; infrequent.

Veronica americana (Raf.) Schw. AMERICAN BROOKLIME. [*R] Borders of brooks; frequent.

VERONICA ARVENSIS L. CORN SPEEDWELL. [R]

VERONICA LONGIFOLIA L. (*V. maritima* of House.) [R, 5] An occasional garden escape.

VERONICA OFFICINALIS L. COMMON SPEEDWELL. [*R] Dry banks, fields, and pastures; frequent.

Veronica peregrina L. PURSLANE SPEEDWELL. [*] A weed of cultivated grounds and waste places.

Veronica serpyllifolia L. THYMELEAF SPEEDWELL. [*R] Moist roadsides.

Gerardia paupercula (Gray) Britt. var. **borealis** (Pennell) Pennell. (Proc. Acad. Nat. Sci. Philadelphia 81: 159. 1929.) (*G. paupercula* of Gray's Man., ed. 7; *Agalinis paupercula* of House; *G. purpurea* and *G. purpurea* var. *paupercula* of Monroe Co. List.) [*R, 1] Low sandy borders of the ponds and marshes; infrequent.

Gerardia tenuifolia Vahl. var. **typica** Pennell. (*Agalinis tenuifolia* of House.) SLENDER GERARDIA. [R] Dry open woods.

Aureolaria pedicularia (L.) Raf. var. **intercedens** Pennell. (Torreya 19: 207. 1919.) (*Gerardia pedicularia*, in part, of Gray's Man., ed. 7, and of Monroe Co. List; *A. pedicularia*, in part, of House.) FALSE FOXGLOVE. [*R] Dry open oak woods; infrequent.

Aureolaria virginica (L.) Farw. (*Gerardia flava* of Gray's Man., ed. 7, and of Monroe Co. List.) DOWNY FALSE FOXGLOVE. [*R] Sandy soil in dry open woods; infrequent.

Melampyrum lineare Lam. var. **latifolium** (Muhl.) Beauv. (*M. americanum* of Monroe Co. List.) COW WHEAT. [*] Dry woods; frequent.

Pedicularis canadensis L. LOUSEWORT. WOOD BETONY. [*] Dry woods; frequent.

Pedicularis lanceolata Michx. SWAMP LOUSEWORT. [*R, 5] Lush meadows in marly muck; rare.

BIGNONIACEAE

CATALPA SPECIOSA Warder. CATAWBA TREE. CIGAR TREE. [*R] Roadsides. Planted.

OROBANCHACEAE

Orobanche uniflora L. var. **typica** Achey. (Bull. Torrey Bot. Club 60: 441–451. 1933.) (*Aphyllon uniflorum* of House, and of Monroe Co. List.) ONE-FLOWERED CANCER-ROOT. [*R] A parasite on the wooded slopes of the eskers; rare.

Epifagus virginiana (L.) Bart. (*Leptamnium virginianum* of House; *Epiphegus* of Monroe Co. List.) BEECHDROPS. [*] Beech-maple woods; infrequent.

LENTIBULARIACEAE

Utricularia cornuta Michx. HORNED BLADDERWORT. [C, 1] Reported as rare by *G. T. Fish* in 1896. Collected by *A. J. Eames* and *F. P. Metcalf*, 1917, and in Kennedy's Bog by *K. M. Wiegand*, 1918.

Utricularia gibba L. SWOLLEN-SPURRED BLADDERWORT. [*R, 1] In very shallow water or muck, on marly flats; rare.

Utricularia intermedia Hayne. FLAT-LEAVED BLADDERWORT. [*R, C, 5] Pools and sluggish streams in the marsh meadow north of Quaker Pond; scarce.

Utricularia minor L. LESSER BLADDERWORT. Clausen's report of this species from Mendon [4] should be referred to *U. intermedia* [5].

Utricularia resupinata B. D. Greene. [R, 1, 4] Reported as rare on the muddy margin of Mendon Ponds in 1896.

Utricularia vulgaris L. var. **americana** Gray. (*U. macrorhiza* of House; *U. vulgaris* of Monroe Co. List.) GREAT BLADDERWORT. [*R, 4] In Hundred Acre, Deep and Quaker Ponds; common.

PHRYMACEAE

Phryma Leptostachya L. LOPSEED. [WAM] Moist woods. Collected by *W. A. Matthews*, 1915.

PLANTAGINACEAE

Plantago aristata Michx. (*P. patagonica* var. *aristata* of Monroe Co. List.) BRACTED PLANTAIN. [*R, 5] In dry sand or gravel on the crests of the eskers; infrequent.

PLANTAGO LANCEOLATA L. ENGLISH PLANTAIN. RIB GRASS. [*R] A weed of roadsides, fields and waste places; abundant.

PLANTAGO MAJOR L. PLANTAIN. [*R] Roadsides, fields, lawns, and waste places; common.

Plantago Rugelii Dcne. Plantain. [*] Rich roadsides, fields, and waste places; common. The specimens examined had hairy scapes and should perhaps be referred to var. asperula Farw. (Papers Mich. Acad. Sci. 1: 99. 1923.)

RUBIACEAE

Cephalanthus occidentalis L. Button-bush. [*R] In marshes around the ponds; frequent.

Mitchella repens L. Partridge-berry. [*] Dry woods on the slopes of the eskers; frequent.

Galium Aparine L. Cleavers. Goose Grass. [*] Damp woods and thickets; common.

Galium boreale L. var. **typicum** Beck von Man. (Rhodora 30: 106–110. 1928.) Northern Bedstraw. [*R, 1, 5] Dry open slopes of the eskers or in open oak woods; frequent.

Galium boreale var. **hyssopifolium** (Hoffm.) DC. [*R, 5] Habitat the same as for the typical form.

Galium boreale var. **intermedium** DC. [*R, 5] Sandy soil at edge of an oak opening.

Galium circaezans Michx. var. **hypomalacum** Fern. (Rhodora 39: 450. 1937.) Wild Licorice. [*R, 5] Wooded slopes of the eskers; frequent.

Galium labradoricum Wieg. [*R] Marshes around Quaker Pond; infrequent.

Galium tinctorium L. (Rhodora 41: 388. 1939.) (*G. Claytoni* of Gray's Man., ed. 7, and of House.) [*R] Marshes and boggy woods; frequent.

Galium trifidum L. [*R, C] Boggy woods and marshes around the ponds; frequent.

CAPRIFOLIACEAE

Sambucus canadensis L. Common Elder. [*] Low ground in open places; common.

Sambucus pubens Michx. (*S. racemosa* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) Red-berried Elder. [*] Moist woods and thickets; frequent.

Viburnum acerifolium L. Maple-leaved Viburnum. Arrow-wood. [*R] Dry woods on the slopes of the eskers; common.

Viburnum affine Bush. var. **hypomalacum** Blake. (Rhodora 20: 14. 1918.) (*V. pubescens*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) Arrow-wood. [*R, C] Dry, gravelly crests of the eskers; infrequent.

Viburnum cassinoides L. Withe-rod. [*, 1] Boggy woods in the kettles; infrequent.

Viburnum dentatum L. ARROW-WOOD. Wet thickets around the ponds and bogs; common.

VIBURNUM LANTANA L. WAYFARING-TREE. [*] Roadside planting.

Viburnum Lentago L. NANNYBERRY. SHEEPBERRY. SWEET VIBURNUM. [*] Wet woods and thickets; frequent.

VIBURNUM OPULUS L. [*R] The European species now in roadside plantings.

Viburnum trilobum Marsh. (*V. Opulus* var. *americanum* of Gray's Man., ed. 7; *V. Opulus* of House, and of Monroe Co. List.) CRANBERRY-TREE. HIGHBUSH CRANBERRY. [*] Thickets at the margin of Hundred Acre Pond; infrequent.

Symphoricarpos albus (L.) Blake. (Rhodora 16: 118. 1914.) (*S. racemosus* of Gray's Man., ed. 7; *S. racemosus* var. *pauciflorus* of Monroe Co. List.) SNOWBERRY. [HP, 2] Hillside.

Lonicera canadensis Marsh. (*L. ciliata* of Monroe Co. List.) FLY HONEYSUCKLE. [*R] Dry wooded slopes of the eskers; infrequent.

Lonicera dioica L. (*L. glauca* of Monroe Co. List.) [*] Dry wooded slopes of the eskers; infrequent.

Lonicera oblongifolia (Goldie) Hook. SWAMP FLY HONEYSUCKLE. [*R, 1] Swamps and marly marsh meadows; scarce.

LONICERA SEMPERVIRENS L. TRUMPET HONEYSUCKLE. [*R, 5] Roadside escape; scarce.

Diervilla Lonicera Mill. (*D. Diervilla* of House; *D. trifida* of Monroe Co. List.) BUSH HONEYSUCKLE. [*R] Dry wooded slopes of the eskers; infrequent.

VALERIANACEAE

Valeriana uliginosa (T. & G.). (*V. sylvatica* of Monroe Co. List.) SWAMP VALERIAN. [*R, 1] Wet marly meadows, especially north of Quaker Pond; abundant in this habitat.

DIPSACACEAE

DIPSACUS SYLVESTRIS Huds. WILD TEASEL. [*R] Moist fields, roadsides and waste ground; frequent.

CUCURBITACEAE

Sicyos angulatus L. ONE-SEEDED BUR CUCUMBER. [*] Moist thickets; scarce.

CAMPANULACEAE

Campanula rotundifolia L. var. **intercedens** (Witasek) Farw. (*C. rotundifolia* var. *arctica* and *C. rotundifolia*, in part, of Monroe Co. List.) HAREBELL. BLUEBELL. [*R, 5] Dry open slopes of the eskers, oak openings and moist meadows; frequent.

Campanula uliginosa Rydb. (Probably *C. aparinoides* of Monroe Co. List, in part.) MARSH BELLFLOWER. [*R, C, 5] Marshes and wet marly meadows; frequent.

Specularia perfoliata (L.) A. DC. VENUS LOOKING-GLASS. [R] Collected by *G. T. Fish*, 1866.

LOBELIACEAE

Lobelia inflata L. INDIAN TOBACCO. [*] Dry open slopes; infrequent.

Lobelia Kalmii L. KALM'S LOBELIA. [*R] Shores and wet marly meadows; frequent.

Lobelia siphilitica L. GREAT LOBELIA. [*R] Low ground in woods or swamps; frequent.

COMPOSITAE

Eupatorium fistulosum Barratt. (Rhodora 22: 57–70. 1920; 39: 297–306. 1937.) PURPLE-STEM JOE-PYE-WEED. [*R] Wet meadows; frequent.

Eupatorium maculatum L. (Rhodora 22: 57–70. 1920; 39: 297–306. 1937.) SPOTTED STEM JOE-PYE-WEED. [*R] Wet meadows and swampy places; frequent.

Eupatorium perfoliatum L. THOROUGHWORT. BONESET. [*R] Wet meadows and low grounds; common.

Eupatorium rugosum Houtt. (Rhodora 40: 293. 1938.) (*E. urticaefolium* of Gray's Man., ed. 7, and of House; *E. ageratoides* of Monroe Co. List.) WHITE SNAKEROOT. [*R] Rich woods; common.

Solidago. GOLDENROD.

Solidago altissima L. [*R, 5] Fallow fields and roadsides; frequent.

Solidago arguta Ait. [*R, C] Sandy soil in open woods and thickets; frequent.

Solidago bicolor L. SILVERROD. [*R] Dry soil, in somewhat shady places; frequent.

Solidago caesia L. [*R] Open woods; abundant.

Solidago canadensis L. var. **Hargeri** Fern. [*R, C, 5] Meadows.

Solidago gigantea Ait. (Rhodora 41: 457. 1939.) (*S. serotina* var. *gigantea* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [*R, C] Wet meadows; frequent.

Solidago graminifolia (L.) Salisb. var. **Nuttallii** (Greene) Fern. [*R] Roadsides and abandoned fields; common.

Solidago hispida Muhl. [*] Dry soil, in somewhat shady places; frequent.

Solidago juncea Ait. [*R] The early-flowering species of meadows and hillsides; abundant.

Solidago latifolia L. (*S. flexicaulis* of House.) [*R] Moist wooded slopes; frequent.

Solidago nemoralis Ait. [*R] Dry open hillsides; abundant.

Solidago ohioensis Riddell. [*R, C, 5] Wet marly meadows; infrequent.

Solidago patula Muhl. [*] Boggy woods; scarce.

Solidago rugosa Mill. [*R] Roadsides, fields and thickets; common.

Solidago squarrosa Muhl. [*R] Wooded slopes of the eskers; infrequent.

Solidago ulmifolia Muhl. [C] Damp woods. Collected by *K. M. Wiegand*, 1918).

Solidago uniligulata (DC.) Porter. (*S. neglecta* var. *linoides* of Monroe Co. List.) [*R] Marly meadows north of Quaker Pond; scarce.

Solidago uniligulata var. **levipes** Fern. (Rhodora 17: 7. 1915.) [*R] Marly meadows north of Quaker Pond; scarce. It is possible that the specimens referred to this variety are *S. humilis* Pursh (Rhodora 17: 6. 1915; *S. uliginosa* of Gray's Man., ed. 7, and of Monroe Co. List), but I am uncertain as to the distinction between these groups.

Solidago uniligulata var. **neglecta** (T. & G.) Fern. (Rhodora 23: 292. 1921.) (*S. neglecta* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) [1] No specimens have been seen to confirm this report.

Aster cordifolius L. [*R] Dry fields, roadsides and thickets; common.

Aster divaricatus L. (*A. corymbosus* of Monroe Co. List.) [*] Open woods and thickets.

Aster junceus Ait. [*R, C, 1] Marshes, wet marly meadows, and boggy places; frequent. A specimen previously listed as *A. novi-belgii* var. *elodes* was referred to this species by *K. M. Wiegand.*

Aster laevis L. [*R] Dry fields and thickets; common.

