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Edited by: P. W. Lambley

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Some Effects of Plants on their Neighbours

Introduction

In nature it is unusual to find a plant growing in isolation. It may happen where a small rock crevice offers room for only one plant. It occurs sometimes in harsh conditions where the habitat is hostile to plant establishment and survival. It always occurs, if only briefly, in the earliest stages of the colonisation of any new habitat as the first arrivals stake a claim. In normal circumstances, however, the environment which offers opportunities for growth to one plant, offers them to others of the same or another species, until the environment is blanketed with an unbroken covering of crowded vegetation. Each plant seeks to grow and reproduce, reaching upwards and outwards to gather light, reaching downwards for water and nutrients from the soil, intermingling and jostling and, as the available resources are diminished, competing with other plants. Competition is an important part of the way of life for the majority of plants, from moulds to mosses, from tiny annuals to towering trees.

The essential feature of competition is the presence of a number of individuals drawing upon a pool of resources for growth and development, but where one or more of these resources is in limited supply, the withdrawal of the limited resource will sooner or later deprive other withdrawing individuals, until serious deprivation begins to influence the whole plant population. The pattern of deprivation which develops will depend on a number of variables. At very high densities a stand of even-aged plants may consist of thin, weak individuals, vulnerable to collapse, susceptible to disease, and at risk of total annihilation. Usually, however, and particularly at lower densities, a plant-to-plant variation begins to develop, increasing with the passage of time and as the density stresses build up, until a hierarchy develops with fewer large dominant plants and a larger number of suppressed plants. The place occupied by an individual in the population hierarchy seems to be largely decided by early events — seed size, germination timing, growth rate, growth patterns, response to habitat conditions, etc. In high density stands, suppressed individuals begin to die, and this mortality, which increases in a very regular and predictable way with increasing density, has important controlling and regulating properties.

Plants, however, much more than animals, have the capacity to adjust to density stress by greatly altering the size of the whole plant, or by altering the form or size of the components of the plant body. This plasticity allows the plant to capitalise on a generous environment with ample growth and reproduction, or in response to leaner times it may adapt to competition by reducing the number and size of its parts. This is especially evident in annual plants, partly because they are very plastic and because their short life allows little time to develop hierarchies of survivors, but also because a population frequently shows simultaneous germination and uniform growth.

We can, therefore, discern two broad responses to competition: (a) at lower densities, and particularly for short-lived plants, the deprivations may be fairly evenly distributed between all the diminished individuals in the population; (b) at higher densities, and particularly in the long term, a classically Darwinian situation

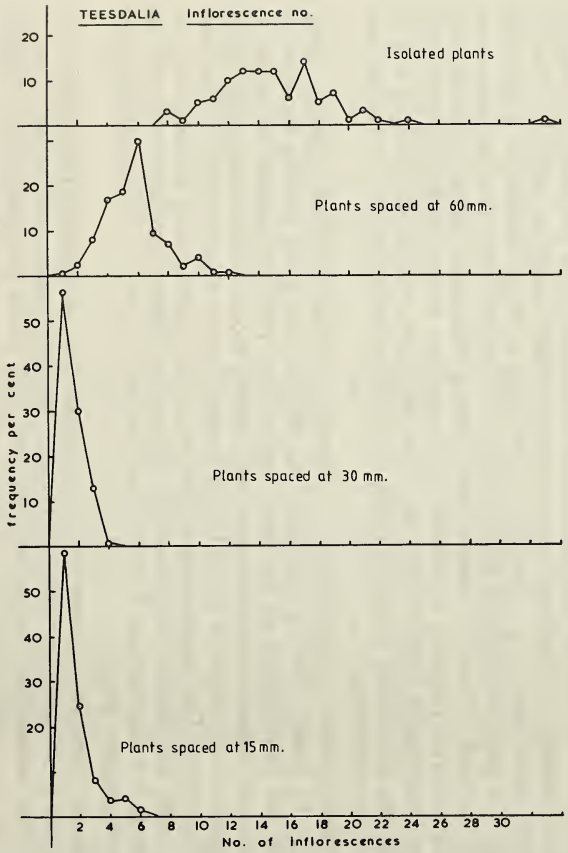

Fig. 1 — *Aira praecox:* Effect of population density on plant diameter.

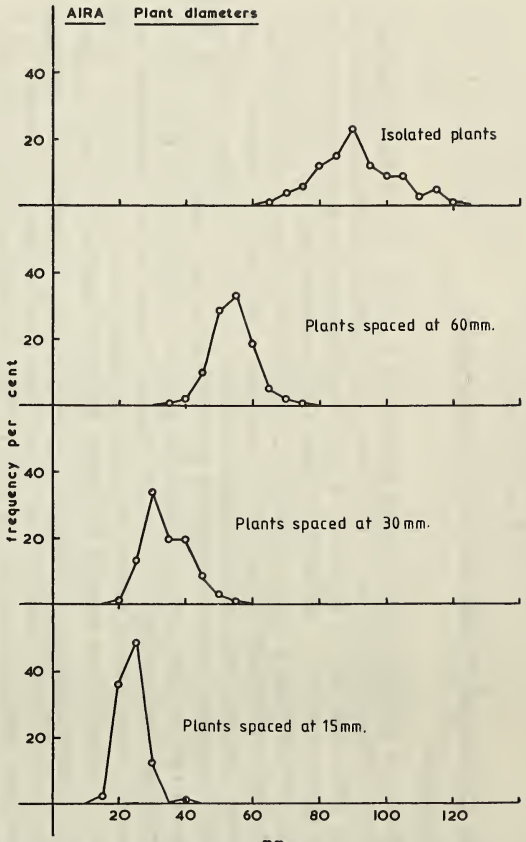

Fig. 2 — *Teesdalia nudicaulis:* Effect of population density on inflorescence number.

develops with the survival of a few dominant plants and the death of a larger number of suppressed plants.

Demand for resources in excess of the environmental supply is part of the general experience of mankind, and an awareness of competitive interaction between plants is likely to have come early in human history. The parable of the sower in Matthew XIII offers a simple illustration of interspecific competition between a crop, presumably wheat or barley, and a weed, believed to be the Star Thistle (*Centaurea calcitrapa* L.). Undoubtedly the formulation of the idea of plant competition advanced with the development of agriculture and forestry, particularly in respect of seeding rates, influence of density on yields in pure stands, the impact of weeds, response to growth in mixtures, and so on, but it was not until this century that biologists began to study the mechanisms of competition in nature, attempting to unravel the processes of interaction between competing plants. The following five investigations were undertaken as a small contribution to the work in this field.

Investigations

1. Density responses of two winter annuals.

Two species of winter annual, the Early Hair-Grass (*Aira praecox* L.) and Shepherd's Cress (*Teesdalia nudicaulis* (L.) R. Br.) which occur together on heaths and in dry, sandy fields, were grown in a series of densities (for intraspecific effects) and a variety of patterned mixtures (for interspecific effects). The plants were grown under cold greenhouse conditions using seed gathered from a Breckland heath, started into growth in late October/early November and planted out in late November. The soil for the investigation was collected from the same heath, steam-treated and, upon analysis, shown to be deficient in all the major and minor plant nutrients compared to a medium loam. Each species was grown in a series of densities — some in isolation to determine potential, and others in experimental populations of 100 plants at spacings of 6 cm, 3 cm and 1.5 cm between individuals. The plants were grown through the winter, flowering in March-April and fruiting in April-May. A number of measurements was made, including plant diameters, plant heights, length of time to flowering, inflorescence numbers and seed numbers.

By mid-January the closest plants were in contact, and a yellowing of older *Aira* leaves and reddening of older *Teesdalia* leaves at higher densities (neither colour change being apparent in widely spaced plants) suggested a developing competition for mineral nutrients. The *Aira* plant diameters (Fig. 1) ranged from a mean of 91 mm in isolation down to 23 mm at 1.5 cm spacing, and *Teesdalia* similarly ranged from 98 mm to 26 mm, although in both cases the diameter reduced by decreasing intervals as the available area decreased, suggesting that the plasticity of the plants diminished as the competitive pressures increased. In *Aira* there was a small but significant delay of 3-5 days between flowering at high density and at low density, possibly because the greater nutrient availability to plants at lower densities prolonged vegetative growth and delayed inflorescence initiation. There was no comparable delay in *Teesdalia*. So far as reproductive effort was concerned, the number of inflorescences per plant varied from 124.02 to 9.57 in *Aira* (a factor of 12.96) and from 14.92 to 1.74 in *Teesdalia* (a factor of 8.57) (Fig. 2); and the number of seeds per plant varied from 3,903.05 to 98.55 in *Aira* (a factor of 39.60) and from 1,120.15 to 28.57 in *Teesdalia* (a factor of 39.21).