Aster lateriflorus (L.) Britt. (Rhodora 30: 172–173. 1928.) (*A. diffusus* and *A. diffusus* var. *hirsuticaulis* of Monroe Co. List.) [*R] Wet meadows; frequent.

Aster macrophyllus L. [*R] Rich moist woods; common.

Aster novae-angliae L. New England Aster. [*] Fields, thickets and roadsides; common.

Aster novi-belgii L. var. *elodes* (T. & G.) Gray. (See note on *A. junceus.*)

Aster paniculatus Lam. var. **simplex** (Willd.) Burgess. (Rhodora 35: 32–34. 1933.) [*R] Damp meadows; frequent.

Aster puniceus L. [*R] Wet meadows and marshes; common.

Aster Schreberi Nees. [*] Dry open woods.

Aster umbellatus Mill. (*Doellingeria umbellata* of House.) [*R] Wet meadows, sometimes in marly places; common.

Erigeron annuus (L.) Pers. Daisy Fleabane. Whitetop. [*R] Dry fields and openings; frequent.

Erigeron canadensis L. (*Leptilon canadense* of House.) Horseweed. [*R] A weed of fields, roadsides and cultivated ground; common.

Erigeron philadelphicus L. FLEABANE. [*R] Moist fields, meadows, and open woods; frequent.

Erigeron pulchellus Michx. (*E. bellidifolius* of Monroe Co. List.) ROBIN'S PLANTAIN. [*R] Dry wooded slopes of the eskers; frequent.

Erigeron ramosus (Walt.) BSP. (*E. strigosus* of Monroe Co. List.) DAISY FLEABANE. [*R] Fields; abundant.

Sericocarpus asteroides (L.) BSP. (*S. conyzoides* of Monroe Co. List.) WHITE-TOPPED ASTER. [*R] Dry open woods; scarce.

Antennaria neglecta Greene. LADIES' TOBACCO. PUSSY'S TOES. [R] Collected by *E. P. Killip*, 1917.

Antennaria petaloidea Fern. [*R, USNM] Dry pasture.

Antennaria plantaginifolia (L.) Richards. LADIES' TOBACCO. PUSSY'S TOES. [*R] Dry sterile fields and pastures; common.

Anaphalis margaritacea (L.) B. & H. var. **intercedens** Hara. (Rhodora 41: 391. 1939.) (*A. margaritacea* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) PEARLY EVERLASTING. [*R] Dry open hillsides; common.

Gnaphalium obtusifolium L. (*G. polycephalum* of Gray's Man., ed. 7, and of Monroe Co. List.) EVERLASTING. [*R] Dry open slopes; frequent.

INULA HELENIUM L. ELECAMPANE. [*R] Moist soil in pastures and waste places; infrequent.

Ambrosia elatior L. (Amer. Midland Nat. 17: 673–700. 1936.) (*A. artemisiifolia* of Gray's Man., ed. 7, and of Monroe Co. List; *A. elatior* var. *artemisiifolia* of House.) COMMON RAGWEED. [*R] A weed of cultivated ground; abundant.

Xanthium italicum Moretti. (See Deam, Flora Indiana: 962. 1940.) (*X. echinatum*, in part, of Gray's Man., ed. 7; *X. canadense* var. *echinatum* of Monroe Co. List.) COCKLEBUR. [*R] Low disturbed ground; infrequent.

RUDBECKIA HIRTA L. BLACK-EYED SUSAN. [*R] A weed of fields and roadsides; common.

Helianthus divaricatus L. WILD SUNFLOWER. [*R] Dry open woods or thickets; frequent.

Helianthus strumosus L. WILD SUNFLOWER. [*R] Dry open woods or thickets; frequent.

Bidens cernua L. NODDING BUR-MARIGOLD. [*R] Muddy margins of the ponds and marshes; common.

Bidens connata Muhl. var. **petiolata** (Nutt.) Farw. (Rhodora 10: 197. 1908.) SWAMP BEGGAR'S TICKS. [*R] Muddy margins of the ponds and marshes; frequent.

Bidens frondosa L. BEGGAR'S TICKS. [*] Low ground; common.

GALINSOGA CILIATA (Raf.) Blake. (Rhodora 24: 34–36. 1922.) (*G. parviflora* var. *hispida* of Gray's Man., ed. 7, and of Monroe Co. List.) QUICKWEED. [WAM] A weed of cultivated ground.

ANTHEMIS ARVENSIS L. CORN CHAMOMILE. [*R] A weed of dry fields and roadsides; common.

ANTHEMIS ARVENSIS var. AGRESTIS (Wallr.) DC. [*R] Habitat the same as for the typical form.

ANTHEMIS COTULA L. MAY-WEED. DOG FENNEL. [*] A weed of dry fields and roadsides; frequent.

ANTHEMIS TINCTORIA L. YELLOW CHAMOMILE. [*R, 5] A roadside adventive.

Achillea Millefolium L. COMMON YARROW. [*R] A weed of fields and roadsides; common.

CHRYSANTHEMUM LEUCANTHEMUM L. var. PINNATIFIDUM Lecoq & Lamotte. OXEYE DAISY. [*] A weed of fields and roadsides; common.

TANACETUM VULGARE L. COMMON TANSY. [*] A garden escape.

ERECHTITES HIERACIFOLIA (L.) Raf. FIREWEED. [*R] Moist thickets and clearings; frequent.

Senecio aureus L. GOLDEN RAGWORT. [*R] Marly marsh meadows and shaded springy places; infrequent. Specimens approaching var. **gracilis** (Pursh) Britt. have been collected.

ARCTIUM MINUS (Hill) Bernh. SMALLER BURDOCK. [*R] A weed of roadsides and waste places; common.

CIRSIUM ARVENSE (L.) Scop. (*Cnicus arvensis* of Monroe Co. List.) CANADA THISTLE. [*R] A weed of moist cultivated ground; common.

Cirsium muticum Michx. (*Cnicus muticus* of Monroe Co. List.) SWAMP THISTLE. [*R] Wet meadows; infrequent.

CIRSIUM VULGARE (Savi) Airy-Shaw. (Fedde Rept. Spec. Nov. 43: 302–315. 1938.) (*C. lanceolatum* of Gray's Man., ed. 7, and of House; *Cnicus lanceolatus* of Monroe Co. List.) BULL THISTLE. [*R] Pastures, fields and roadsides; frequent.

CENTAUREA JACEA L. var. LACERA Koch. [*R, 5] A roadside weed; scarce.

CICHORIUM INTYBUS L. CHICORY. [*] A roadside weed; common.

PICRIS HIERACIOIDES L. [*R, 5] An adventive of fields and roadsides; infrequent.

TRAGOPOGON PRATENSIS L. GOAT'S BEARD. [*] A roadside weed; frequent.

TARAXACUM PALUSTRE (Lyons) Lam. & DC. var. VULGARE (Lam.) Fern. (Rhodora 35: 380. 1933.) (*T. officinale* of Gray's Man., ed. 7, and of Monroe Co. List; *Leontodon Taraxacum* of House.) DANDELION. [*] A weed of roadsides, fields, and lawns; common.

LACTUCA SCARIOLA L. PRICKLY LETTUCE. [*R] An adventive in cultivated places.

LACTUCA SCARIOLA var. INTEGRATA Gren. & Godr. [*R] Habitat the same as for the typical form; common.

Lactuca spicata (Lam.) Hitchc. (*L. leucophaea* of Monroe Co. List.) BLUE LETTUCE. [*R] Low ground, in thickets and at the borders of woods; frequent.

Prenanthes alba L. (*Nabalus albus* of House.) RATTLESNAKE ROOT. WHITE LETTUCE. LION'S-FOOT. [*] Open woods; frequent.

Prenanthes altissima L. (*Nabalus altissimus* of House.) RATTLESNAKE ROOT. LION'S-FOOT. [*R] Moist woods; frequent.

HIERACIUM AURANTIACUM L. ORANGE HAWKWEED. DEVIL'S PAINT-BRUSH. [*] A weed of dry fields and pastures; common.

HIERACIUM PRATENSE Tausch. KING DEVIL. [*] A weed of dry fields and pastures; common.

Hieracium venosum L. RATTLESNAKE-WEED. [*R] Dry open woods on the slopes of the eskers; frequent.

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NOTES ON THE FLORA OF MONROE COUNTY, NEW YORK[1]

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Since the publication of *Plants of Monroe County, New York, and Adjacent Territory* (Beckwith and Macauley, 1896) and subsequent supplements (Beckwith, Macauley and Baxter, 1910, 1917) additional information on the vascular flora of this area has become available. Field work during the past twenty-five years has contributed a number of species previously unrecorded from the county and has yielded a clearer picture of the distribution of certain significant species. This paper brings together information of both these types from several sources:

(1) Previously unreported collections from Monroe County, principally by members of the Botanical Section of the Rochester Academy of Science, most of which are on file in the Herbarium of the Academy now on deposit in the Herbarium of the University of Rochester. Collections from adjacent counties have been intentionally omitted from this list.

(2) Collections by one or both of the authors during the last five years. All records are from this source unless otherwise indicated, and the supporting specimens have been deposited in the Herbarium of the University of Rochester.

(3) Scattered records in the literature, principally the reports of the State Botanist (House, 1918, 1919, 1921, 1923, 1924), for which no supporting specimens have been seen by the authors.

(4) Data on distribution of aquatic plants in the New York State Conservation Department's *Biological Survey of the Lake Ontario Watershed* (Clausen, 1940).

(5) Unpublished data on plant distribution compiled during the course of an ecological survey of the vegetation of Monroe County jointly sponsored by the New York State Museum and the Monroe County Division of Regional Planning, 1938–1942. Copies of these data are filed at Albany and Rochester, and the report of this survey (Shanks, 1943) will be published as a bulletin of the New York State Museum.

Several factors have contributed to the wide diversity of the vegetation of this relatively small area and are responsible for its floristic richness. The 119 soil separations recognized in the soil survey of Monroe County (Sweet *et al.*, 1938) reflect the wide range of soil material and drainage conditions. It is apparent that the climate also varies

[1] Received for publication December 10, 1942.

within the county, particularly with distance from the lake (Mordoff, 1934; Monroe County Division of Regional Planning, 1938). The land surface has been exposed since early post-glacial time, and species have migrated into the area from the south, east and west. Climatic and physiographic changes during this period have brought about broad changes in the plant cover, and many species formerly widespread have been restricted to those sites most favorable for them or least favorable for the regional dominants which have succeeded them over most of the area.

The plant communities which made up the natural vegetation of the area prior to white settlement have been mapped and discussed in detail in the report of the previously mentioned vegetation survey of Monroe County (Shanks, 1943). The beech-sugar maple association was most extensive, occupying more than half of the county. It occupied large areas exclusively and some portion of every town in the county. The elm-ash-maple swamp forest and its variants occurred locally along stream margins and on other poorly drained sites throughout the beech-sugar maple area, but the largest continuous swamp forest occupied the flats of the Genesee River in the central and southern parts of the county. Large stands of the hemlock-northern hardwood association occurred in the northeastern and northwestern corners of the county (*cf.* Maps 5 and 6) and the greater part of the oak-chestnut-pine type occurred in the area between them, near Irondequoit Bay and the mouth of the Genesee River, north of the present city of Rochester (*cf.* Maps 1, 2 and 3). Upland oak and oak-hickory forests which did not include chestnut or pine as an important constituent were rather widely distributed in the southern half of the county, occupying extensive acreage in the southernmost towns and extending northward along the valleys of Irondequoit Creek and the Genesee River. Local "oak openings" characterized by typical prairie species were commonest on the over-drained sites in these upland oak forests, but also occurred in the oak-pine areas adjacent to Irondequoit Bay. Their approximate distribution is indicated in Map 12, which shows the combined distribution of tall bluestem, little bluestem and Indian grass, the three dominant grasses in eastward extensions of the prairie. Bogs occupied a rather insignificant total area but were widely distributed in a broad belt extending east and west across the county (*cf.* Maps 7 and 8).

These plant communities are for the most part clearly defined and constitute more or less distinct floristic units. This tendency is reflected in the accompanying maps, which have been selected to show types of species distribution. They are based on extensive field work during which every natural area in the county was visited. It is not claimed that every station in the county for these species is shown, but it is believed that the records are complete enough to give a clear picture of their range. Distribution notes for other woody species in the list are derived from the same source.

Certain conventions have been followed in the annotated list. Scientific names of native plants are printed in **bold face** type. Those of introduced species and common names are printed in SMALL CAPITALS. Nomenclature conforms insofar as possible with the International Rules. Wherever the scientific names differ from those of *Gray's Manual*, edition 7, of the *Annotated List of the Ferns and Flowering Plants of New York State* (House, 1924), or of the previously published lists of the flora of Monroe County, New York (Beckwith *et al.*, 1896, 1910, 1917), the synonyms are given in *italics*.

Unless otherwise indicated, specimens cited have been collected by the authors. Names of collectors other than the authors are given in italics along with the year of collection. Specimens are deposited in the Herbarium of the University of Rochester (R), the Herbarium of Cornell University, College of Agriculture (C), the Herbarium of the New York State Museum (NYS), the Herbarium of the United States National Museum (USNM), or the personal herbarium of Mr. Warren A. Matthews of Rochester (WAM). The distribution data available in previous Monroe County lists has been included in the following notes, without citation.

POLYPODIACEAE

Dryopteris marginalis (L.) Gray × **D. spinulosa** (O. F. Muell.) Watt. var. **intermedia** (Muhl.) Underw. Hipp's Brook, Penfield, *M. S. Baxter*, 1917 (R). Fide P. Dowell.