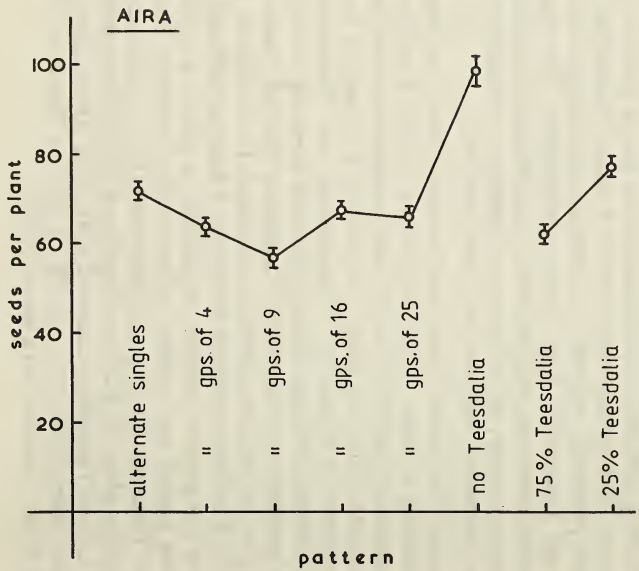

Fig. 3 — *Aira praecox:* Seed yield in intraspecific and interspecific competition.

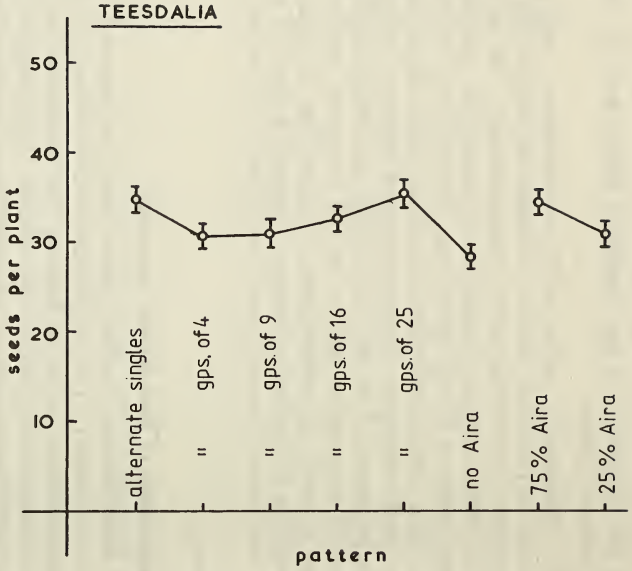

Fig. 4 — *Teesdalia nudicaulis:* Seed yield in intraspecific and interspecific competition.

The two species were at the same time grown in a range of mixtures, all in experimental populations of 100 plants and at spacings of 1.5 cm. The mixtures contained equal numbers of the plants of each species, but the patterning ranged from single plants alternating in row and file (so that each individual was immediately surrounded by four plants of the other species), through alternating blocks of four plants (with each individual immediately surrounded by two like and two unlike plants), alternating blocks of nine plants, of 16 plants and of 25 plants. Other mixtures were unequal, containing either 75 *Aira* plants with 25 *Teesdalia* plants, or vice versa. In a set of complex results, the chief feature was that in all the mixtures, the seed production of *Aira* was significantly lower (62.62 to 77.20 seeds per plant) than when growing on its own (98.55 s.p.p.) (Fig. 3), while the seed production of *Teesdalia* was significantly higher in the mixtures (30.73 to 35.52 seeds per plant) than on its own (28.57 s.p.p.) (Fig. 4). However, this depression of *Aira* seed yields in mixtures with *Teesdalia* may be partly offset by an observed increase of the incidence of sterile and aborted capsules in *Teesdalia* when grown with *Aira*.

2. Density response of two perennials

In its brief life the annual is hurried through its vegetative phase, gathering such resources as the environment offers and converting them into a single flowering and fruiting before dying. In the case of the perennial, however, there is more time, so that a more leisurely approach to seed production may be enjoyed, and there may also be opportunities for investing resources in vegetative as well as sexual reproduction.

Two herbaceous perennials of dissimilar habit — Couch Grass (*Elymus repens* (L.) Gould = *Agropyron repens* (L.) Beauv.) and the Great Plantain (*Plantago major* L.) were grown in populations at each of two densities and at each of two levels of nutrient supply. Seeds of Couch Grass were collected from rough grassland overlying a disused rubbish tip, and seeds of the Great Plantain were taken from heavily trampled grassland adjacent to a supermarket in Earlham Road, Norwich. The seeds were germinated and planted out in early March in numbers sufficient to allow for three successive harvests. The high density plants were spaced 1.5 cm apart, 44 plants in a 12.5 cm pot, the central group of ten plants being used for results, and the pots were sunk rim-deep into the ground. The low density plants were set out in the open ground at a spacing of 20 cm. Half of the sets of plants were grown in the dark fertile loam of a riverside garden, and the other half in a light, poor, dry, sandy soil associated with abandoned gravel workings. The areas were about 200 metres apart and both had a history of cultivation. Groups of plants were harvested in June, July and August, the plant material being washed free from soil, divided into its component parts, oven-dried and weighed.

In *Elymus* there was a great disparity in size, the dry weights of plants enjoying the best, and plants subjected to the worst, environmental conditions differing by a factor of 50. Despite this great capacity for absorbing the impact of stress by making growth adjustments, the percentage distribution of dry weight between parts of the plant showed a remarkable similarity (Fig. 5). The proportion of dry weight devoted to rhizomes is similar in all groups, and since the mean primary rhizome length is similar, the more privileged plants increased their stolon investment by increasing stolon numbers and/or by patterns of branching into secondary rhizomes. Plants in the low-density/high-nutrient group, however, invested heavily in

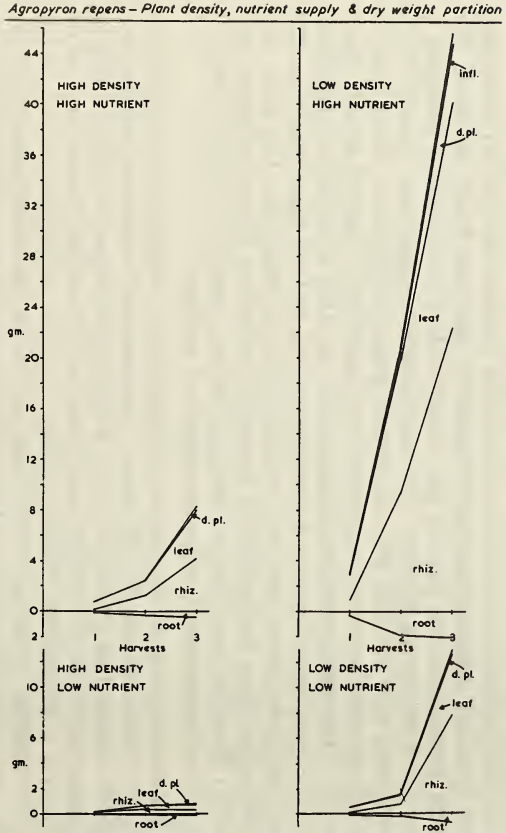

Fig. 5 — *Elymus repens* (= *Agropyron repens*): Variation in amount and distribution of dry weight in relation to population density and nutrient supply.

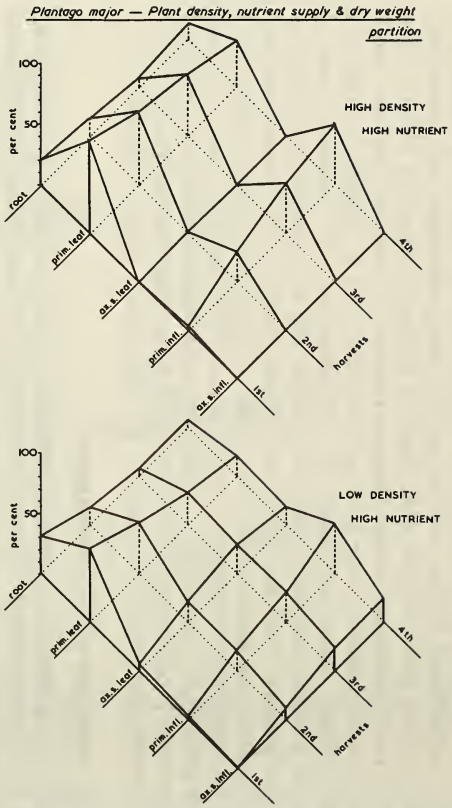

Fig. 6 — *Plantago major:* Percentage distribution of dry weight between roots, primary leaves, axillary shoot leaves, primary inflorescences and axillary shoot inflorescences in relation to population density.

reproductive structures. Each of the plants in this most favoured group formed on average over thirty daughter plants compared to less than three in the plants of other groups. These daughter-plants were considerably heavier than those of the less-endowed groups, and a greater proportion of the available resources was invested in them. The most dramatic result was the complete failure of plants in three of the four groups to form inflorescences: instead of a graded plasticity, the stresses imposed by high densities or by nutrient deficiency were met by a complete failure to flower or form seed.

In *Plantago*, also, the most impressive response to density and nutrient stress was a reduction in size, dry weight reducing by a factor of about 45 between the two extreme treatments. Unlike *Elymus*, however, there were significant redistributions of weight. In the low-nutrient groups about two-fifths of the plant weight was devoted to the roots, while other groups invested about one-fifth falling to one-tenth. The low-density/high-nutrient group used its ample resources to make more and bigger leaves, but the major difference was given by the growth of axillary shoots which provided a very useful alternative site for investment. In the mature plant, half the leaf weight is accounted for in the leaves of the axillary shoots, but there were virtually no axillary shoots formed in other groups. In addition, inflorescences growing from the axillary shoots accounted for about half the inflorescence number of the total formed by the plant (Fig. 6). The effect of this investment, taken with the primary inflorescences, is to raise the total seed production for the low-density/high-nutrient group to an average of 54,000 per plant compared to about 5,000 per plant in the high-density/high-nutrient plants. By contrast the low-nutrient plants could only manage just over 800 seeds per plant in the low-density group and barely more than 200 seeds per plant in the high-density group.

The response of a polycarpic perennial like *Elymus* with adequate means for vegetative spread and reproduction, when faced with adverse circumstances of high plant densities and/or low-nutrient levels, is to postpone flowering and seed production until conditions improve. *Plantago* differs significantly from this pattern, not only seeding prodigiously under favourable circumstances, but still devoting almost one-fifth of its total dry weight to seed production under the most difficult circumstances. In terms of seed production and of reproductive plasticity overall, it behaves almost like an annual plant, and may well be a short-lived perennial plant.

3. Density response of three summer annuals

In the earlier work on annual plants, no account was taken of the distribution of dry weight to the various plant structures. Since the previous investigation had provided detailed results from two perennials, comparable data was sought by growing three summer annuals of different form and habit in a range of three densities in a cold greenhouse pot experiment. The species used were Fern Grass (*Desmazeria rigida* (L.) Tutin = *Catapodium rigidum* (L.) Hubbard), a grass of dry banks, walls, and stony or sandy places: Two-row Barley (*Hordeum distichon* L.) commonly cultivated as a cereal: and Annual Meadow-Grass (*Poa annua* L.) growing in a variety of situations but most commonly on cultivated and waste ground. The seeds were germinated and planted out as follows: low-density — five plants in a 25 cm pot at 6 cm spacing; medium-density — 44 plants in a 25 cm pot at 3 cm spacing, the central ten plants being used for data; high-density — 44 plants in a 12.5 cm pot at 1.5 cm spacing, the central 10 plants used for data. The substrate was a

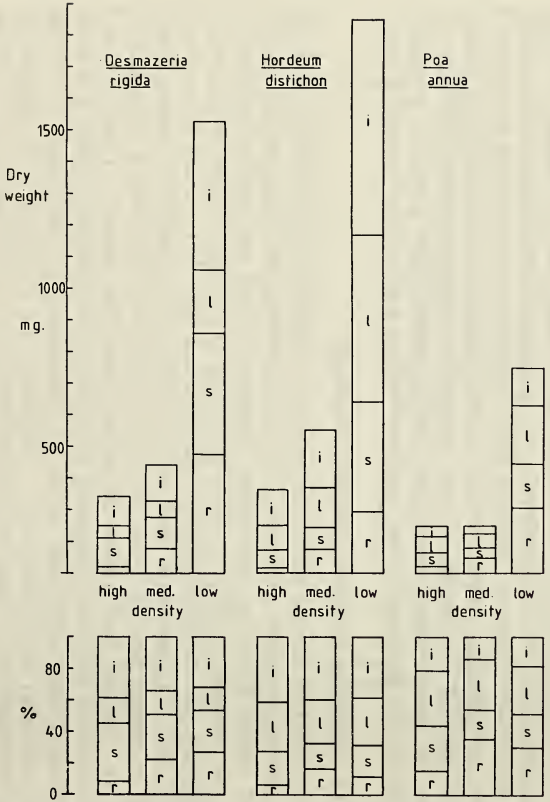

Fig. 7 — *Desmazeria rigida, Hordeum distichon & Poa annua:* Variation in amount, and in real and percentage distribution of dry weight between root, stem, leaf and inflorescence, in relation to population density.

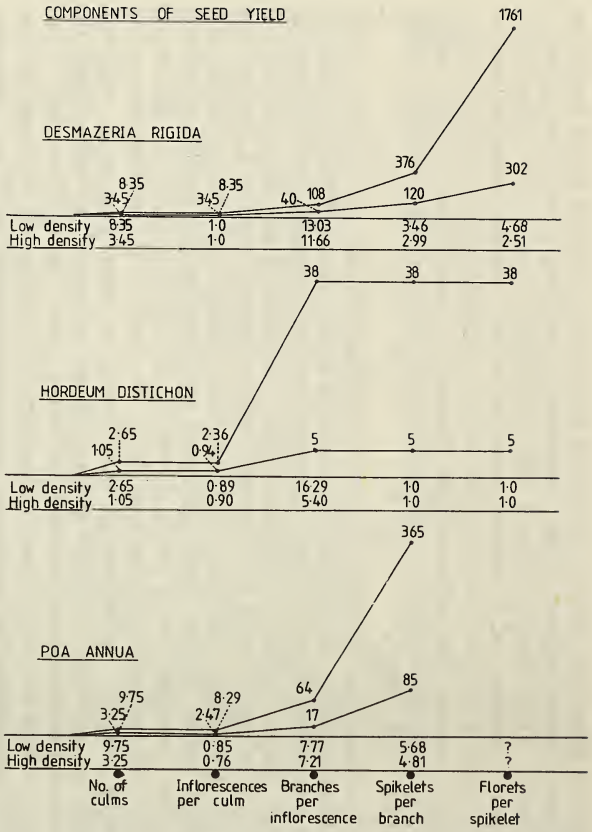

Fig. 8 — *Desmazeria rigida, Hordeum distichon & Poa annua:* Relative contribution of different yield factors in relation to population density.

commercial John Innes compost, and the plantings were made in early May, the plants being harvested at maturity during July and August. Information was collected about plant height, culm or tiller numbers, leaf numbers and lengths, and numbers of inflorescences, inflorescence branches, spikelets and florets and/or seeds. The mature plants were divided into root, stem, leaf and inflorescence, and dry weights were determined.

As Fig. 7 shows, the predictable weight difference between entire plants in low-density and high-density conditions is immediately apparent. In proportionate terms the percentage of mature dry weight made over to the inflorescence was greater in the low-density groups, being 38.3% to 32.6% in *Desmazeria*, 41.9% to 38.7% in *Hordeum* and 20.9% to 18.1% in *Poa*. Considering the weight or number ratios of the three species, i.e. the number of times greater the variable is under low-density than under high-density, the more important comparisons are as follows:

	Desmazeria	*Hordeum*	*Poa*
Root weight	19.2	12.1	9.2
Stem weight	4.2	6.1	3.2
Leaf weight	5.0	6.5	3.5
Inflorescence weight	5.1	6.1	3.8
Leaf number	2.9	1.9	2.7
Inflorescence number	2.4	2.5	2.7
Spikelet number (per plant)	3.1	6.8	3.4

These ratios offer some measure of the plasticity of each of these species in respect of their different parts under the same range of competitive pressures.

The number of seeds, or reproductive units, produced by a plant will depend upon a number of factors, collectively described as the components of yield. Thus a plant may grow one or more stems, each bearing one or more inflorescences, each of which may consist of one or more flowers, each of which may produce one or more fruits, each of which may contain one or more seeds. The number of seeds produced by the plant as a whole will depend on the size of each of these factors. Fig. 8 indicates that there are differences in the pattern of pathways by which the final seed count is determined in the three species, and the investigation also shows that these factors differ significantly in their sensitivity to competition. *Desmazeria* depends more on the number of culms that develop, and less on the florets per spikelet, and spikelets per branch, although these make a contribution. The pattern with *Poa* is similar, although there is a greater proportionate dependence on culm numbers. In the case of *Hordeum*, the tillering response at these densities looks less important than the number of branches per inflorescence, and since there is invariably no more than one floret per spikelet, and one spikelet per branch, there is no opportunity to extend seed production by increasing these.

4. High plant densities and mortality in a winter annual

The responses of the Early Hair-Grass (*Aira praecox* L.) to moderate competition (at a spacing of 6 cm, 3 cm and 1.5 cm between plants) was investigated earlier. Here a further set of investigations was planned to observe the response of the same species to much higher densities such as were likely to induce a significant degree of mortality in the experimental populations. As previously, the seeds and soil were gathered from a Breckland heath: half the populations were grown in the soil as

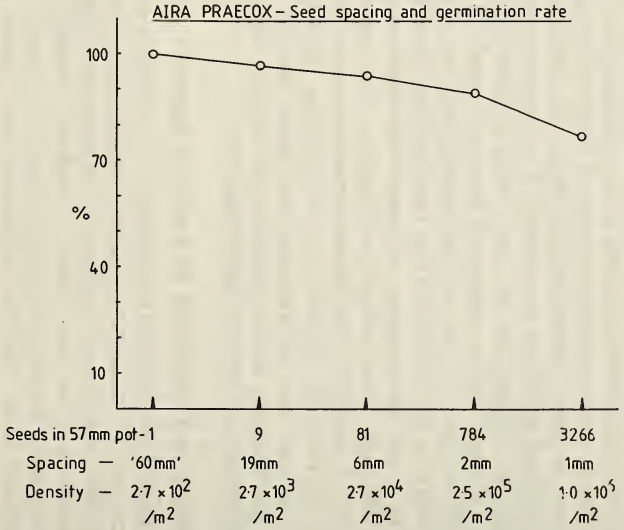

Fig. 9 — *Aira praecox:* Effect of sowing density on germination rate.