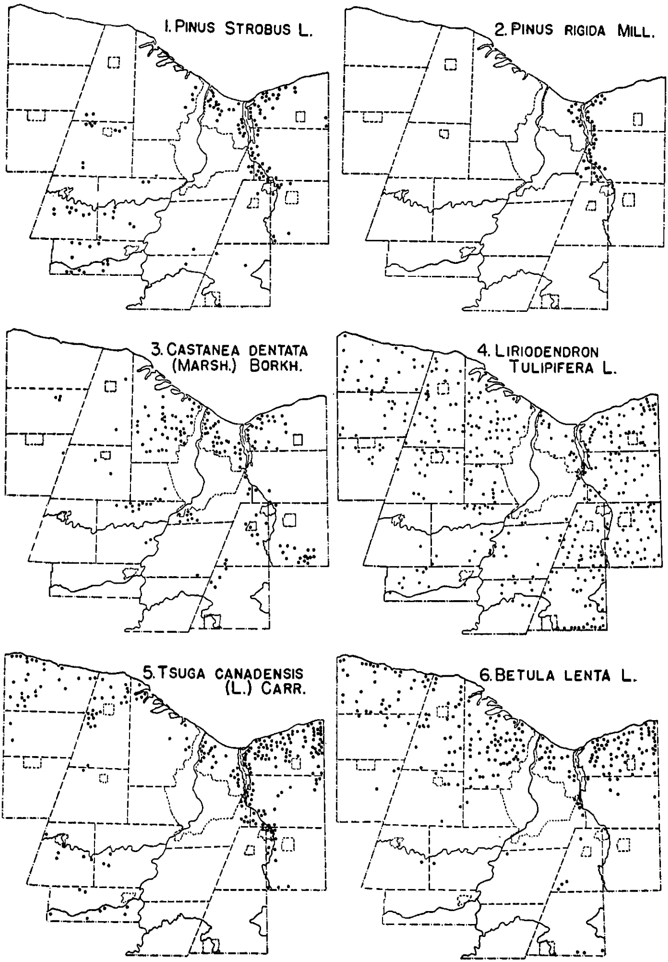
Athyrium pycnocarpon (Spreng.) Tidestr. (*Asplenium angustifolium* of Gray's Man., ed. 7, and of Monroe Co. List.) NARROW-LEAVED SPLEENWORT. Rich moist woods. Adams Basin, *M. S. Baxter*, 1878 (R); Egypt, Perinton, *E. P. Killip*, 1915 (R); south of Fairport, *M. S. Baxter*, 1927 (R); Webster (Edson, 1928). Previously listed from near Rochester, Penfield, Gates, and Brockport.

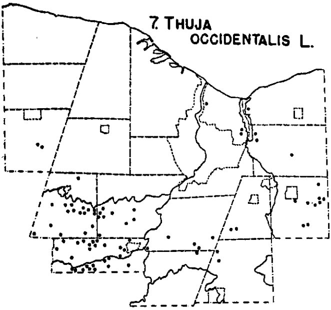
SALVINIACEAE

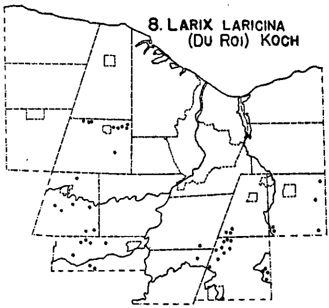
Azolla caroliniana Willd. WATER FERN. Mouth of Sandy Creek, abundant; Irondequoit Bay (R), Round Pond, frequent; Braddock Bay, rare (Clausen, 1940). Previously reported "in all the side waters of Lake Ontario."

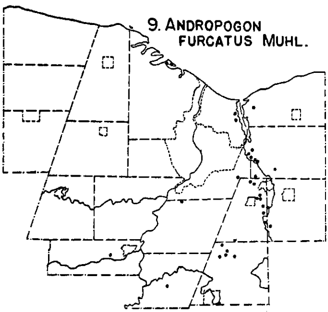
EQUISETACEAE

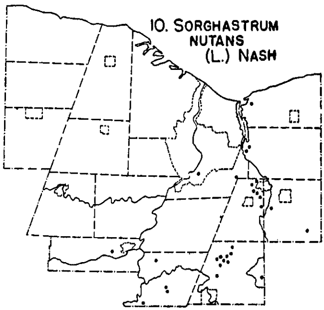
Equisetum fluviatile L. (*E. limosum* of Monroe Co. List.) WATER HORSETAIL. Mendon Ponds Park (R). Previously listed from Rochester, Gates, and Brockport.

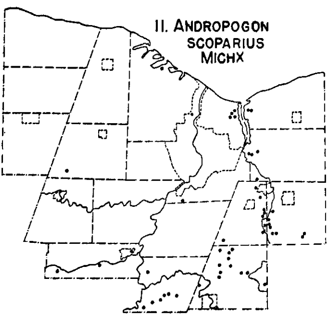

1. PINUS STROBUS L.
2. PINUS RIGIDA MILL.
3. CASTANEA DENTATA (MARSH.) BORKH.
4. LIRIODENDRON TULIPIFERA L.
5. TSUGA CANADENSIS (L.) CARR.
6. BETULA LENTA L.

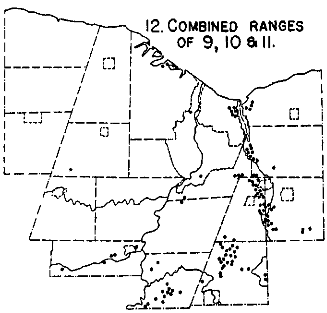

7. THUJA
OCCIDENTALIS L.


8. LARIX LARICINA
(DU ROI) KOCH


9. ANDROPOGON
FURCATUS MUHL.


10. SORGHASTRUM
NUTANS
(L.) NASH


11. ANDROPOGON
SCOPARIUS
MICHX


12. COMBINED RANGES
OF 9, 10 & 11.

Equisetum scirpoides Michx. Seneca Park, *M. S. Baxter*, 1917 (R); growing on stumps, arbor vitae swamp, Riga (R); pastured hillside, Densmore Creek, Irondequoit (R). Previously listed from Greece, Rochester, banks of Irondequoit Creek and Bay, and Webster.

TAXACEAE

Taxus canadensis Marsh. American Yew. Usually associated with hemlock or arbor vitae, either in upland woods or in bogs. Recorded from thirteen widely scattered stations in Hamlin, Parma, Webster, Sweden, Riga, Rush, Pittsford, and Penfield.

PINACEAE

Pinus rigida Mill. Pitch Pine. Map 2. Apparently restricted to the deep sands along Irondequoit Bay and the lower valley of Irondequoit Creek. This is the westernmost county from which the species has been reported in the Ontario plain. Extensive stands occurred on the sand deposits east of the bay and a station on the Pittsford-Perinton town line south of East Rochester was reported in the original land survey notes (Gilbert, 1789). The species may also have been native in Seneca Park, where a number of rather large specimens occur. Previously listed from Irondequoit, Brighton, Penfield, and Webster.

Pinus Strobus L. White Pine. Map 1. Rather widely distributed in the county, occupying habitats of two distinct types. North and east of Rochester its distribution indicates the extent of the oak-chestnut-pine forests of which it was an important constituent. In this area it occurs on dry ridges and sand plains. Elsewhere in the county it is largely restricted to bog forests in association with arbor vitae, tamarack and yellow birch. It has, however, been recorded from the following widely scattered upland sites: Pine Hill, near the Parma-Ogden town line; Widger Road, Ogden; north of Bowen Road, Chili; Burrell Road near Oatka Creek, Wheatland; and Pine Hill near Honeoye Creek, Rush. Now rather widely used in reforestation in the area.

Larix laricina (Du Roi) Koch. (*L. americana* of Monroe Co. List.) Tamarack. Larch. Map 8. Apparently the first tree species to invade open bogs where it persists until drainage occurs or it is shaded out by other species. Restricted to such habitats. Land survey records indicate that it was formerly more widely distributed in the area, but there are no records of its occurrence north of the Ridge.

Tsuga canadensis (L.) Carr. Hemlock. Map 5. Although previously listed as common, it is entirely absent from large parts of the area. Its pattern of distribution near the lake and in the valley of Irondequoit Creek indicates the former extent of hemlock-northern hardwood forests, which were largely restricted to the Lake Iroquois plain, north of the Ridge. With the exception of local stands on Oatka Creek in Wheatland, the stations in the southwestern part of the county are in forested bogs, in association with arbor vitae and white pine.

Thuja occidentalis L. (*Thuya* of Monroe Co. List.) ARBOR VITAE. WHITE CEDAR. Map 7. Largely restricted to bogs underlain with marl from which there is some surface drainage. Such bogs occur in a broad band across the county in the Salina depression, between the Lockport and Onondaga escarpments. The Bergen Swamp, a short distance west of the Monroe County line, belongs to this general type (Stewart & Merrell, 1937). This species is also recorded from upland sites along the Genesee River, Irondequoit Bay and Oatka Creek.

NAJADACEAE[2]

Potamogeton americanus Cham. & Schlecht. (*P. lonchitis* of House; *P. fluitans* of Monroe Co. List.) Irondequoit Bay, rare; Braddock Bay, frequent; mouth of Sandy Creek, common; Mendon Ponds, *M. S. Baxter*, 1921, 1926 (R), common. Also previously listed from the Genesee River and Long Pond.

Potamogeton amplifolius Tuckerm. Hamlin, *E. L. Hankenson*, 1894 (R); Mendon Ponds, *W. A. Matthews*, 1921 (NYS). Previously listed from Irondequoit Bay and Long Pond.

Potamogeton angustifolius Berch. & Presl. Irondequoit Bay, *W. A. Matthews*, 1924 (NYS); Mendon Ponds, *M. S. Baxter*, 1922 (R), common. Probably the early reports of *P. lucens* L. should be referred to this species.

Potamogeton Berchtoldi Fieb. (Rhodora 42: 246. 1940.) (*P. pusillus* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) Braddock Bay, frequent; Mendon Ponds, *M. S. Baxter*, 1923 (NYS), frequent. Previously listed from Irondequoit Bay.

Potamogeton compressus L. (*P. zosterifolius* of Gray's Man., ed. 7, and of Monroe Co. List; *P. zosteriformis* Fern.) Round Pond, Buck Pond, frequent; Long Pond, Cranberry Pond, mouth of Sandy Creek, rare; Braddock Bay, *E. P. Killip*, 1914 (R), common; Mendon Ponds, *M. S. Baxter*, 1922 (R), *W. A. Matthews* (NYS), cited by Fernald (Mem. Amer. Acad. Arts & Sciences 17: 1–183. 1932.), common. Also previously listed from Irondequoit Bay.

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[2] All species of *Potamogeton* and *Najas* in previous Monroe County lists have been included. Records and notes on distribution are those of Clausen (1940) unless otherwise indicated. We are indebted to Dr. W. C. Muenscher for determinations of specimens of *Potamogeton*.

Potamogeton crispus L. Irondequoit Bay, *M. S. Baxter*, 1921 (R), Braddock Bay, rare; Round Pond, frequent. Previously listed from Long Pond.

Potamogeton filiformis Pers. var. **borealis** (Raf.) St. John. (Rhodora 18: 134. 1916.) Outlet of Long Pond, *M. W. Allen*, 1937 (C).

Potamogeton foliosus Raf. (*P. pauciflorus* of Monroe Co. List.) Round Pond, Buck Pond, frequent; Braddock Bay, rare.

Potamogeton Friesii Rupr. Irondequoit Bay, *J. B. Fuller*, 1866 (R), *W. A. Matthews*, 1924 (NYS), cited by Fernald (Mem. Amer. Acad. Arts & Sciences 17: 1–183. 1932.).

Potamogeton gramineus L. var. **graminifolius** Fries. (*P. heterophyllus* of Gray's Man., ed. 7, and of Monroe Co. List.) Mendon Ponds, *M. S. Baxter*, 1921 (R), common. Previously listed as common in Irondequoit Bay.

Potamogeton lucens L. (See note on *P. angustifolius*.)

Potamogeton natans L. Irondequoit Bay and Buck Pond, *M. S. Baxter*, 1921 (R); Round Pond, Braddock Bay, common; Long Pond, rare; mouth of Sandy Creek, Mendon Ponds, *M. S. Baxter*, 1921 (R), frequent.

Potamogeton panormitanus Biv. var. **major** G. Fischer. (*P. pusillus* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) Irondequoit Bay at Newport, *W. A. Matthews*, 1924 (NYS), cited by Fernald (Mem. Amer. Acad. Arts & Sciences 17: 1–183. 1932.); deep water, Braddock Bay, *R. T. Clausen & W. A. Hinkey*, 1939 (C, NYS), rare.

Potamogeton pectinatus L. Irondequoit Bay, *E. P. Killip*, 1915 (R), Round Pond, Braddock Bay, frequent; Buck Pond, Long Pond, Cranberry Pond, mouth of Sandy Creek, rare; Mendon Ponds (R), common.

Potamogeton perfoliatus L. Previously listed as common in the bays, ponds and slow streams. Clausen (1940) doubts the specific distinction between *P. perfoliatus* and *P. Richardsonii*. The early reports should perhaps be referred to the latter species.

Potamogeton praelongus Wulf. Mendon Ponds, *M. S. Baxter*, 1922 (R), common; not reported elsewhere within the county.

Potamogeton Richardsonii (Benn.) Rydb. (*P. perfoliatus* var. *lanceolatus* of Monroe Co. List.) Growing in 3–4 feet of water. Irondequoit Bay, *E. P. Killip*, 1915 (R); Buck Pond, *M. S. Baxter*, 1921 (R), Braddock Bay, mouth of Sandy Creek, rare.

Potamogeton Robbinsii Oakes. Previously listed as common in Irondequoit Bay.

Potamogeton strictifolius Benn. var. **rutiloides** Fern. (Memoirs Gray Herb. 3: 57–60. 1932.) Growing in 2–4 feet of water, Mendon Ponds, *W. Stepka*, 1940 (R), *M. S. Baxter*, 1921 (R, NYS), abundant. This station is cited by Fernald (Mem. Amer. Acad. Arts and Sciences 17: 1–183. 1932.)