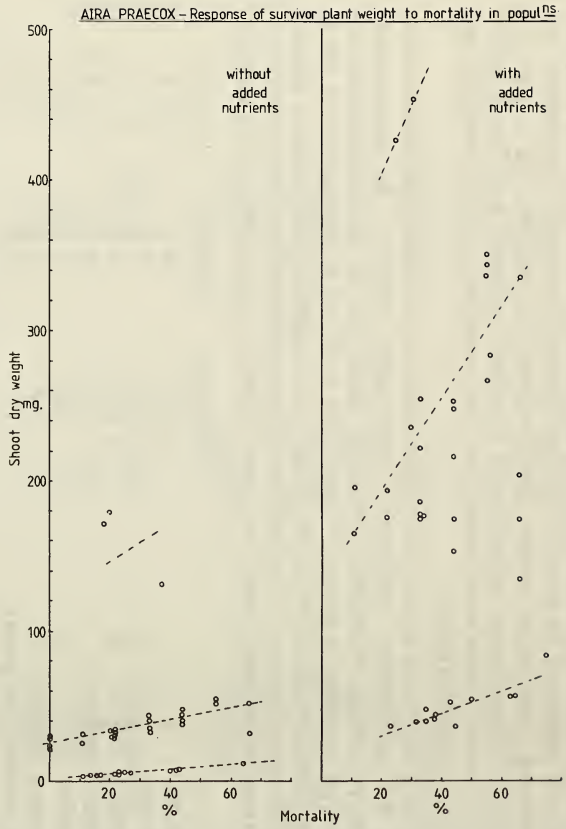

Fig. 10 — *Aira praecox:* Dry weight of survivor plants in relation to mortality following *Pyrenophora* infection of an experimental population.

collected, but half were supplied with added nutrients in the form of a complete soluble fertiliser. Germination levels proved high enough to consider planting ungerminated seed in spaced holes made by patterns of spaced pins in polystyrene planting boards, the seed being transferred on the moistened tip of a fine brush adhering to the seed awn. The investigation was based on the use of 57 mm square plastic pots, and five densities were used:

1 plant per pot, a notional 60 mm apart, equivalent to a density of $2.7 \times 10^2/m^2$ — a total of 96 pots, half with added nutrients.
9 plants per pot, arranged 3 x 3 at a spacing of 19 mm, a density of $2.7 \times 10^3/m^2$ — a total of 48 pots, half with added nutrients.
81 plants per pot, arranged 9 x 9 at a spacing of 6 mm, a density of $2.7 \times 10^4/m^2$ — a total of 24 pots, half with added nutrients.
784 plants per pot, arranged 28 x 28 at a spacing of 2 mm, a density of $2.5 \times 10^5/m^2$ — a total of 12 pots, half with added nutrients.
3,266 (equivalent) plants per pot, although two difficulties were met: the matrix proved too coarse to allow seeds to be inserted at the required spacing of 1 mm, so seeds were distributed over the surface and thinly covered with soil; also the seed numbers demanded for sowing the required 12 pots, half with added nutrient, were too high, so the space was cut down by inserting a glass tube of 25 mm diameter into the centre of the pot and introducing the proportionate number of seeds at 380 per tube; density of $1 \times 10^6/m^2$.

The investigation was set up in early November, with nutrient beginning to be added to half the populations in late November. Germination was 100% in seeds sown in isolation, but as shown in Fig. 9 germination levels dropped steadily as the population densities increased, reaching 76.44% at the highest density used. The experiment was carried out in a cold greenhouse, and the pots were occasionally frozen solid for several periods during December and January. A note on December 10th noted two thin patches in a population, together with fine threads at the soil surface, and by January it was quite clear that a major fungal attack was developing. Material was submitted to Dr. E. A. Ellis who established that the pathogen was *Dreschlera* state of a *Pyrenophora*, most nearly matching *Pyrenophora avenae*, responsible for various leaf-spot diseases in cereals and meadow grasses of many kinds. (It was interesting, although little consolation, to learn that *Aira praecox* had not previously been noted as a host to this fungal parasite).

All populations were sprayed with a fungicide on February 6th but substantial mortality had already occurred. While it was not possible to gather the kind of data originally envisaged, it did prove possible to examine the recovery of the populations after the attack and, as Fig. 10 shows, the dry weight of maturing plants was highest in populations which had suffered the greatest mortality, i.e. survivors profited most from the available resources left in populations which suffered the greatest mortality.

5. Germination timing and competitive effects

It was suggested in the introduction that events in the early stages of the establishment of a population probably have a strong — and perhaps decisive — bearing on the outcome of competitive interaction. One of these early events is the starting into growth of the individual plants in the population. Other things being equal, it seems likely that some advantage would follow an early start, and to test this a set of

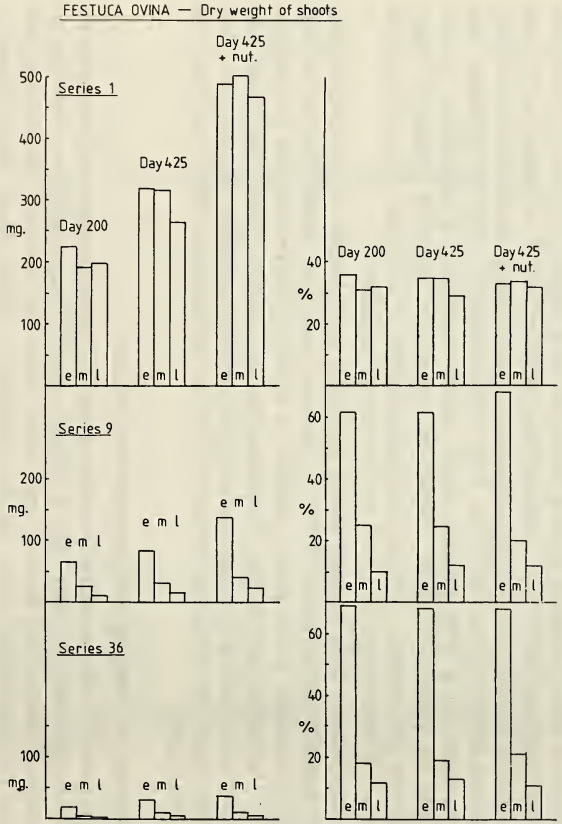

Fig. 11 — *Festuca ovina:* Real and percentage accumulation of dry weight by early, mid and late entrants to experimental populations of 9 and 36 plants.

Fig. 12 — *Festuca ovina:* Relationship between shoot dry weight and flowering behaviour.

investigations using Sheep's Fescue (*Festuca ovina* L.) was set up as follows. Seeds gathered from a Breckland heath were germinated and an early cohort was planted out on March 29th. Another batch of seeds was germinated and a second cohort was planted out ten days later on April 8th, following which a third batch of seeds was germinated and a third cohort was planted out ten days later again on April 18th. The plants were arranged at three densities using 57 mm square plastic pots: (a) 45 pots with one plant in each, for each of the three cohorts; (b) 45 pots with nine plants in each, three of each cohort planted in order; (c) 15 pots with 36 plants in each, twelve of each cohort planted in order. The plants were grown through the summer season in a cold greenhouse, and on October 15th (day 200) one third of the pots were harvested, and subsequently dried and weighed.

The remaining two-thirds of the plants were kept through the winter, and on April 3rd (Day 370) nutrients were applied to half of the remaining pots. After flowering all plants were harvested on May 28th (Day 425), dried and weighed.

It was to be expected that earlier plants might gain some competitive advantage, but it was surprising to discover that a start of only ten days could enable the early cohort of plants to capture enough of the available resources in the mixtures to account for about two-thirds of the total dry weight produced by each pot (Fig. 11). Plants of the second cohort, starting ten days later, finally accounted for about one-fifth of the dry weight, while the later plants produced only about one-tenth. Clearly a very small advantage at the start had, in every case, been converted into a very substantial advantage within a single growing season, and in the longer time could be expected to mark the difference between life and death. The effect of the nutrients added in the second spring added substantially to the dry weights of the recipient plants, although in the mixtures the plants of the three cohorts seemed to profit in proportion to their size, i.e. the added nutrients did little to interfere with the hierarchy which was by that time well established.