Najas flexilis (Willd.) Rostk. & Schmidt. NAIAD. Irondequoit Bay, rare; Round Pond, Buck Pond, mouth of Sandy Creek, frequent; Braddock Bay, Mendon Ponds, *E. P. Killip*, 1915 (R), Bullhead Pond, *R. T. Clausen & W. A. Hinkey*, 1939 (C), common. Previously listed as common.

Najas marina L. LARGE NAIAD. In 3 feet of water, Mendon Ponds, *R. T. Clausen & W. A. Hinkey*, 1939 (C). Formerly in Irondequoit Bay, *G. T. Fish*, 1865 (R); *M. S. Baxter*, 1915 (R, NYS); *E. P. Killip*, 1915 (R), and previously reported.

Najas minor Allioni. Braddock Bay, *R. T. Clausen & W. A. Hinkey*, 1939 (C), frequent.

JUNCAGINACEAE

Triglochin palustris L. ARROW-GRASS. Marly meadows and shores. Mendon Ponds Park (R); north of Langpap Rd., Mendon (R); Blue Pond, Scottsville, *W. A. Matthews*, 1931 (WAM).

ALISMACEAE

Alisma Plantago-aquatica L. var. **parviflorum** (Pursh) Farwell. Muddy stream margin, Mendon Ponds Park (R).

GRAMINEAE[3]

BROMUS COMMUTATUS Schrad. HAIRY CHESS. Adventive, Mendon Ponds Park (R).

BROMUS INERMIS Leyss. SMOOTH BROME GRASS. Corbett's Glen, Brighton, *M. S. Baxter*, 1921 (R); East Rochester, *M. S. Baxter*, cited by House (N. Y. State Mus. Bull. 254: 124. 1924.); Forest Lawn, Webster, *M. S. Baxter*, 1924 (R).

BROMUS MOLLIS L. (*B. hordeaceus* of Gray's Man., ed. 7, and of House.) SOFT CHESS. Adventive in waste ground, Jaeschke's Mill, Bushnell's Basin, *E. P. Killip*, 1919 (R). Previously listed but with no specific location.

FESTUCA CAPILLATA Lam. (*F. ovina* var. *capillata* of Gray's Man., ed. 7.) HAIR FESCUE. Pittsford, *F. S. Boughton*, 1919 (R).

Poa languida Hitchc. (Biol. Soc. Wash. Proc. 41: 158. 1928.) (*P. debilis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) Meadows, Adams Basin, *M. S. Baxter*, 1877 (R); sphagnum bogs, Perinton, *M. S. Baxter*, 1911 (R); woods, Pittsford, *E. P. Killip*, 1919 (R). Previously listed from Irondequoit and Mendon.

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[3] Owing to the large number of misidentifications of *Panicum* all species in this genus in previous Monroe County lists have been included and locality citations have been given whenever specimens were available. The authors are indebted to Mrs. Agnes Chase for identifying all of the specimens cited in this difficult group and a number of specimens in other genera of the Gramineae, as well.

Eragrostis hypnoides (Lam.) BSP. (*E. reptans* of Monroe Co. List.) Wet sand. Henrietta, *M. S. Baxter*, 1908 (R). Previously listed from the shores of Lake Ontario and the banks of the Genesee River and also from Penfield and Greece (Paine, 1865).

Eragrostis peregrina Wieg. (Rhodora 19: 95. 1917.) East Rochester, *M. S. Baxter*, 1923 (R).

ERAGROSTIS POAEOIDES (L.) Beauv. (*E. minor* of Gray's Man., ed. 7; *E. Eragrostis* of House.) Adventive. Pittsford, *F. S. Boughton*, 1917 (R), *M. S. Baxter*, 1921 (R); East Rochester, *M. S. Baxter*, 1920 (R); Charlotte, *W. A. Matthews & D. M. White*, 1931 (WAM); Rochester (R).

CYNOSURUS CRISTATUS L. CRESTED DOGTAIL. Adventive in waste places and cultivated fields. Pittsford, *F. S. Boughton*, 1919 (R). Previously listed from Rochester.

Phragmites communis Trin. (*Phragmites Phragmites* of House.) REED GRASS. Bog, east of Spencerport, Ogden (R); Buck Pond marsh (R). Previously listed from Hamlin, Round Pond and Mendon Ponds.

Triodia flava (L.) Smyth. (*Tridens flavus* of Gray's Man., ed. 7, and of Monroe Co. List.) The previous report from Bushnell's Basin (Proc. Roch. Acad. Sci. 5: 78. 1917.) was based on a misidentification of *Panicum virgatum*.

AGROPYRON SMITHII Rydb. BLUESTEM WHEATGRASS. Cobb's Hill, Rochester, *M. S. Baxter*, 1920 (R); along the railroad, East Rochester, *M. S. Baxter*, 1920 (R), cited by House (N. Y. State Mus. Bull. 243–244: 38. 1923.) under the name *A. pseudorepens*.

Agropyron subsecundum (Link) Hitchc. (Amer. Jour. Bot. 21: 131. 1934.) (*A. caninum* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) BEARDED WHEATGRASS. Mendon Ponds, *G. T. Fish*, 1865 (R). Previously listed as frequent.

Sphenopholis intermedia (Rydb.) Rydb. (*S. pallens* of Gray's Man., ed. 7, and of House; probably *Eatonia pennsylvanica* of Monroe Co. List.) SLENDER WEDGEGRASS. Penfield, *M. S. Baxter*, 1910 (R); Mendon, *M. S. Baxter*, 1921 (R). Previously listed as frequent on moist banks and at the borders of marshes.

Sphenopholis nitida (Spreng.) Scribn. (*Eatonia Dudleyi* of Monroe Co. List.) WEDGEGRASS. Dry wooded hillsides. Around Irondequoit Bay, *M. S. Baxter*, *E. P. Killip*, 1919 (R); Mendon Ponds, *E. P. Killip*, 1919 (R); Woolston's, Perinton, *E. P. Killip*, 1921 (R). Previously listed from the moist bank of the Genesee River.

ARRHENATHERUM ELATIUS (L.) Mert. & Koch. (*A. avenaceum* of Monroe Co. List.) TALL OATGRASS. Roadsides, Mendon, *M. S. Baxter*, 1905 (R). Previously listed from Rochester.

HOLCUS LANATUS L. (*Notholcus lanatus* of House.) VELVET GRASS. Roadside, Mendon Ponds Park (R). Previously listed from Genesee Valley Park and from Rochester.

Calamagrostis inexpansa Gray. NORTHERN REEDGRASS. Marly meadow, Mendon Ponds Park (R).

Sporobolus asper (Michx.) Kunth. East Rochester, *M. S. Baxter*, 1921 (R).

Sporobolus cryptandrus (Torr.) Gray. Cobb's Hill, Rochester, *M. S. Baxter*, 1922 (R). Previously listed from the sandy shore of Lake Ontario.

Sporobolus neglectus Nash. Genesee Valley Park, Rochester, *M. S. Baxter*, 1918 (R).

Leptoloma cognatum (Schult.) Chase. FALL WITCHGRASS. Along the railroad tracks near East Rochester, *M. S. Baxter*, 1920 (R), *D. M. White*, cited by House (N. Y. State Mus. Bull. 243–244: 38. 1923.).

Panicum barbulatum Michx.[8] Near Float Bridge, Irondequoit Bay, *M. S. Baxter*, 1919 (R); dry wooded slopes, Mendon Ponds Park, *R. H. Goodwin*, 1942 (USNM).

Panicum boreale Nash. Sandy fields, Mendon Ponds, *K. M. Wiegand*, 1918 (C). Previously listed from Irondequoit.

Panicum Boscii Poir. Woolston's, Perinton, *M. S. Baxter*, 1920 (R).

Panicum capillare L. WITCHGRASS. A common weed. Previously listed.

Panicum clandestinum L. Previously listed from Penfield. No specimens have been seen.

Panicum commutatum Schult. Rochester, *M. S. Baxter*, 1879 (R). Previously listed from Irondequoit.

Panicum depauperatum Muhl. (Including *P. depauperatum* var. *psilophyllum* Fern.) Irondequoit Bay at Sea Breeze, *M. S. Baxter*, 1917 (R) and at Inspiration Point, *M. S. Baxter*, 1921 (R); East Rochester, *M. S. Baxter*, 1927 (R). Previously listed as frequent within the county.

Panicum dichotomiflorum Michx. (*P. proliferum* of Monroe Co. Lists.) Railroad yards, Rochester, *C. M. Booth*, 1896 (R). Previously listed from Penfield.

Panicum dichotomum L. Dry fields, Perinton, *M. S. Baxter*, 1911 (R); Mendon, *E. P. Killip*, 1915 (R); Irondequoit Bay, *E. P. Killip*, 1919 (R). Previously listed as common within the county.

Panicum huachucae Ashe. Mendon, *M. S. Baxter*, 1909 (R); Long Pond, *M. S. Baxter*, 1919 (R); Seneca Park, Rochester, *M. S. Baxter*, 1920 (R); Buck Pond and Irondequoit Bay, *M. S. Baxter*, 1922 (R); Braddock Bay (R, USNM).

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[8] See footnote, page 307.

Panicum huachucae var. **fasciculatum** (Torr.) F. T. Hubb. (*P. huachucae* var. *silvicola* of Gray's Man., ed. 7, and of House.) Dry sandy field, Mendon Ponds, *K. M. Wiegand*, 1918 (C).

Panicum implicatum Scribn. Woods Crossing, *M. S. Baxter*, 1917 (R); Buck Pond, *M. S. Baxter*, 1922 (R). The specimens previously listed should have been referred to other species.

Panicum latifolium L. (*P. macrocarpon* of Monroe Co. List.) River Bank, near Rochester, *J. B. Fuller* (R); Penfield, *M. S. Baxter*, 1893 (R); dry wooded slopes, Mendon Ponds Park, *R. H. Goodwin*, 1942 (USNM). Previously listed as frequent.

Panicum linearifolium Scribn. Dry wooded slopes, Mendon Ponds Park, *R. H. Goodwin*, 1942 (USNM).

Panicum meridionale Ashe. Penfield, *M. S. Baxter*, 1895 (R).

PANICUM MILIACEUM L. BROOMCORN MILLET. An escape, Rochester, *J. B. Fuller*, 1897 (R), *M. S. Baxter*, 1922 (R). Previously listed from Rochester.

Panicum scoparium Lam. (*P. pubescens* of Monroe Co. List.) Previously listed from Irondequoit. No specimens have been seen.

Panicum Scribnerianum Nash. Penfield, *M. S. Baxter*, 1910 (R); Manitou Beach, *E. P. Killip*, 1915 (R); Pittsford, *F. S. Boughton*, 1919 (R); Inspiration Point, Irondequoit Bay, *M. S. Baxter*, 1921 (R); East Rochester and Buck Pond, *M. S. Baxter*, 1922 (R); Long Pond, Greece, *A. B. Lechenby* (R), *H. D. House* (N. Y. State Mus. Bull. 254: 82. 1924.). Previously listed from Irondequoit and Mendon.

Panicum sphaerocarpon Ell. Penfield, *M. S. Baxter*, 1895 (R); Woolston's, Perinton, *M. S. Baxter*, 1920 (R); Irondequoit, *H. D. House* (N. Y. State Mus. Bull. 254: 82. 1924.); Irondequoit Bay, *M. S. Baxter*, 1922 (R); Mendon Ponds Park (R).

Panicum spretum Schult. Previously listed from Irondequoit. No specimens have been seen.

Panicum subvillosum Ashe. Dry sandy soil. Mendon, *E. P. Killip*, 1915 (R); Inspiration Point, Irondequoit Bay, *M. S. Baxter*, 1921 (R). The Mendon specimens were erroneously reported as *P. implicatum* (Proc. Roch. Acad. Sci. 5: 77. 1917; N. Y. State Mus. Bull. 254: 79. 1924.).

Panicum tennesseense Ashe. Wet meadow, Long Pond, Greece, *E. P. Killip*, 1917 (R).

Panicum tsugetorum Nash. Penfield, *M. S. Baxter*, 1910 (R); Mendon, *M. S. Baxter*, 1918 (R); Inspiration Point, Irondequoit Bay, *M. S. Baxter*, 1921 (R); East Rochester, *M. S. Baxter*, 1927 (R).

Panicum villosissimum Nash. Penfield, *M. S. Baxter*, 1895 (R); sandy hillside in partial shade, Irondequoit, *H. D. House*, 1919 (NYS)

(N. Y. State Mus. Bull. 233–234: 11. 1921; 254: 81. 1924.), *M. S. Baxter*, 1919 (R); Woolston's, Perinton, *M. S. Baxter*, 1920 (R).

Panicum virgatum L. SWITCHGRASS. Bushnell's Basin, *M. S. Baxter*, 1910 (R); railroad tracks, East Rochester, *M. S. Baxter*, 1920 (R). Previously listed as rare, in sandy soil, Penfield. The specimens from Bushnell's Basin were erroneously reported as *Tridens flavus* (Proc. Roch. Acad. Sci. 5: 78. 1917.).

SETARIA LUTESCENS (Wiegel) F. T. Hubb. (*S. glauca* of Gray's Man., ed. 7, and of Monroe Co. List; *Chaetochloa lutescens* of House.) YELLOW BRISTLEGRASS. YELLOW FOXTAIL. Fields, roadsides and waste ground, common. Adams Basin, *M. S. Baxter*, 1878 (R); Rochester, *M. S. Baxter*, 1897 (R); Irondequoit, *F. Beckwith*, 1912 (R); Mendon Ponds Park (R). Previously reported as common. A specimen from Mendon (*E. P. Killip*, 1915 (R)) was erroneously listed as *S. virescens* (Proc. Roch. Acad. Sci. 5: 77. 1917.).

SETARIA VERTICILLATA (L.) Beauv. (*Chaetochloa verticillata* of House.) BUR BRISTLEGRASS. Pittsford, *F. S. Boughton*, 1918 (R). Previously listed from Rochester.

Andropogon furcatus Muhl. TALL BLUESTEM. Map 9. With the exception of the station on the Brighton-Henrietta town line, which represents a recent introduction along a railroad right-of-way, the stations for this species occur on sand or gravel deposits and mark the locations of local prairie communities which occupied openings in the upland oak forests. The Wheatland station is in the Garbutt Cemetery about a mile east of a "great lot" described as "excellent openings" in the original land survey notes (Smith, 1804).

Andropogon scoparius Michx. LITTLE BLUESTEM. Map 11. More widespread and occupying even drier sites. This was the most abundant and characteristic grass of the oak openings. In addition to the sandy and gravelly sites mentioned, it also occurs on thin soils associated with outcrops of the Onondaga limestone near the escarpment in southern Rush and southwestern Wheatland.

Sorghastrum nutans (L.) Nash. (*Chrysopogon nutans* of Monroe Co. List.) INDIAN GRASS. Map 10. Associated with *Andropogon furcatus* and *A. scoparius* in the oak openings and persisting on the same or similar sites. Also present in the marly meadow north of Quaker Pond, Mendon Ponds Park (R).

CYPERACEAE[4]

Cyperus filiculmis Vahl. var. **macilentus** Fern. (Rhodora 37: 153–154. 1935.) Open places in dry sandy soil. Mendon Ponds Park (R). Previously reported as *C. filiculmis* from the region surrounding Irondequoit Bay.

[4] We are indebted to Dr. Henry K. Svenson for the determination of specimens of *Scirpus*, *Cyperus*, and *Eleocharis*, and to Dr. Frederick J. Hermann for the determination of specimens of *Carex*.

Cyperus rivularis Kunth. Mendon, *M. S. Baxter*, 1917 (R), *K. M. Wiegand*, 1918 (C); mud at margin of Quaker Pond, Mendon Ponds Park (R).

Scirpus acutus Muhl. (*S. occidentalis* of Gray's Man., ed. 7, and of Monroe Co. List.) BULRUSH. Buck Pond, *M. S. Baxter*, 1919 (R), Long Pond, Braddock Bay, *M. S. Baxter*, 1917 (R), common; Cranberry Pond, frequent; Irondequoit Bay, *M. S. Baxter*, 1916 (R) and mouth of Sandy Creek, rare; Mendon Ponds (R), common (Clausen, 1940); Ontario Beach, *W. A. Matthews*, 1921 (NYS). Previously listed only from Braddock Bay.

Scirpus atrovirens Muhl. var. **georgianus** (Harper) Fern. (Rhodora 23: 134. 1921.) (*S. georgianus* of Gray's Man., ed. 7.) Mendon, *W. A. Matthews*, cited by House (N. Y. State Mus. Bull. 254: 149. 1924.).

Scirpus pedicellatus Fern. Pittsford, *H. D. House* (N. Y. State Mus. Bull. 254: 151. 1924.); wet depression, Mendon Ponds Park (R).

Scirpus planifolius Muhl. Dry wooded hillsides. Perinton, *M. S. Baxter*, 1911 (R); Mendon Ponds Park (R).

Scirpus polyphyllus Vahl. Boggy woods, Mendon Ponds Park, *R. H. Goodwin & W. Stepka*, 1940 (R).

Scirpus validus Vahl. (*S. lacustris* of Monroe Co. List.) GREAT BULRUSH. Irondequoit Bay, *E. P. Killip*, 1917 (R), Round Pond, frequent; Long Pond, Braddock Bay, *M. S. Baxter*, 1920 (R), mouth of Sandy Creek, rare; Mendon Ponds (R), common (Clausen, 1940). Churchville, *M. S. Baxter*, 1917 (R); Adams Basin, *M. S. Baxter*, 1878 (R); Hamlin, *M. S. Baxter*, 1894 (R). Previously listed as common.

Eleocharis calva Torr. (*E. palustris*, in part, of recent authors.) Margins of ponds. Manitou, *E. P. Killip*, 1915 (R); Woolston's, Perinton, *M. S. Baxter*, 1915 (R); Buck Pond and Long Pond, *M. S. Baxter*, 1919 (R); Pittsford, *E. P. Killip*, 1919 (R); Mendon Ponds Park (R). A collection from Mendon, *E. P. Killip*, 1915, was erroneously reported as *E. rostellata* (Proc. Roch. Acad. Sci. 5: 79. 1917.).

Eleocharis elliptica Kunth. (Rhodora 41: 65. 1939.) Mendon Ponds, *M. S. Baxter*, 1919 (R). Fide H. K. Svenson.

Eleocharis equisetoides (Ell.) Torr. (*E. interstincta* of Gray's Man., ed. 7, and of House.) Growing in 1–2 feet of water, Mendon Ponds, *W. A. Matthews*, 1921, cited by House (N. Y. State Mus. Bull. 243–244: 40. 1923; 254: 136. 1924.); *M. S. Baxter*, 1921 (R, NYS). This was the only known station for this species within the state and it apparently no longer occurs in this locality.

Eleocharis palustris (L.) R. & S. var. **major** Sonder. (Rhodora 31: 61. 1929.) (*E. palustris*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) Cranberry Pond, *M. S. Baxter*, 1922 (R); outlet of Long Pond, *M. W. Allen*, 1937 (C).

Eleocharis pauciflora (Lightf.) Link. (*Scirpus pauciflorus* of Gray's Man., ed. 7, and of House.) Marly marsh-meadow, Mendon Ponds Park (R). Fide H. K. Svenson.

Eleocharis rostellata Torr. Marly meadow, Mendon Ponds Park (R).

Eleocharis Smallii Britton. (*E. palustris*, in part, of recent authors.) Bullhead Pond, *R. T. Clausen & W. A. Hinkey*, 1939 (C), rare.

Fimbristylis autumnalis (L.) R. & S. var. **mucronulata** (Michx.) Fern. (Rhodora 37: 398. 1935.) (*F. Frankii* of Gray's Man., ed. 7; *Trichelostylis autumnalis* of House.) Sandbar, outlet of Irondequoit Bay, *W. A. Matthews*, 1922 (R, NYS), cited by Clausen (1940) as *F. mucronulata* (Michx.) Blake.

Rynchospora capillacea Torr. Lily Pond bog, Bushnell's Basin (R); marly springy places, Mendon Ponds Park (R). Collected periodically since 1878 at Mendon Ponds by *M. S. Baxter*. Previously reported from the banks of the Genesee River at Rochester.

Carex albursina Sheldon. (*C. laxiflora* var. *latifolia* of Gray's Man., ed. 7, and of Monroe Co. List.) Rich woods. Palmer's Glen, *H. D. House*, 1917 (N. Y. State Mus. Bull. 205–206: 16. 1919.); Mendon Ponds Park (R). Previously listed as frequent.

Carex alopecoidea Tuckerm. Margin of Little Black Creek, Chili (R). Previously listed from Monroe Co. with no specific location.

Carex blanda Dewey. (*C. laxiflora* var. *blanda* of Gray's Man., ed. 7, and of Monroe Co. List.) Dry woods. Pinnacle Hills, Rochester, *M. S. Baxter*, 1893 (R); Mendon Ponds Park (R). Previously listed from Mendon.

Carex Buxbaumii Wahl. (*C. polygama* of Gray's Man., ed. 7; *C. fusca* of Monroe Co. List.) Marsh meadows, Mendon Ponds Park (R), *H. D. House*, 1917 (N. Y. State Mus. Bull. 205–206: 16. 1919.). Previously reported from the banks of the Genesee River (Greece) by *S. B. Bradley* (Paine, 1865).

Carex canescens L. Sphagnum bog, Mendon Ponds Park (R).

Carex canescens var. **disjuncta** Fern. Sphagnum bog, Mendon Ponds Park (R).

Carex canescens var. **subloliacea** Laest. Mucky margin of sphagnum bog, Mendon Ponds Park (R).

Carex Careyana Torr. Brockport, *M. S. Baxter*, 1897 (R); Pittsford, *M. S. Baxter*, 1922 (R). Previously listed from woods near the Genesee River, Henrietta, and Mendon.

Carex castanea Wahl. Sphagnum bog, Mendon Ponds, *E. P. Killip*, 1917 (R).

Carex comosa Boott. × **C. retrorsa** Schw. Mendon Pond, *M. S. Baxter*, 1911 (R), cited by House (N. Y. State Mus. Bull. 254: 199. 1924.). Previously listed as *C. vulpinoidea* × *C. comosa* (Proc. Roch. Acad. Sci. 5: 80. 1917.).

Carex conoidea Schk. Near Quaker Pond, Mendon Ponds Park, *M. S. Baxter*, 1917 (R). Previously listed from Long Pond.

Carex convoluta Mack. (Bull. Torrey Bot. Club 43: 428. 1916.) Woolston's, Perinton, *M. S. Baxter*, 1917 (R); Palmer's Glen, *H. D. House* (N. Y. State Mus. Bull. 243–244: 38. 1923.); Mendon Ponds Park (R).

Carex cryptolepis Mack. (Torreya 14: 156. 1914.) (*C. flava*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) Wet meadows, Mendon Ponds Park (R), *M. S. Baxter*, 1917 (R).

Carex Davisii Schw. & Torr. Rich alluvial woods, West Rush, *K. M. Wiegand*, 1921 (C), *M. S. Baxter*, 1921 (R).

Carex eburnea Boott. Boggy stream margin, arbor vitae swamp, Riga (R). Previously reported as frequent on dry cliffs along the Genesee River.

Carex exilis Dewey. Marly meadows, Mendon Ponds Park (R).

Carex formosa Dewey. Rush, *M. S. Baxter*, 1920 (R). Previously listed from Seneca Park.

Carex Grayii Carey. (*C. Asa-grayi* of House.) Alluvial woods and meadows. Black Creek, Chili (R); Rush, *M. S. Baxter*, 1920 (R); Mendon Ponds Park, *W. A. Matthews*. Previously reported from near Rochester and from Irondequoit Bay.

Carex grisea Wahl. West Rush, *M. S. Baxter*, 1917 (R); Perinton, *M. S. Baxter*, cited by House (N. Y. State Mus. Bull. 254: 184. 1924.); Chili (R). Previously listed from the vicinity of Rochester.

Carex Haleana Olney. (*C. granularis* var. *Haleana* of Gray's Man., ed. 7, and of Monroe Co. List; *C. Shriveri* of House.) Moist woods, Mendon Ponds Park (R).

Carex hirtifolia Mack. (Bull. Torrey Bot. Club 37: 244. 1910.) (*C. pubescens* of Gray's Man., ed. 7, and of Monroe Co. List.) Jaeschke's Mill, Bushnell's Basin, *M. S. Baxter*, 1921 (R).

Carex Howei Mack. (Bull. Torrey Bot. Club 37: 245. 1910.) (*C. scirpoides* var. *capillacea* of Gray's Man., ed. 7.) Riga, *F. Beckwith*, 1910 (R); mossy hummocks in wet boggy woods, Mendon Ponds Park (R), *M. S. Baxter*, 1917 (R); sphagnum bog near Woolston's, Perinton, *E. P. Killip*, 1921 (R).

Carex Jamesii Schwein. Open woods, near Honeoye Falls, Mendon, *W. A. Matthews*, 1941 (R).

Carex laevivaginata (Kükenth.) Mack. (Rhodora 17: 231. 1915.) (*C. stipata*, in part, of Gray's Man., ed. 7.) Palmer's Glen, *M. S. Baxter*, 1922 (R); Mendon Ponds Park (R).

Carex lasiocarpa Ehrh. (*C. filiformis* of Gray's Man., ed. 7, and of Monroe Co. List.) Marshes, Mendon Ponds, *E. P. Killip*, 1917 (R); lake beach at Long Pond, *M. S. Baxter*, 1919 (R).

Carex laxiflora Lam. Dry woods. Palmer's Glen, *E. P. Killip*, 1917 (R); Mendon Ponds Park (R). Previously listed as frequent.

Carex leptonervia (Fern.) Fern. Dry woods, Pittsford, *M. S. Baxter*, 1895 (R).

Carex livida (Wahl.) Willd. Marsh, Mendon Ponds, *M. S. Baxter*, 1917 (R); *E. P. Killip*, cited by House (N. Y. State Mus. Bull. 205–206: 16. 1919; 254: 178. 1924.).

Carex Muhlenbergii Schk. Dry sandy soil. Jaeschke's Mill, Bushnell's Basin, *E. P. Killip* (R); west of East Rochester, Pittsford (R). Previously listed from near Irondequoit Bay, Braddock Bay, and Mendon Ponds.

Carex Muhlenbergii var. **enervis** Boott. (*C. plana* of House.) Crests of the dry gravelly eskers, Mendon Ponds Park (R). Baxter (Proc. Roch. Acad. Sci. 3: 122. 1896.) reported a form approaching this variety at Mendon Ponds.

Carex pallescens L. Moist meadows. Irondequoit Creek, Penfield, *E. P. Killip*, 1916 (R); Mendon, *M. S. Baxter*, 1917 (R); Little Black Creek, Chili (R). Previously listed from Woolston's, Perinton, and Seneca Park, Rochester.

Carex Peckii E. C. Howe. (*C. Emmonsii* Dewey var. *elliptica* Boott.) Reported from Rochester by *C. Dewey* (Paine, 1865). No specimen has been seen to confirm this report.

Carex prairea Dewey. (*C. diandra* var. *ramosa* of Gray's Man., ed. 7; *C. teretiuscula* var. *ramosa* of Monroe Co. List.) Boggy meadow, Mendon Ponds Park (R).

Carex rugosperma Mack. (Bull. Torrey Bot. Club 42: 621. 1915.) (*C. umbellata*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) Dry sandy soil. Bushnell's Basin, *M. S. Baxter*, 1919 (R); near Irondequoit Bay, Webster, *M. S. Baxter*, 1924 (R).