A side issue of interest was the flowering behaviour pattern (Fig. 12). *Festuca ovina* is a polycarpic perennial grass, which will delay flower initiation until conditions are right, one of these conditions being plant size. None of the plants grown at the highest density (36 in a 57 mm pot) flowered, and only one of the plants at the intermediate density (9 in a 57 mm pot) flowered, whereas 34 out of 90 (37.8%) of the plants at the lowest density (1 in a 57 mm pot) flowered. Although the addition of nutrients at the beginning of April produced significant increases in the size of plants, it did not much alter the pattern of flowering. Since the inflorescences were probably beginning to be initiated by the time the nutrient was added, the question of flowering or not flowering was probably already decided, although there is a suggestion that some plants receiving nutrients had a greater number of inflorescences than others.

Acknowledgments

I would like to thank Dr. R. L. Jefferies for his co-operation in Expts. 1 & 2; Dr. A. J. Davy for his co-operation in Expt. 3; Elveden Estates Company for permission to collect on their land for Expts. 1 & 4; Dr. E. A. Ellis for identifying the pathogen in Expt. 4; and to my wife and children for their help and forbearance particularly during Expts. 1 & 2.

THE WOODLICE OF NORFOLK

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Introduction

Woodlice are terrestrial crustaceans of the order Isopoda, and are commonly known as slaters, sowbugs or pillbugs. In the British Isles, thirty-four species are considered native or naturalised of which twenty-four are found in Norfolk. Many species are synanthropic, i.e. they occur near man in houses, walls, gardens, farm buildings, glasshouses, dung heaps, rubbish dumps and piles of rubble. Several species are restricted to coastal habitats, a few are confined to damp soil or litter, and many require lime-rich substrates.

Because of these habitat associations, the distribution of woodlice is of considerable interest and a national recording scheme was started by the British Isopoda Study Group in 1969. An atlas of woodlice in the British Isles is to be produced in 1984 (Harding and Sutton, in press). Most of the records used in the present paper resulted from our own fieldwork from 1981 to 1983. In addition we have extracted other records from the data bank at the Biological Records Centre at Monks Wood and have incorporated data from the collection in Norwich Castle Museum. We have also studied the published records of Norfolk woodlice, although some of these require confirmation.* The full data are not present here. Copies are deposited in the data bank at Norwich Castle Museum and at the Biological Records Centre, Monks Wood. Specimens of rare and critical species are in the collections of Norwich Castle and King's Lynn Musuems.

There has been little previously published work on Norfolk woodlice. A. E. Ellis (1942) published a detailed account of the species found at Wheatfen Broad, together with a list from Thorpe St. Andrew. He followed this with faunal lists from localities in Norwich and lists of localities for some interesting species (A. E. Ellis, 1943, 1946). E. A. Ellis (1945) also published records of interesting species, as well as an account of breeding *Metoponorthus pruinosus* in captivity (E. A. Ellis, 1972). More recent papers by P. T. Harding are cited in the accounts of *Eluma purpurascens* and *Halophiloscia zosterae*. The provisional atlas (Harding, 1976a) included a large number of Norfolk records, but our knowledge of the country fauna has increased considerably since then.

Collecting and identification

Because of their crustacean inheritance, woodlice need relatively damp conditions. They shun light and are most easily found by looking under stones or logs or by sieving soil or litter. Some species are more easily found at night when they wander in search of food or shelter. Different techniques need to be used in a range of habitats in order to find all the species. Our apparently common species are really those which are large and live in easily accessible situations (e.g. under a log). Other, supposedly rare species may be very common, but are seldom found because

*Since this paper was written we have learnt that A. E. Ellis deposited his collection in the Zoology Dept., University of Oxford. [Obituary in *J. Conch* **31**: 193-199 (1983).] It is hoped to examine this collection and confirm the identity of Ellis's specimens.

they are very small and live within the soil. Woodlice are very sensitive to changes in humidity and temperature. They migrate down into the soil in winter to escape freezing and in summer to escape desiccation. Spring and autumn are the most profitable seasons for fieldwork, spring being the more favoured because then there are few immatures to confuse the inexperienced collector.

Female woodlice retain their eggs in a fluid-filled brood-pouch where the embryos develop. When the pouch ruptures, miniature almost independent woodlice emerge. Apart from the difference in size, the immatures may be very different in shape, colour and texture, so that it is not always obvious to which species they belong. Even among adult woodlice, a single species can exhibit great variation in colour to further confuse the collector and several of the tiny species can only be identified with certainty by reference to the male genitalia! Despite this, most problems of identification can be overcome quite quickly and field identification is the accepted method of recording for most species. Sutton (1980) is the standard text on woodlice and includes much biological information, as well as a key to most of the British species. The key, which includes some colour plates, is also published separately (Sutton *et al*, 1972) and is available from Publication Sales, Institute of Terrestrial Ecology, 68 Hills Road, Cambridge, CB2 1LA. (Current price £1.00 + p.&p.).

Short descriptions of some of the species are given here and Figs. 1-12 show the range of form which may be found in the Norfolk fauna. Characters used for identification are the shape, colour, pattern and texture of the body, the structure of the uropods (posterior appendages) and antennae, the size and structure of the eyes and overall body size. Anyone wishing to study woodlice should read Sutton (1980), or contact us for practical help and advice. Although the Atlas is in press, the national recording scheme continues and there is still much to be discovered. Anyone who has a keen eye and the inclination to lie on a shingle beach in a hailstorm can make a significant contribution to our knowledge of woodlice in the county.

The Norfolk fauna

The Norfolk woodlouse fauna is enhanced by the inclusion of several coastal species which are rare (i.e. seldom collected) elsewhere in Britain. Apart from these, the fauna is typical of many counties in the south of England, comprising a few totally synanthropic species, many species which are probably under-recorded because they are difficult to collect and a group of common species known to some as the 'Big Five'. These five species — *Armadillidium vulgare, Oniscus asellus, Philoscia muscorum, Porcellio scaber,* and *Trichoniscus pusillus* — are usually easy to find, particularly in synanthropic habitats, and they form the initial target when recording at a new site. Since they have been recorded from nearly every 10 km square in Norfolk we have not produced maps for them. Nor have we produced maps for those species known from only one or two sites in the county. The maps that we have included here reflect habitat preferences for some species but mainly show the areas where we have collected intensively. It is hoped that naturalists in the county will be encouraged to collect in underworked areas and thus improve our knowledge of woodlice distribution.

Two of the richest sites in Norfolk are the authors' gardens and any mature garden may be expected to yield ten species. By contrast heathland may support only two or three species. The following species accounts are arranged alphabetically.

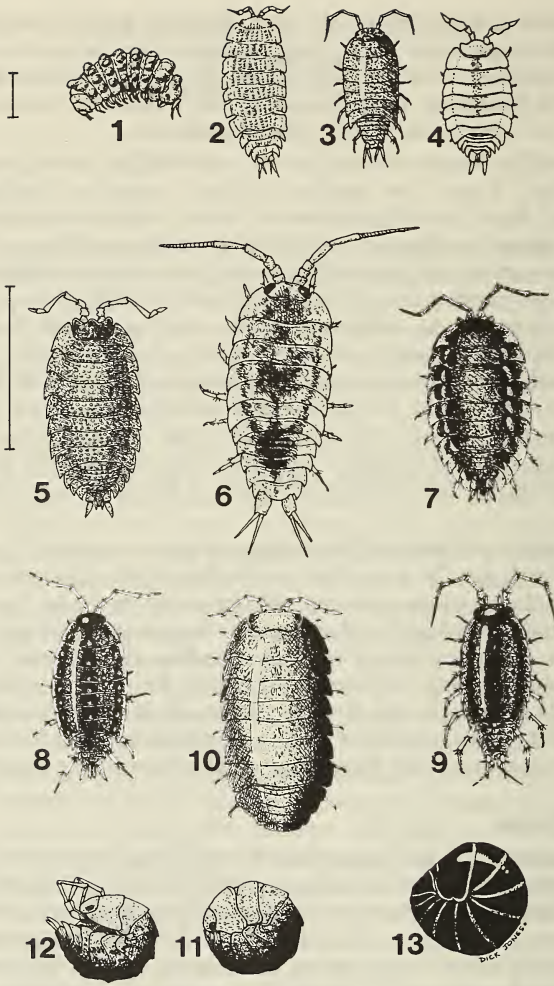
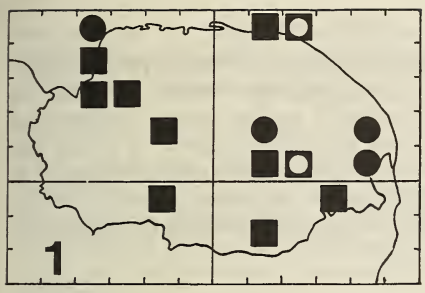


Fig. 1. *Buddelundiella cataractae;*
Fig. 2. *Haplophthalmus danicus;*
Fig. 3. *Trichoniscus pusillus;*
Fig. 4. *Platyarthrus hoffmannseggii;*
Fig. 5. *Porcellio scaber;*
Fig. 6. *Ligia oceanica;*
Fig. 7. *Oniscus asellus;*
Fig. 8. *Philoscia muscorum;*
Fig. 9. *Ligidium hypnorum;*
Fig. 10, 11. *Armadillidium vulgare;*
Fig. 12. *Cylisticus convexus;*
Fig. 13. *Glomeris marginata.*

(Scale lines: Fig. 1-4, 1 mm; Fig. 5-13, 10 mm).