Carex saltuensis Bailey. (*C. vaginata* of Gray's Man., ed. 7, and of House.) Powder Mills, Perinton, *M. S. Baxter*, 1921 (R); Riga, *M. S. Baxter*, 1921 (NYS). According to Mackenzie (North Amer. Flora 18: 241. 1935.) Bergen Swamp, Genesee Co., is the type locality for this species.

Carex Sartwellii Dewey. Marsh meadows, Mendon Ponds Park (R), *M. S. Baxter*, 1917 (R), 1921, cited by House (N. Y. State Mus. Bull. 243–244: 38. 1923.). Previously listed as rare in Monroe Co.

Carex scabrata Schw. Swampy woods, Riga, *W. A. Matthews*, 1940 (WAM). Previously listed from Rich's Dugway.

Carex siccata Dewey. Dry sandy soil. Penfield, *M. S. Baxter*, 1897 (R); Mendon Ponds, *M. S. Baxter*, 1920 (R); Inspiration Point, Webster, *M. S. Baxter*, 1921 (R); East Rochester, Pittsford (R). Previously listed from Penfield.

Carex strictior Dewey. (Mackenzie, North Amer. Flora 18: 404. 1935.) (Probably *C. stricta*, in part, of Monroe Co. List.) Mendon, *M. S. Baxter*, 1896 (R). Fide F. J. Hermann.

Carex substricta (Kükenth.) Mack. (Rydberg, Flora Rocky Mts. 139. 1917.) (*C. aquatilis*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) Marsh meadows, Mendon Ponds Park (R); Round Pond, *H. D. House* (N. Y. State Mus. Bull. 254: 192. 1924.).

Carex tetanica Schk. Mendon Ponds, *G. T. Fish*, 1868 (R), *H. D. House* (N. Y. State Mus. Bull. 254: 178. 1924.); Woolston's, Perinton, *M. S. Baxter*, 1917 (R).

Carex tonsa (Fern.) Bickn. (*C. umbellata* var. *tonsa* of Gray's Man., ed. 7; *C. umbellata*, in part, of Monroe Co. List.) Dry sandy soil. East Rochester, *M. S. Baxter*, 1911 (R), cited by House (N. Y. State Mus. Bull. 254: 176. 1924.); Penfield, *M. S. Baxter*, 1918 (R); Jaeschke's Mill, Bushnell's Basin, *E. P. Killip*, 1919 (R).

Carex trisperma Dewey var. **Billingsii** Knight. Sphagnum bog, Mendon Ponds Park (R), *M. S. Baxter*, 1906 (R), *H. D. House* (N. Y. State Mus. Bull. 243–244: 38. 1923.).

Carex Tuckermani Boott. Low woods near Mendon Center, *W. A. Matthews*, 1941 (R). Previously listed from Charlotte, Chili, and Penfield.

Carex umbellata Schk. Dry sandy soil, east side of Irondequoit Bay, *G. T. Fish*, 1865 (R). Previously listed as infrequent.

Carex virescens Muhl. Upland woods. Palmer's Glen, *E. P. Killip*, 1917 (R), *M. S. Baxter*, 1921 (R); near Braddock Bay, Greece (R). Previously listed from near Rochester and from Adams Basin.

Carex Woodii Dewey. (*C. tetanica* var. *Woodii* of Gray's Man., ed. 7, and of Monroe Co. List.) East Rush, *W. A. Matthews*, 1930 (R); Burroughs-Audubon Station, near Powder Mill Park, *E. P. Killip*, 1936 (R).

ARACEAE

Arisaema Stewardsonii Britt. (Britton & Brown, Ill. Flora, ed. 2, 1: 443. 1913.) Boggy woods, Mendon Ponds Park (R). This form has been reduced to a variety of the former *A. triphyllum* (see Fernald's note to this effect in Rhodora 23: 136. 1921.), but in view of the recent change in name of *A. triphyllum* to *A. atrorubens*, Fernald's more recent treatment of this group (Rhodora 42: 247–254. 1940.) has been followed here.

LEMNACEAE

Wolffia columbiana Karst. (*Bruniera columbiana* of House.) COMMON WOLFFIA. Irondequoit Bay (R), Buck Pond, pond on the River Campus of the University of Rochester, Mendon Ponds (R). Previously listed from Irondequoit Bay.

Wolffia punctata Griseb. (*Bruniera punctata* of House; *W. brasiliensis* of Monroe Co. List.) DOTTED WOLFFIA. Irondequoit Bay, Round Pond, Buck Pond, Long Pond, Braddock Bay, mouth of Sandy Creek, Mendon Ponds (Clausen, 1940). Previously listed from Irondequoit Bay.

JUNCACEAE

Juncus alpinus Vill. var. **rariflorus** Hartm. (Rhodora 35: 233. 1933.) (*J. alpinus* var. *insignis* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) Marshes and sandy shores. Hamlin, *M. S. Baxter*, 1894 (R); sandbar, Braddock Bay, *E. P. Killip*, 1915 (R); sandbar, Irondequoit Bay, *M. S. Baxter*, 1916 (R). Previously listed from the mouth of the Genesee River and Long Pond.

Juncus articulatus L. Gravelly shore, Mendon Ponds Park (R); gravel pit southeast of Parma, Greece (R); Brighton (R); Robertson Road, Riga (R); beach at Charlotte (R); sandbar, Braddock Bay (R). Previously listed from near the shores of Lake Ontario.

Juncus bálticus Willd. var. **littoralis** Engelm. Wet meadows, Mendon Ponds Park (R). Previously listed from the sandy shores of Lake Ontario, where it is not uncommon.

Juncus brachycephalus (Engelm.) Buch. Marly meadows, Mendon Ponds Park (R). Previously reported from Mumford by *E. J. Hill* (Bull. Torrey Bot. Club 8: 47. 1881.).

Juncus Dudleyi Wieg. Wet shores and pastures. Mendon Ponds Park (R); Chili (R); Robertson Road, Riga (R).

Juncus Torreyi Coville. (*J. nodosus* var. *megacephalus* of Monroe Co. List.) Riga (R); sandbar, Braddock Bay (R). Previously listed from the wet sandy shore of Lake Ontario and from Long Pond.

LILIACEAE

Chamaelirium luteum (L.) Gray. (*C. carolinianum* of Monroe Co. List.) DEVIL'S BIT. BLAZING STAR. Beech woods, on steep gravelly slopes, Mendon Ponds Park, *G. T. Fish*, 1867 (R). This station still persists. Previously listed from the sandy ridges around Irondequoit Bay.

Trillium cernuum L. var. **macranthum** Wieg. (Rhodora 25: 191. 1923.) Rich moist woods, Coldwater Swamp, Gates, *K. M. Wiegand*, 1924 (C). The typical form of the species has previously been collected and reported from this station.

ORCHIDACEAE

SERAPIAS HELLEBORINE L. (*Epipactis Helleborine* of Monroe Co. List.) Shaded lawns, gardens, roadsides, thickets and woodlands; generally distributed throughout the county, our only weedy orchid. According to House (1924) this species was first recorded from New York State near Syracuse in 1879. It was probably originally introduced from Europe on account of supposed medicinal value. First collected in Monroe Co. near Rochester in 1894, it was subsequently listed from Webster, Forest Lawn, North Rush and South Henrietta and, in 1917, from the east side of Irondequoit Bay, Rattlesnake Point and Hamlin. A note in 1917 (Proc. Roch. Acad. Sci. 5: 63. 1917.) states that this species "in 1910 . . . was still considered scarce" . . . but that in 1917 ". . . it is being found in so many places that we are beginning to consider it almost common." The following additional stations are now reported, but the species can probably be found in a majority of the woodlots within the county. Highland Park, Genesee Valley Park, Rochester; Brighton; Fairport, Bushnell's Basin, Powder Mill Park, Baker Hill, Perinton; Mendon Ponds Park; Greece (R).

SALICACEAE

Salix petiolaris J. E. Smith. Round Pond, *E. P. Killip*, 1917 (R); Mendon Ponds (R), *A. J. Eames*, 1917 (C), *K. M. Wiegand*, 1918 (C); Coldwater Swamp, Gates, *K. M. Wiegand*, 1924 (C). Previously reported from Seneca Park.

Salix serissima (Bail.) Fern. AUTUMN WILLOW. Swamps, Mendon Ponds Park (R), *K. M. Wiegand*, 1918 (C). Previously reported from near Spencerport.

MYRICACEAE

Myrica carolinensis Mill. (*M. cerifera* of Monroe Co. List.) BAYBERRY. Local in bogs and marly meadows, rarely on upland sites. Northeast corner of Ogden; Attridge Road bog, Riga; Mendon Ponds Park; southeastern Mendon. Previously reported from Seneca Park, Parma, Wheatland and Adams Basin.

BETULACEAE

Betula lenta L. SWEET BIRCH. BLACK BIRCH. Map 6. Frequent on the Lake Iroquois plain, north of the Ridge, where it was a characteristic though minor constituent of the hemlock-northern hardwood forest. South of the Ridge it is very infrequent, and usually occurs in bogs or areas of recent bog history. A comparison with the distribution of hemlock (Map 5) indicates the high degree of fidelity to the hemlock-northern hardwood forest type exhibited by this species.

Betula lutea Michx. f. Yellow Birch. Although yellow birch is also a characteristic associate of hemlock in the hemlock-northern hardwood type, and is generally a more important constituent of these mixed stands than sweet birch, it is much less restricted in its distribution. It is known to occur in every town in the county. South of the Ridge it is largely restricted to bogs and swamps, but north of the Ridge it occurs on the upland as well.

FAGACEAE

Castanea dentata (Marsh.) Borkh. (*C. sativa* var. *americana* of Monroe Co. List.) Chestnut. Map 3. This species not only shared dominance in the oak-chestnut-pine forests north of Rochester but also occurred as a minor constituent of the more mesophytic forests of adjacent Greece and Webster, the Mendon Ponds region and the kame region of Perinton. Outlying stations occurred on local sand deposits, such as the area near Lawrence Road in Clarkson, Chestnut Ridge in Chili, and the scattered sandy knolls in Brighton. The chestnut has been almost completely eliminated as a forest tree by the chestnut blight during the last twenty years, but some trees continue to sprout and occasionally bear fruit.

Quercus bicolor Willd. Swamp White Oak. Widely distributed in the better-drained phases of the swamp forest, frequently associated with bur oak and shagbark hickory. Recorded from every town, but infrequent near the lake, in the Irondequoit Bay area and the kame area of southern Perinton.

Quercus macrocarpa Michx. Bur Oak. Mossycup Oak. Widely distributed in the better-drained phases of the swamp forest and occasional on dry sites in the more open oak forests of southern Monroe County. Recorded from every town except Irondequoit but very infrequent near the lake and in the eastern towns.

Quercus montana Willd. (Rhodora 17: 40. 1915.) (*Q. Prinus* of Gray's Man., ed. 7, and of Monroe Co. List.) Chestnut Oak. Local on dry hills in the southeastern part of the county in association with white, black and red oaks. Recorded only from the kame area of southern Perinton and the Hopper Hills of southeastern Mendon. Previously listed from "banks of the Genesee river, ravines and hillsides; infrequent." The Genesee River report is supported by a collection from Seneca Park, *M. S. Baxter*, 1906 (R), but other former collections assigned to this species proved to be *Q. Muhlenbergii.*

Quercus Muhlenbergii Engelm. Yellow Oak. Local in the better-drained phases of the swamp forest and on limestone outcrops. Recorded most frequently from the towns of Wheatland, Rush, Mendon, Riga, Chili, and Henrietta; also on thin soils overlying the Lockport dolomite north of the Ridge, Clarkson; west of Brockport, Sweden; southwest corner of Ogden; west of Elmgrove, Greece; and south of East Rochester, Pittsford. Previously listed from the west bank of the Genesee River, Rochester.

Quercus velutina Lam. (*Q. coccinea* var. *tinctoria* of Monroe Co. List.) BLACK OAK. Widely distributed on dry slopes and uplands. Abundant in the oak forests of the southern part of the county, the Irondequoit valley and town of Irondequoit. Elsewhere infrequent, being absent from typical beech-maple or swamp forest stands. Recorded from every town, but infrequently from Hamlin, Clarkson, Sweden, Parma and Henrietta and the eastern parts of Webster and Penfield.

ULMACEAE

Ulmus racemosa Thomas. (*U. Thomasi* of House.) CORK ELM. ROCK ELM. Widely distributed in the county but of infrequent occurrence except in the southern parts of Rush and Mendon near the Onondaga escarpment. Apparently restricted to calcareous sites, it is the rarest of our three native elms. Not recorded from Clarkson, Ogden, Gates, Irondequoit or Webster. Previously listed from Brighton, Henrietta, and Sweden.

Celtis occidentalis L. HACKBERRY. Principally on low ground near streams in the southwest quarter of the county: near Black Creek in Chili and Riga; near Oatka Creek, Wheatland; near Honeoye Creek, Rush; and near the Genesee River in Wheatland and Henrietta. Previously listed from the east shore of Irondequoit Bay, Webster, where it still occurs, and near the Genesee River, Rochester.

URTICACEAE

Boehmeria cylindrica (L.) Sw. var. **Drummondiana** Wedd. (Rhodora 12: 10. 1910.) (*B. cylindrica* var. *scabra* of Gray's Man., ed. 7.) Marshes, Mendon Ponds Park (R), common. House (N. Y. State Mus. Bull. 243–244: 39. 1923.) cites a specimen collected by *M. S. Baxter*.

SANTALACEAE

Comandra Richardsiana Fern. A previous report of this species from Irondequoit (N. Y. State Mus. Bull. 254: 285. 1924.) should be referred to *C. umbellata*, fide H. D. House.