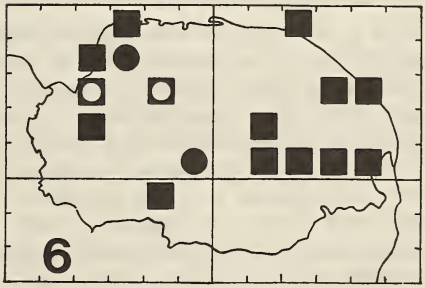
Androniscus dentiger | Cylisticus convexus | Both species

Haplophthalmus danicus | Haplophthalmus mengei | Both species

Ligidium hypnorum | Ligia oceanica | Both species

Metoponorthus pruinosus | Trichoniscus pygmaeus | Both species

Platyarthrus hoffmannseggi



Porcellio spinicornis | Porcellio dilitatus | Both species

Maps 1-6 10 km square distribution of some Norfolk woodlice.

Androniscus dentiger Verhoeff (Map 1)

This is a medium-sized brilliant orange or pink species often with a yellow dorsal stripe. It occurs in synanthropic situations throughout the county. Despite its stunning appearance it is often overlooked because it prefers damp undisturbed habitats. It is often found under objects which are sitting on concrete or brick, and when it is found in soil this is usually clay. *A. dentiger* is also found commonly in coastal cliffs of slumping clay in N.E. Norfolk and is recorded from the stable shingle bank at Snettisham. These may represent natural habitats for this species in Britain.

Armadillidium album Dollfus

A. album is the smallest Norfolk pill-woodlouse. It is white or off-white, speckled with grey and ginger, thus closely matching the sand in which it occurs. A coastal species, it may be found burrowed into the sand and under driftwood along the highest strandlines of dune systems out of reach of all but the highest spring tides. It can also occur in the upper reaches of saltmarshes where these back onto dunes. Although a scarce species nationally, in Norfolk it can be found from Holme to Holkham and is particularly common on Scolt Head. It has not yet been recorded from the dune systems of east Norfolk.

Armadillidium nasatum Budde-Lund

This uncommon pill-woodlouse occurs throughout southern England and Wales although it has only twice been found in Norfolk. The first occasion was reported (as *A. speyeri* Jackson) by A. E. Ellis (1943) who found the species in Daniels' Nurseries and Earlham Park in Norwich. More recently, in 1982, both immatures and adults were found at a stone importer's yard near Aylsham. Quarries throughout England supply this firm so the origin of this colony is unknown.

Armadillidium vulgare (Latrielle) (Figs. 10, 11)

This is the only pill-woodlouse widespread in Norfolk. It is found in a variety of colour forms, the most common of which are shiny slate grey and mottled grey on a pale background. Another frequently found form is orange-red. All of these forms may have yellow speckles along the mid-line. Large individuals may reach 20 mm in length. When rolled up, *A. vulgare* is perfectly spherical, which distinguishes it from similar species, as well as the pill-millipede, *Glomeris marginata* (Fig. 13). Its wide distribution includes grassland, arable, wasteland, gardens, shingle beaches and sand dunes. On beaches it may occur in the higher strandline litter and on sandy beaches it may be found alongside *A. album*. It is notably absent from damp habitats and acid heath.

Buddelundiella cataractae Verhoeff (Fig. 1)

This tiny woodlouse closely resembles a grain of sand when it is rolled up, so it is not surprising that it remained undiscovered in Britain until 1981. The first specimens were found in a garden in Cardiff and the species is synanthropic throughout most of Europe (Oliver, 1983). In March 1982 (during a hailstorm) we were amazed to discover *B. cataractae* in a stable shingle bank at Snettisham. The woodlice were found in densities over 6,000 m^{-2} and were mainly present at 10 to 20 cm depth. The shingle is thinly covered with the grass *Arrhenatherum elatius* and litter from this, together with old buried strandlines, provides the primary food-

source for a large invertebrate community. *Trichoniscus pusillus* and *Haplophthalmus mengei* were also found in large numbers at this site, which is being surveyed in detail at present.

Cylisticus convexus (DeGeer) (Fig. 12; Map 1)

This uncommon pill-woodlouse is not very good at rolling into a ball. Unlike *Armadillidium vulgare* the large antennae are left sticking out. *Cylisticus* is recorded from several synanthropic sites in Norfolk as well as in unstabilised scree below chalk cliffs at Hunstanton and among clay blocks on slumping cliffs at Overstrand. It has also been found in a rotten log lying on saltmarsh beside Breydon Water (East Suffolk).

Eluma purpurascens Budde-Lund

This purple-grey pill-woodlouse is very similar to *Armadillidium vulgare*. However its slender build and waxy bloom on the cuticle are characteristic. Elsewhere in the British Isles it is known from few localities including sand dunes in Dublin and streamside flood refuse in Kent. In Norfolk it was first discovered in 1975 at Overstrand, where the clay scree of the cliffs is colonised by coltsfoot (Harding, 1976b). *Armadillidium vulgare* and *Eluma* both occur here, but the *Eluma* tend to burrow into the soil while the *Armadillidium* remain on the surface.

Halophiloscia zosterae (Verhoeff)

H. zosterae is a medium-sized species which has very long antennae and uropods. It is known from Norfolk from a single specimen collected in a pitfall trap on a sandy beach on Scolt Head. Harding *et al* (1980) give details and also record the species from a shingle ridge in Devon and a gravel beach in Essex. It is probable that this species will be found elsewhere on the Norfolk coast, when suitable collecting strategies have been devised.

Haplophthalmus danicus Budde-Lund (Fig. 2; Map 2)

A small species, *H. danicus* is usually white or off-white but may occasionally be pink. It occurs throughout the county, preferring damp, humus-rich, friable soil. Rotting wood is another favoured substrate, and it is frequently found under the bark of decaying hardwood logs, particularly ash and elm. It has also been recorded from synanthropic situations such as damp, well-rotted straw in barns.

Haplophthalmus mengei (Zaddach) (Map 2)

This species resembles *H. danicus* in all but minute details and it is very occasionally found with it. Although less frequently associated with rotting wood than *H. danicus*, it inhabits the same type of humus rich, friable soil and synanthropic situations. We have not found this species as often as *H. danicus* but the use of sieving techniques on the stable shingle bank at Snettisham have produced numbers approaching 4,000 m^{-2}. The distribution of this species will be better understood when suitable collecting techniques have been employed more widely.

Ligia oceanica (Linneaus) (Fig. 6; Map 3)

The 'sea slater' is the largest of the British woodlice with a head and body length of up to 30 mm. It is littoral in habit, preferring rocky shores where it is commonest around the high tide mark, but it is able to maintain colonies around the Norfolk

coast in sea walls, groynes, quays etc. It penetrates the tidal reaches of estuaries, being found in the River Nene, River Ouse and Breydon Water. There is a single inland record from a woodyard in Norwich in 1964. Individuals may frequently be found under debris on the strandline.

Ligidium hypnorum (Cuvier) (Fig. 9; Map 3)

Superficially resembling *Philoscia muscorum*, this species can be recognised by its large compound eyes and long thin uropods. Like *P. muscorum* it is extremely agile. It occurs in two major types of habitat. The first is river valleys where it occurs in the litter of open and tussocky fens, carr, river banks and poplar plantations. It has also been collected from *Sphagnum*. The second habitat is woodland on heavy clay where it is to be found under logs and in the thin litter layer which accumulates on such soils. It has been recorded from Horningtoft, Wayland and Brooke Woods.

Metoponorthus pruinosus (Brandt) (Map 4)

This is an easily identified woodlouse, being grey (rarely orange) with a distinctive white bloom which is like that of a plum and can be rubbed off. In addition its white feet and pale spots on the antennae are conspicuous. It is possibly not native and is only found in synanthropic situations such as farmyards and gardens, where it is almost invariably associated with old manure or compost heaps. It has also been found in barns and a municipal rubbish tip. Where a suitable habitat occurs it can be very abundant. E. A. Ellis (1972) records his observations on specimens collected from Harford tip.

Oniscus asellus (Linneaus) (Fig. 7)

One of our larger and more common species, it can reach 15 mm in length. Its colour varies from grey to brown with irregular pale markings. These markings may form a weak row of pale dots down each side and the lateral margins are invariably translucent. The back is frequently speckled with yellow. A striking colour form where the grey is replaced by orange has been found in the county on several occasions. *O. asellus* is found everywhere except the shore, dunes and open heath. It is particularly common in woodland where it congregates in large numbers under dead bark.

Philoscia muscorum (Scopoli) (Fig. 8)

This shiny, fast-moving woodlouse displays a great variety of colour forms in browns, greys, reds and yellows. Typically the animal has a dark head and a central dark stripe along the body. It is a widespread species, particularly abundant in grassland, but found in all major habitats in the county.