CHENOPODIACEAE

CORISPERMUM HYSSOPIFOLIUM L. BUG-SEED. Adventive along railroad. East Rochester, *M. S. Baxter*, 1921 (R), cited by House (N. Y, State Mus. Bull. 243–244: 40. 1923.).

AMARANTHACEAE

FROELICHIA GRACILIS (Hook.) Moq. Western adventive along the railroad tracks, East Rochester, *W. A. Matthews*, 1920 (WAM), *D. M. White*, cited by House (N. Y. State Mus. Bull. 243–244: 39. 1923; 254: 303. 1924.).

CARYOPHYLLACEAE

SPERGULA SATIVA Boenn. SPURRY. Adventive in lawn, Rochester (R).

DIANTHUS ARMERIA L. DEPTFORD PINK. Roadside escape. Rochester, *E. P. Killip*, 1913 (R); Mendon Ponds Park (R). Previously listed from Penfield and Gates.

RANUNCULACEAE

Ranunculus hispidus Michx. BRISTLY BUTTERCUP. Sandy upland woods. Irondequoit Bay, *H. C. Maine*, 1881 (R), *D. M. White*, 1917, cited by House (N. Y. State Mus. Bull. 243–244: 39. 1923.); Mendon Ponds Park (R); Bushnell's Basin, *M. S. Baxter*, 1921 (R), cited by House (loc. cit.). Both the species and its var. **falsus** Fern. (Rhodora 22: 30. 1920.) occur at these stations.

Thalictrum revolutum DC. WAXY MEADOW RUE. Dry sandy woods, east side of Irondequoit Bay, *K. M. Wiegand & M. S. Baxter*, 1921 (R), cited by House (N. Y. State Mus. Bull. 243–244: 40. 1923.).

MAGNOLIACEAE

Magnolia acuminata L. CUCUMBER TREE. Rare in the mesophytic upland woods of southeastern Mendon. Recorded from five woodlots, all less than a mile from the county line. Previously reported from Parma in the original land survey notes (Smith, 1805) and in the Monroe Co. List, *M. S. Baxter*, 1878 (R), but it has not been recorded from there in recent years.

Liriodendron Tulipifera L. TULIP TREE. TULIP POPLAR. Map 4. Infrequent but widely distributed throughout the county in mesophytic woods. Recorded from every town in the county, but there are no records from most of Riga, the southern part of Sweden or the southern part of Rush.

ANONACEAE

Asimina triloba (L.) Dunal. PAWPAW. Moist woods, principally near streams, in the western part of the county. Recorded from twenty-seven stations in the towns of Clarkson, Sweden, Parma, Ogden, Riga, and Greece. Previously listed as rare, from Greece, Parma, Brockport, and Adams Basin.

CRUCIFERAE

LEPIDIUM PERFOLIATUM L. PERFOLIATE PEPPERGRASS. Adventive along railroad, Pittsford, *F. S. Boughton*, 1921 (R), *M. S. Baxter*, 1921 (NYS), cited by House (N. Y. State Mus. Bull. 243–244: 40. 1923; 254: 360. 1924.).

CAMELINA MICROCARPA Andrz. FALSE FLAX. Dry fields and roadsides. Riga (R); Mendon (R); Irondequoit, *H. D. House*, 1916 (N. Y. State Mus. Bull. 197: 55. 1918.). Listed from Bergen under the name *C. sativa* (L.) Crantz (Proc. Roch. Acad. Sci. 3: 46. 1896.). No specimen has been found to confirm the report of *C. sativa* from Rochester by Vollertsen (Proc. Roch. Acad. Sci. 5: 85. 1917.).

Rorippa islandica (Oed.) Borbás var. **hispida** (Desv.) Butters & Abbe. (Rhodora 42: 26. 1940.) *Radicula palustris* var. *hispida* of Gray's Man., ed. 7; *Radicula hispida* of House; *Nasturtium palustre* var. *hispida* of Monroe Co. Lists.) HISPID YELLOW CRESS. Sandbar, Braddock Bay, *E. P. Killip*, 1914 (R), *H. D. House*, 1917 (N. Y. State Mus. Bull. 205–206: 25. 1919.). Previously listed from Long Pond and Brighton.

BERTEROA INCANA (L.) DC. HOARY ALYSSUM. Roadside, west of Five Points, Rush (R); Bushnell's Basin, *W. A. Matthews*, 1927 (WAM).

LUNARIA ANNUA L. HONESTY. Roadside escape, Rochester, *R. Warner*, 1942 (R).

ROSACEAE

Spiraea alba DuRoi. (*S. salicifolia*, in part, of Gray's Man., ed. 7, and of Monroe Co. List.) MEADOW-SWEET. Two miles south of Ogden (R). Previously listed from Hamlin, Long Pond, Brighton, and Mendon Ponds.

Amelanchier amabilis Wieg. (Wiegand & Eames, Flora Cayuga Lake Basin, 1926: 247.) (*A. canadensis* var. *rotundifolia*, in part, of Monroe Co. List: *A. grandiflora* Wieg.) Along the Genesee River in the Rochester Parks, *B. H. Slavin*, cited by Wiegand (Rhodora 22: 149. 1920); crest of an esker, Mendon Ponds Park (R).

Amelanchier intermedia Spach. (Rhodora 22: 147. 1920.) Marshes, Mendon Ponds Park (R), *W. A. Matthews*, 1935 (C).

Amelanchier sanguinea (Pursh) DC. (Rhodora 14: 138. 1912.) (*A. spicata* of Gray's Man., ed. 7; *A. canadensis* var. *rotundifolia*, in part, of Monroe Co. List.) Swamps and gravelly crests of the eskers, Mendon Ponds Park (R), *A. J. Eames*, 1917 (C), *B. H. Slavin*, 1922 (HP). Previously listed from the banks of the Genesee River and Irondequoit Bay.

Amelanchier stolonifera Wieg. (Rhodora 14: 144. 1912.) Dry sandy woods. Durand Eastman Park, *K. M. Wiegand*, 1921 (C); Irondequoit Bay at Inspiration Point, *K. M. Wiegand*, 1921 (C), and at Sea Breeze, *K. M. Wiegand*, 1924 (C). Previously listed from Mendon.

Potentilla fructicosa L. SHRUBBY CINQUEFOIL. Calcareous bogs and marshes. Recorded from east of Trabold Road, Gates; frequent in the town of Sweden. Previously listed from Perinton and Mendon, where still abundant, and from Greece.

Sanguisorba canadensis L. (*Poterium canadense* of Monroe Co. List.) CANADIAN BURNET. Swampy thickets. Mendon Ponds Park (R); Powder Mill Park. Previously listed from the following localities: the head of Irondequoit Bay, Penfield; Brighton; two miles east of Pittsford; and one mile west of Fairport.

LEGUMINOSAE

CYTISUS SCOPARIUS (L.) Link. (*Sarothamnus scoparius* of House.) SCOTCH BROOM. Well established in a sandy field, Mendon Ponds Park, *R. Warner*, 1942 (R).

AMORPHA FRUTICOSA L. INDIGOBUSH. FALSE INDIGO. Now well established along the Genesee River at Genesee Valley Park (R), and forming extensive thickets in the Genesee Gorge below the Lower Falls, Rochester. Listed as an escape around Irondequoit Bay in 1896.

Astragalus neglectus (T. & G.) Sheldon. (*Phaca neglecta* of House; *A. Cooperi* of Monroe Co. List.) Open oak woods in gravelly soil, Mendon Ponds Park (R), rare. Previously listed from the bank of the Genesee River at Rochester.

VICIA TETRASPERMA (L.) Moench. Adventive in garden, *M. S. Baxter*, 1876 (R); base of sandy bank, Sea Breeze, Irondequoit Bay, *W. C. Muenscher, K. M. Wiegand & A. H. Wright*, 1924 (C).

VICIA VILLOSA Roth. HAIRY VETCH. WINTER VETCH. Near Fairport, *R. Warner*, 1942 (R); Mendon Ponds Park, *B. H. Leonard*, 1942 (R). Previously listed from Rochester; now a frequent escape.

Lathyrus ochroleucus Hook. CREAMCOLOR PEA. Charlotte, *J. Laird*, 1897 (R); Brighton, *M. S. Baxter*, 1895 (R); Ellison Park, *A. Slater*, 1942 (R). Previously listed from the banks of the Genesee River.

GERANIACEAE

GERANIUM PRATENSE L. Naturalized escape, Garbutt, Wheatland (R).

EUPHORBIACEAE

EUPHORBIA DENTATA Michx. Adventive along the railroad, East Rochester, *D. M. White*, cited by House (N. Y. State Mus. Bull. 243–244: 39. 1923.); East Rochester, *M. S. Baxter*, 1921 (R).

Euphorbia glyptosperma Engelm. Chili, *M. S. Baxter*, 1906 (R). Previously reported from Irondequoit.

ANACARDIACEAE

Rhus Vernix L. (*R. venenata* of Monroe Co. List.) Poison Sumac. A characteristic bog species which invades open bogs and persists until shaded out by the bog forest. Recorded from the Pine Hill area of Parma and Ogden; the northeastern corner of Ogden; the Attridge Road bog, Riga; the Blue Pond area and east of Mumford, Wheatland; from the Mendon Ponds and Powder Mill areas and several bogs in the eastern edge of the town of Mendon.

AQUIFOLIACEAE

Nemopanthus mucronata (L.) Trel. (*Nemopanthes fascicularis* of Monroe Co. List.) Mountain Holly. Bogs west of Harloff Road, Mendon. Previously listed from Mendon Ponds, margin of Irondequoit Bay, Penfield, and Adams Basin.

CELASTRACEAE

Evonymus atropurpureus Jacq. (*Euonymus* of House and of Monroe Co. List.) Wahoo. Stream banks and open areas, principally in the southern part of the county. Northwest and southwest corners of Riga; west of Belcoda, Wheatland; near the Genesee River in Wheatland and Rush; east of Honeoye Falls, Mendon; near Irondequoit Creek, Pittsford; Powder Mill Park, Perinton. Also previously listed from Seneca Park, Greece and Penfield.

ACERACEAE

Acer ginnala Maxim. Escaping in the vicinity of Genesee Valley Park, Rochester (R).

Acer Negundo L. (*Negundo aceroides* of Monroe Co. List.) Box Elder. Well established along the Genesee River at Genesee Valley Park (R). Previously listed from Chili.

Acer pennsylvanicum L. Striped Maple. Moosewood. Recorded from seven woodlots in the hemlock-northern hardwood area between Phillips and Basket roads, Webster, and from the hemlock stand along Hobbie Creek, Irondequoit. Outlying stations occur east of Pine Hill near the south line of Parma and south of Crittenden Road, Brighton. The species is doubtfully native at the Brighton station. Previously listed from Seneca Park and Webster.

RHAMNACEAE

Rhamnus alnifolia L'Hér. Alder-leaved Buckthorn. Bogs, principally over marl. Attridge Road bog, Riga; Thousand Acre Swamp and north of Roseland, Penfield; Henrietta, *G. T. Fish*, 1864 (R); Mendon Ponds Park (R) and bogs in the southeastern part of Mendon. Previously listed in swamps and marshy places.

VITACEAE

Parthenocissus inserta (Kerner) Fritsch. (Jour. Arnold Arboretum 20: 419. 1939.) (*Psedera vitacea* of Gray's Man., ed. 7, and of House; *Ampelopsis quinquefolia*, in part, of Monroe Co. List.) Fence along the roadside, Mendon, *K. M. Wiegand*, 1918 (C); Mendon Ponds Park (R).

HYPERICACEAE

Hypericum boreale (Britt.) Bickn. Bushnell's Basin, *M. S. Baxter*, 1910 (R); moist meadow, Greece, *W. A. Matthews*, 1937 (NYS).

Hypericum majus (Gray) Britt. (*H. canadense* var. *majus* of Monroe Co. List.) Moist pasture, Mendon Ponds, *K. M. Wiegand*, 1918 (C).

CISTACEAE

Helianthemum canadense (L.) Michx. FROSTWEED. Dry sandy oak opening, Mendon Ponds Park (R); Woolston's, Perinton, *E. P. Killip*, 1913 (R). Previously listed from the banks of the Genesee River, Irondequoit, Greece, and Penfield.

VIOLACEAE

Viola striata Ait. Powder Mill Park, *E. P. Killip*, 1915 (R). Previously listed from West Rush and Scottsville.

Viola triloba Schw. Mendon, *E. P. Killip*, 1917 (R), *H. D. House*, 1917 (N. Y. State Mus. Bull. 205–206: 28. 1919.).

THYMELAEACEAE

Dirca palustris L. LEATHERWOOD. Infrequent, but widely distributed in moist woods. Recorded 52 times from 13 towns. No records from Hamlin, Clarkson, Wheatland, Rush, Irondequoit or Webster.

ELAEAGNACEAE

Shepherdia canadensis (L.) Nutt. (*Lepargyraea canadensis* of House.) Rocky outcrops along Oatka Creek southwest of Garbutt, Wheatland. Previously listed from the banks of the Genesee River, the Pinnacle Hills, and the shores of Irondequoit Bay.

LYTHRACEAE

LYTHRUM SALICARIA L. PURPLE LOOSESTRIFE. Braddock Bay (R); barge canal, Brighton. Previously listed from Irondequoit Bay and Palmer's Glen.

CUPHEA PETIOLATA (L.) Koehne. (*Parsonsia petiolata* of House.) CLAMMY CUPHEA. Mendon Ponds, *W. A. Matthews*, 1921 (R), cited by House (N. Y. State Mus. Bull. 243–244: 41. 1923.).

ONAGRACEAE

Epilobium densum Raf. (*E. lineare* of House, and of Monroe Co. List.) Marly marsh meadows, Mendon Ponds Park (R); Ogden, *G. Arnold*, 1910 (C). Previously listed from the banks of the Genesee River, and from Chili.