Platyarthrus hoffmannseggi (Brandt) (Fig. 4; Map 5)

This enchanting little species is blind, white and very broad. It is a common inhabitant of ants' nests where it probably feeds on excreta. It is widely distributed in Norfolk and has been found most frequently with *Lasius niger* but also with *L. flavus, L. umbratus* and *Myrmica rubra.* Occasionally it has been found in soil without ants. Viable ant-free colonies can be maintained for several generations. (R. E. Evans, *pers. comm.)*

Porcellio dilatatus (Brandt) (Map 6)

The inexperienced observer may find it difficult to separate this species from *P. scaber* and thus it has probably been overlooked in the past. It is grey-brown with well defined stripes along each side. All recent records have been from synanthropic situations in West Norfolk where it occurs in and around farm buildings, particularly field barns. A. E. Ellis recorded it from several East Norfolk localities in the 1940's but we have not seen these specimens. In the Collinge collection (Harding, 1977) there are specimens of *P. dilatatus* from Sussex collected by Ellis in 1943, so clearly he was familiar with the species at that time.

Porcellio laevis Latrielle

This very large (up to 18 mm long) shiny brown *Porcellio* is nationally rare. Almost certainly introduced it is found in similar habitats to *Metoponorthus pruinosus.* The only Norfolk colony known at present is in and around the compost heap on the Castle Mound, Norwich. A. E. Ellis collected it from a garden in Thorpe St. Andrew in 1942. He also recorded it from Daniels' Nurseries, Norwich in 1942 and Waxham in 1944 but these specimens have not been traced for confirmation.

Porcellio scaber Latrielle (Fig. 5)

P. scaber is one of the most familiar woodlice and is found commonly in nearly all Norfolk habitats. It is the dominant woodlouse of dry areas such as sand dunes and sandy heaths. It is abundant under the bark of rotten logs and is frequently found climbing trees. The colour of the rough cuticle ranges from a uniform dark grey to pale buff with brown speckles. These colour forms seem to be related to habitat much more than in other species. The very pale forms are typical of sand dunes, and a form which is brick red with or without blue speckles is most often found among piles of soft red bricks.

Porcellio spinicornis Say (Map 6)

This large attractive species is mottled brown and yellow with a dark head. It is native on limestone screes and chalk cliffs but in Norfolk is only found where limestone or lime mortar are used in buildings. Although widely distributed in the county, it seldom occurs in large numbers. It is often found in ruined walls, on doorsteps and even on rooftops!

Trichoniscoides albidus (Budde-Lund)

This tiny species is cream or pink in colour and can only be identified with certainty by examining the male genitalia. There are three Norfolk records — from a roadside ditch at North Tuddenham, in leaf litter from Wayland Wood, and in riverside litter at Tasburgh. There is evidence to show that elsewhere in Britain this species is grossly under-recorded (Rundle, 1979) and it probably occurs in suitable habitats throughout Norfolk.

Trichoniscoides saeroeensis Lohmander

This is a tiny white or pink woodlouse with bright pink eyes. It is occasionally found in caves and mines, but is primarily a coastal species in Britain, living on cliffs and banks above the high water mark. In Norfolk it has only been recorded from the shingle banks at Cley. It occurs on the main bank underneath large concrete and brick blocks, and behind the main bank in stable, sandy shingle at 10 to 20 cm depth.

Trichoniscus pusillus Brandt (Fig. 3)

This is Britain's most abundant woodlouse but being a small soil species, its numbers are often underestimated. The usual colour is reddish brown but certain individuals are a brilliant purple. It is abundant nearly everywhere, but cannot tolerate dry conditions, so migrates into the soil during dry periods. It appears to be absent from sand dunes and heathland.

Trichoniscus pygmaeus Sars (Map 4)

This tiny white or pink soil species is probably one of our more common woodlice but it is difficult to find and thus grossly under-recorded. It prefers slightly damp, friable soil and occurs in woodland, grassland, wasteland and gardens where it may be found by looking under rocks and logs. Large numbers occur within the stable shingle bank at Snettisham.

What next?

The above accounts form an interim statement of our knowledge. Of the ten species in the British Isles but not yet found in Norfolk, three are restricted to rocky western coasts, two are found mainly on limestone, in northern and western Britain, and one is only found in Ireland. Two have a south-western distribution in Britain, but one of these (*Armadillidium depressum*) is found commonly in gardens, so it could possibly be transported to Norfolk. However the two most likely additions are *Trachelipus rathkei* which is frequent on damp calcareous grassland in Huntingdon and looks like a striped *Porcellio scaber*; and *Trichoniscoides sarsi*, a tiny soil species which, though rarely found, occurs mainly in chalk scree and lime-rich friable soil and has been recorded from Cambridgeshire.

Apart from the finding of additional species, there are many exciting areas of study based on the Norfolk fauna. Much of the coastline is unexplored, yet it is essential to know the exact distribution of the rare coastal species if they are to be protected adequately. The habitat distribution of the different colour forms of *Porcellio scaber* would make a rewarding project, particularly for someone who was prepared to undertake breeding experiments to unravel the genetic mechanisms involved. Howard (1962, 1981) has investigated the colour polymorphism of *Armadillidium vulgare* populations near Cambridge.

Dr. Mark Hassall and his team at the University of East Anglia have been researching into the feeding ecology and population biology of several species of Norfolk woodlice, particularly those found on Breckland grass heaths. (Hassall and Rushton, 1982; Rushton and Hassall, 1983a, 1983b). This work provides us with a better understanding of how our common woodlice survive, but it also poses many questions which could well be answered by the amateur naturalist.

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CHANGES IN LAND USE IN THE THURNE CATCHMENT AREA DURING THE PERIOD 1931-32 TO 1973

by R. J. DRISCOLL.

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Introduction

In 1973 the Nature Conservancy commissioned a survey of land use in the coastal part of the catchment area of the River Thurne. Five Internal Drainage Board (I.D.B.) sub-areas were included in the survey (Figure 1) which was part of an investigation of the interrelationships between land use, drainage and the aquatic flora and fauna of the dykes draining the area (Driscoll 1975, Driscoll and Lees 1973).

The field data from the land use survey were used to prepare a set of maps showing land use in the Thurne catchment area, using Ordnance Survey 1:10560 (6 in to 1 mile) maps as the base maps. Four major classes of land use were indicated on the maps, i.e. natural and semi-natural vegetation, arable, grassland and woodland. Each of these classes was subdivided to give a total of twenty-eight subclasses, e.g. 'arable' was subdivided according to crop into wheat, barley, potatoes, etc. As the survey was primarily concerned with agricultural or potentially agricultural land no attempt was made to classify land use in built-up areas.

Maps showing land use in the Thurne catchment area were available from three earlier surveys, the Land Utilisation Survey of Britain (1931-32), the Second Land Utilisation of Britain (1961-62) and the Broadland Land Use Survey (1967). By comparing the results of the four surveys it was possible to describe the changes in land use that had taken place in the five I.D.B. sub-areas studied in 1973 during a period of just over 40 years (1931-32 to 1973).

The four surveys of land use in the Thurne catchment area had all used different classifications of land use. Before the results of the surveys could be compared it was necessary to reclassify them using a single classification. The original classifications varied so much that only a very simple system could accomodate the results of the four surveys. The basic 1973 classification of natural and semi-natural vegetation, arable, grassland and woodland was chosen and the results of the four surveys remapped at a scale of 1:25000 (approximately 2½ in to 1 mile) using this simple classification.

Comparison of the results of the four land use surveys

A set of maps was prepared at a scale of 1:10560 that showed the boundaries of the I.D.B. sub-areas studied and the area of virtually every parcel of land in the Thurne catchment area. The I.D.B. sub-area boundaries were copied from 1:10560 and 1:2500 (25.344in to 1 mile) maps held by Happisburgh — Winterton and Smallburgh Internal Drainage Boards. The areas, in acres, accurate to three decimal places, were taken from the relevant Ordnance Survey 1:2500 County Series maps.

Using this set of maps the areas of the five I.D.B. sub-areas studied were calculated by simply adding up the areas of the parcels of land they contained (Table 1).

Using the maps in conjunction with the set of land use maps described above, the proportion of each sub-area that had been devoted to each class of land use was calculated for each survey (Tables 2-6).

Unfortunately the 1961-62 maps excluded the southern part of Smallburgh I.D.B. sub-area 3 and the 1967 survey had excluded parts of Happisburgh — Winterton I.D.B. sub-areas 1, 2 and 3. The unsurveyed parts of Happisburgh — Winterton I.D.B. sub-areas 1 and 2 corresponded to the coastal dunes and associated areas of fen and heath. As it was unlikely that this area had changed much between 1967 and 1973 the relevant figures for 1973 were substituted for the missing 1967 figures in Tables 2 and 3. The unsurveyed parts of Happisburgh — Winterton I.D.B. sub-area 3 and Smallburgh I.D.B. sub-area 3 included agricultural land and in view of the changes in land use that were known to have occurred during the 1960's, no attempt was made to replace the missing data. Hence the results for 1961 and 1967 were ommitted from Tables 4 and 6 respectively.