HALORAGIDACEAE

Myriophyllum exalbescens Fernald. (Rhodora 21: 120. 1919.) (*M. spicatum* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) Water Milfoil. Round Pond, Buck Pond, Braddock Bay, mouth of Sandy Creek, Mendon Ponds (R) (Clausen, 1940). Also previously listed from Irondequoit Bay (R).

Myriophyllum heterophyllum Michx. Round Pond and Braddock Bay, rare (Clausen, 1940). Previously listed from Irondequoit Bay.

Myriophyllum verticillatum L. var. **pectinatum** Wallr. (*M. verticillatum* of House, and of Monroe Co. List.) Mendon Ponds, *M. S. Baxter*, 1922 (R). Previously listed as rare in Irondequoit Bay.

CORNACEAE

Nyssa sylvatica Marsh. Sour Gum. Black Gum. Pepperidge. Rare, but widely scattered, occurring in ten towns. Recorded from single stations in Clarkson, Sweden, Gates and Rush, from two stations each in Parma, Ogden and Mendon, and from four stations in Greece. Previously listed from Seneca Park, Irondequoit, Gates, Chili and Mendon. The Mendon material (R) appears to belong to the var. **caroliniana** (Poir.) Fern. (Rhodora 37: 433–437. 1935.).

ERICACEAE

Rhododendron nudiflorum (L.) Torr. var. **roseum** (Loisel.) Wieg. (Rhodora 26: 4. 1924.) (*R. canescens* of Gray's Man., ed. 7; *Azalea periclymenoides* of House; *R. nudiflorum* of Monroe Co. List.) Pink Azalea. Pinxter Flower. Widely distributed in the county, occurring in swamps and bogs as well as on the acid soils of the upland oak forests. Especially common in the Irondequoit valley, the Mendon and Perinton kame regions and swampy woods in the town of Gates. Not recorded from Hamlin, Clarkson, Sweden, Greece or Rush.

Epigaea repens L. Trailing Arbutus. Mayflower. Recorded only from the eastern half of the county where it is frequent on the acid sands and slopes of the Irondequoit valley and the Mendon and Perinton kame regions. Outlying stations occur in Pittsford, Perinton and Penfield. Previously listed from the dry banks of the Genesee River.

Chiogenes hispidula (L.) T. & G. (*C. serpyllifolia* of Monroe Co. List.) CREEPING SNOWBERRY. Swampy woods, Riga (R), rare.

Vaccinium corymbosum L. var. **glabrum** Gray. (*V. caesariense* of House.) Sphagnum bog, Mendon Ponds, *K. M. Wiegand*, 1918 (C).

PRIMULACEAE

PRIMULA VERIS L. var. MACROCALYX Koch. Naturalized and covering several acres three miles south of Pittsford, *M. S. Baxter*, 1920 (R).

OLEACEAE

Fraxinus nigra Marsh. (*F. sambucifolia* of Monroe Co. List.) BLACK ASH. Widely distributed in the area, occurring in bog forests and the wetter phases of the swamp forest, where the water table is continuously high. Red maple is its most constant associate. Not recorded from the town of Irondequoit and notably infrequent in the region adjacent to Irondequoit Bay and the valley of Irondequoit Creek.

GENTIANACEAE

CENTAURIUM UMBELLATUM Gilib. (*C. Centaurium* of House; *Erythraea Centaurium* of Monroe Co. List.) CENTAURY. Turk's Hill, Perinton, *A. B. Hamman*, 1928 (NYS); Perinton (R). Previously listed from Cartersville, Pittsford.

APOCYNACEAE

Apocynum cannabinum L. var. **pubescens** (Mitchell) A. DC. (*A. pubescens* of House.) INDIAN HEMP. Wet meadows, Mendon, *M. S. Baxter*, 1912 (R).

Apocynum hypericifolium Ait. (*A. cannabinum* var. *hypericifolium* of Gray's Man., ed. 7; *A. sibericum* of House.) Margin of a bog, Mendon Ponds, *K. M. Wiegand*, 1918 (C).

Apocynum medium Greene. Dry fields, Mendon, *M. S. Baxter*, 1912 (R). A recent investigation by Anderson (1936) has shown that the various forms of this "species" are in reality derived from crosses between *A. androsaemifolium* and *A. cannabinum*.

CONVOLVULACEAE

Convolvulus spithamaeus L. Fairport Road, Pittsford (R). Previously listed from the bank of the Genesee River, Rochester.

BORAGINACEAE

MYOSOTIS MICRANTHA Pall. Adventive in a cindered roadbed, Rochester, *W. Stepka*, 1940 (R).

Myosotis virginica (L.) BSP. (*M. verna* of Monroe Co. List.) Sandy hillside, Ellison Park, *A. Slater*, 1942 (R). Previously listed from Irondequoit Bay, Webster, and Penfield.

ECHIUM VULGARE L. BLUE WEED. BLUE DEVIL. A weed of gravelly fields and banks. Hopper Hills, Mendon, *J. Laird*, 1900 (R); Pittsford, *F. S. Boughton*, 1914 (R); Powder Mill Park, *E. P. Killip*, 1915 (R); Baker Hill, Perinton; Mendon Ponds Park (R). Previously listed from Greece, Seneca Park, and Brockport. Considered rare in 1896; now locally abundant.

LABIATAE

SALVIA SYLVESTRIS L. SAGE. An escape on dry open slopes, Mendon Ponds Park (R, USNM).

Lycopus uniflorus Michx. (Apparently *L. virginicus* of Monroe Co. List.) BUGLE WEED. Marshes. Irondequoit Bay, *G. T. Fish*, 1864 (R); Rochester, *M. S. Baxter*, 1895 (R); Pittsford, *E. P. Killip*, 1907 (R); Woolston's, Perinton, *M. S. Baxter*, 1918 (R); Buck Pond, *M. S. Baxter*, 1921 (R); Mendon Ponds Park (R).

SCROPHULARIACEAE

LINARIA MINOR (L.) Desf. (*L. minus* of House.) Adventive along the railroad, East Rochester, *M. S. Baxter*, 1920 (R), *D. M. White*, 1920 (NYS).

PENSTEMON DIGITALIS Nutt. (*P. laevigatus* var. *Digitalis* of Gray's Man., ed. 7, and of Monroe Co. List.) FOXGLOVE PENSTEMON. BEARDTONGUE. Adventive, Mendon Ponds Park (R).

VERONICA BECCABUNGA L. (Including *V. Baxteri* House, N. Y. State Mus. Bull. 233–234: 11. 1921; see Pennell, Acad. Nat. Sci. Philadelphia Monogr. 1: 362. 1935.) EUROPEAN BROOKLIME. Wet meadows, Irondequoit, *M. S. Baxter*, 1915 (R), *A. Suydam*, 1916 (R).

VERONICA LONGIFOLIA L. (*V. maritima* of House.) An occasional garden escape. Mendon, *M. Francis* (R); Henrietta (R).

Pedicularis lanceolata Michx. SWAMP LOUSEWORT. Wet meadows, Mendon Ponds Park (R). Previously listed from the bank of the Genesee River, near Irondequoit Bay, and Irondequoit Creek.

LENTIBULARICAEAE

Utricularia intermedia Hayne. FLAT-LEAVED BLADDERWORT. Pools and sluggish streams in marsh meadows, Mendon Ponds Park (R), *E. P. Killip*, 1917 (R). The Killip collection was originally identified as *U. minor* and was so cited by Clausen (1940). It should be referred to *U. intermedia*, fide R. T. Clausen.

PLANTAGINACEAE

Plantago aristata Michx. (*P. patagonica* var. *aristata* of Monroe Co. Lists.) BRACTED PLANTAIN. Dry sandy crests of the eskers, Mendon Ponds Park (R). Previously listed from Rochester and Woolston Road, Perinton.

RUBIACEAE

Galium boreale L. var. **typicum** Beck von Man. (Rhodora 30: 106–110. 1928.) NORTHERN BEDSTRAW. Mendon Ponds Park (R).

Galium boreale L. var. **hyssopifolium** (Hoffm.) DC. Mendon Ponds Park (R); Penfield, *M. S. Baxter*, 1913 (R).

Galium boreale L. var. **intermedium** DC. Mendon Ponds Park (R).

Galium circaezans Michx. WILD LICORICE. Fernald (Rhodora 39: 449–450. 1937.) distinguishes two varieties of this species: var. *typicum* with "larger leaves 1.5–2.5 cm. long and 0.7–1.4 cm. broad, their nerves beneath sparingly short-hispid to glabrous" and a southerly distribution; and var. *hypomalacum* with "larger leaves 2–5 cm. long and 1–2.5 cm. broad" and a more northerly range. These varieties cannot be clearly separated in Monroe Co. material. About half the specimens appear to be var. *hypomalacum* and the other half lack either the long-hirsute nerves or the large leaf size, but not both.

GALIUM MOLLUGO L. Adventive along the railroad, Egypt, Perinton, *E. P. Killip*, 1915 (R). Previously listed from Gates.

CAPRIFOLIACEAE

Lonicera dioica L. var. **glaucescens** (Rydb.) Butters. (*L. glaucescens* of Gray's Man., ed. 7, and of House; *L. Douglasii* of Monroe Co. List.) East side of Irondequoit Bay, *G. T. Fish*, 1865 (R); west side of Irondequoit Bay, *H. D. House* (N. Y. State Mus. Bull. 254: 651. 1924.); south of Charlotte, *J. Laird*, 1897 (R); Ellison Park, *A. Slater*, 1942 (R). Previously listed from the rocky bank of the Genesee River.

Lonicera oblongifolia (Goldie) Hook. SWAMP FLY HONEYSUCKLE. Bog east of Spencerport, Ogden (R). Previously listed from Adams Basin, Mendon, and Seneca Park.

LONICERA SEMPERVIRENS L. TRUMPET HONEYSUCKLE. Sandy roadside, Mendon Ponds Park (R). Previously listed from Mumford.

CAMPANULACEAE

Campanula rotundifolia L. var. **intercedens** (Witasek) Farw. (*C. rotundifolia* var. *arctica* and *C. rotundifolia*, in part, of Monroe Co. List.) HAREBELL. BLUEBELL. Roadside, Webster, *S. H. Burnett*, 1893 (C); Pittsford, *E. P. Killip*, 1912 (R); Mendon Ponds Park (R). Previously listed from the ridges west of Irondequoit Bay.

Campanula uliginosa Rydb. MARSH BELLFLOWER. Marshes, Mendon Ponds Park (R), *G. T. Fish*, 1866 (R). Much of the material previously reported as *C. aparinoides* should probably be referred to this species.

COMPOSITAE

GRINDELIA SQUARROSA (Pursh) Dunal. GUM PLANT. TAR WEED. Dry open pasture south of Woolston's, Perinton, *M. S. Baxter*, 1918 (R). Previously listed from Rochester.

Solidago altissima L. TALL GOLDENROD. Dry fields. Pittsford, *M. S. Baxter*, 1895 (R); Charlotte, *J. Laird*, 1897 (R); Irondequoit Bay, *E. P. Killip*, 1916 (R); Mendon Ponds Park (R).

Solidago canadensis L. var. **Hargeri** Fern. (Rhodora 17: 11. 1915.) (*S. canadensis*, in part, of recent authors.) Dry fields. Adams Basin, *M. S. Baxter*, 1895 (R); Egypt, Perinton, *M. S. Baxter*, 1911 (R); Mendon Ponds Park (R), *K. M. Wiegand*, 1918 (C).

Solidago ohioensis Riddell. Wet marly meadow, Mendon Ponds Park (R), *K. M. Wiegand*, 1918 (C). Previously reported from Rochester and Pittsford.

Helianthus grosseserratus Martens. SAWTOOTH SUNFLOWER. Sandy roadside, Gates (R).

HELIANTHUS SUBRHOMBOIDEUS Rydb. Adventive along the railroad, East Rochester, *D. M. White*, 1920 (R), cited by House (N. Y. State Mus. Bull. 243–244: 39. 1923.).

Bidens frondosa L. var. **anomala** Porter. Summerville, *W. A. Matthews & D. M. White*, 1939 (R).

ANTHEMIS TINCTORIA L. YELLOW CHAMOMILE. Waste land, Rochester, *W. Stepka*, 1940 (R); roadside, Mendon Ponds Park (R).

Petasites palmatus (Ait.) Gray. SWEET COLTSFOOT. Seneca Park, *W. A. Matthews*, 1922 (WAM); swampy woods, Riga, *W. A. Matthews*, 1940 (WAM). Previously listed from the Genesee Valley in the town of Irondequoit.

CENTAUREA JACEA L. var. LACERA Koch. Roadside, Mendon Ponds Park (R).

CENTAUREA JACEA L. var. NIGRA (L.) Briq. (*C. nigra* of Gray's Man., ed. 7, of House, and of Monroe Co. List.) SPANISH BUTTONS. Manitou, 1912 (R); Riga, *F. Beckwith*, 1925 (R). Previously reported from Pittsford.

CENTAUREA JACEA L. var. PRATENSIS (Thuill.) Vis. East of Troutburg, Hamlin, *F. Beckwith*, 1920 (R).

PICRIS HIERACIOIDES L. Roadside weed, Mendon Ponds Park (R). Previously listed from Brighton.

TRAGOPOGON PRATENSIS L. × T. PORRIFOLIUS L. Waste ground, growing among both parent species at several places in Rochester (R, USNM). The characters of this hybrid are intermediate, but the color and size variation of the flowers suggests that back-crosses may occasionally occur. For a genetic study of this complex see Winge (1938).

TARAXACUM LAEVIGATUM (Willd.) DC. (*T. erythrospermum* of Gray's Man., ed. 7; *Leontodon laevigatus* of House.) RED-SEEDED DANDELION. Sandy soil, Braddock Bay (R).

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FAMILIES, GENERA[1] AND COMMON NAMES

[1] All names in *italics* are synonyms.