Results

The Thurne catchment area consists of low-lying marshland, which is artificially drained by a network of dykes and associated pumps that empty into the river system, and land at a slightly higher elevation which drains naturally. Breaches in the sea defences have caused flooding of the marshes on numerous occasions. The earliest recorded breach occurred in 1287 (Sainty *et al* 1939). During the period covered by the four surveys extensive areas of marshland were flooded twice, in 1938 and 1953 (Harland and Harland 1980).

The five I.D.B. sub-areas surveyed in the Thurne catchment area had a combined area of 4616.450 ha. (Table 1). When the area was first surveyed during 1931 and 1932 it included 2015.920 ha. of arable, 1373.941 ha. of grassland, 1125.156 ha. of natural and semi-natural vegetation and 97.033 ha. of woodland. By 1973 the area of arable had increased to 2271.095 ha., the areas of grassland and natural and semi-natural vegetation had decreased to 1211.616 ha. and 915.346 ha. respectively and the area of woodland had increased to 179.811 ha.

Although changes in land use occurred in all five sub-areas during the period covered by the four surveys, the changes in each sub-area were sufficiently distinct to merit separate description.

Happisburgh — Winterton I.D.B. sub-area 1 (Table 2)

The sub-area consists of a ridge of higher land, which runs through Somerton Holmes and Winterton Holmes, with marshland to the north-west and south and coastal dunes to the east.

When the sub-area was surveyed during 1931 and 1932 the marshland was used mainly for grazing or hay. Arable land was virtually restricted to the ridge of higher ground. A large area near the sea consisted of sand dunes, heath, fen and patches of scrub and woodland.

Between 1931-32 and 1961 there was little change in the pattern of land use in the sub-area. The apparant changes in the areas of natural and semi-natural vegetation and woodland were probably the result of differences in the classification systems used by the two surveys.

Between 1961 and 1967 large areas of marshland near Winterton Holmes and south of Somerton Holmes were converted from grassland to arable. Although the coastal part of the sub-area was not systematically surveyed in 1967, observations made in the area during a survey of coastal dunes (Driscoll and Mather 1968) indicated that the vegetation was very similar to that which was recorded in 1973.

By 1973 much of the marshland that had been improved during the 1960's had reverted to grassland. East of Winterton Holmes some of the scrub that had been recorded in 1961 and 1967 had developed into woodland.

Happisburgh — Winterton I.D.B. sub-area 2 (Table 3)

The sub-area consists of higher land, which is occupied by Horsey village, surrounded by marshland and separated from the sea by a belt of sand dunes.

During 1931 and 1932 arable land was largely restricted to the higher ground. Most of the marshland was used for grazing or hay although several fields near Ford's Farm, south-east of the village, were arable. The coastal part of the sub-area consisted of sand dunes and fen. Several small areas of woodland were dotted about the marshes.

By 1961 most of the woodland had disappeared, having been killed by the 1938 floods (Sainty *et al* 1939, Buxton 1940, 1941). Land use in the rest of the sub-area hardly changed between 1931 and 1961 although some of the marshes near Ford's Farm reverted to grassland.

Between 1961 and 1967 a large area of grazing marsh south of Horsey Mere was flooded and converted to reed bed. The marshes north-east of the village were converted to arable. The coastal part of the sub-area was excluded from the 1967 survey. However, casual observations indicated that no significant changes had taken place in the area since 1961.

Between 1967 and 1973 a number of small areas of marshland were allowed to develop into reed swamp or scrub. Several of these areas occupied the sites of woodland that had been lost in the 1938 floods (see above). The pattern of arable land in 1973 was very similar to the pattern in 1961.

Happisburgh — Winterton I.D.B. sub-area 3 (Table 4)

The sub-area includes a larger proportion of higher land than any of the other sub-areas studied. Three areas of higher ground, on which stand the villages of Waxham, Sea Palling and Hempstead, are separated by Great Moss Fen and Hempstead Marshes, two areas of marshland. Brograve Level is the largest continuous block of marshland in the sub-area.

During 1931 and 1932 the higher land was almost exclusively arable. Although areas of marshland near Poplar Farm, Sea Palling, Lound Farm and Ingham were arable, most of the marshland was under grass. Several areas of woodland were present, the largest of which surrounded Calthorpe Broad.

Between 1931-32 and 1961 improvements in land drainage made it possible to convert part of Brograve Level from grassland to arable and to improve the quality of the grassland that remained. The marshes near Poplar Farm reverted to grassland and the area of arable land in the sub-area as a whole decreased. Several areas of fen near Hempstead Heath and Calthorpe Broad developed into woodland as a result of continued neglect. One of the more significant changes in land use during the period was the construction of an estate of holiday chalets on the coast north-west of Eccles.

Between 1961 and 1967 the marshes near Poplar Farm and most of the remaining area of Brograve Level were converted from grassland to arable. A large part of the sub-area was not surveyed in 1967 and information was not available from other

sources to make up the deficit. Within the area that was surveyed in both 1961 and 1967 there was a considerable increase in the area of arable land.

Between 1967 and 1973 there were no major changes in the pattern of arable land in the area that was common to both surveys. The area of woodland increased and the chalet estate north west of Eccles continued to expand.

Smallburgh I.D.B. sub-area 1 (Table 5)

The sub-area consists of two ridges of higher land which run between Hickling village and Stubb Mill and Eastfield Mill. Marshland lies between and to the north and south of these ridges.

Arable land was virtually restricted to the ridges of higher ground when the sub-area was first surveyed during 1931 and 1932. Extensive areas of fen occurred in the northern part of the sub-area, at Long Gore Marshes, and in the southern part, south of Stubb Farm.

The pattern of arable land hardly changed between 1931-32 and 1961. The area of woodland increased as the vegetation of neglected fen continued to develop. Some of the apparent decrease in natural and semi-natural vegetation and increase in grassland during this period was probably the result of differences in the classification systems used by the two surveys.

Between 1961 and 1967 there was little change in the pattern of arable land. Yet again apparent changes in the areas of grassland and natural and semi-natural vegetation may have been partly due to the use of different classifiation systems. The 1967 results were much closer to the 1973 results than the 1961 results were.

Between 1967 and 1973 several small areas of marshland were converted from grassland to arable, although the area of arable decreased in the sub-area as a whole. Whereas in the past land use had been uniform throughout large tracts of marshland, in 1973 the marshes consisted of a patchwork of arable, grassland and neglected grassland that was reverting to fen. An area of reed bed south of Stubb Mill was being managed on a commercial basis in 1973.

Smallburgh I.D.B. sub-area 3 (Table 6)

The sub-area consists of a small area of higher ground, Heigham Holmes, surrounded by marshland.

When it was first surveyed during 1931 and 1932 the entire sub-area was used for grazing or hay.

Between 1931-32 and 1961 a small area near Heigham Holmes was converted to arable and a small wet area fell into disuse. Information was not available for the southern part of the sub-area in 1961.

The only change (in the area common to both surveys) between 1961 and 1967 was an increase in the area of arable.

Between 1967 and 1973 several other parcels of land were converted from grassland to arable and another small area fell into disuse.

Discussion

Between 1931-32 and 1973 the area of arable land in the Thurne catchment area increased and the area of grassland decreased, largely as a result of the reclamation of areas of grazing marsh and their conversion to arable (Rendel, Palmer and Tritton

1977). The area of woodland increased as neglected areas of scrub and fen developed into woodland (George 1976). Reclamation of some areas and the development of woodland in others led to a decrease in the area of natural and semi-natural vegetation. Nevertheless, apart from the conversion of most of Brograve Level from grassland to permanant arable and the setting aside of large areas of land for the purpose of nature conservation, the overall pattern of land use in 1973 was similar to the pattern in 1931 and 1932.

The detailed pattern of agricultural land use, in particular the area and distribution of arable land, was determined by several interdependant factors including: topography and drainage, land drainage technology, soil type, wild life conservation and economics, of which the last was probably the most important.

Throughout most of the period covered by the four surveys permanant arable farming was largely restricted to the higher well drained land as the water table in large areas of the reclaimed marshland was too high. Although some of the marshland had been arable in the 19th century (Clarke 1965) it had reverted to grassland by the time of the first survey. During the early part of the period studied the economic benefits of conversion from grassland to arable were not sufficient to justify the increased expenditure on land drainage that conversion of the marshes would have entailed.

The reclaimed marshes were drained by a network of open dykes. Improvements to the drainage system and lowering of the water table were necessary before the marshes could be converted to permanant arable. From the 1950's onwards more efficient excavators and improved underdrainage systems made improvement economically feasible.

Happisburgh — Winterton I.D.B. sub-areas 1 and 2 included extensive areas of heath and fen just inland of the dunes. The soil in this part of the catchment area was so poor that reclamation and conversion to arable were not economically viable as the expected crop yields would have been so low.

Happisburgh — Winterton I.D.B. sub-area 2 and Smallburgh I.D.B. sub-area 1 included land that was managed solely or primarily for its ecological interest rather than for financial gain, e.g. the areas of marshland around Horsey that were allowed to develop into scrub and fen between 1967 and 1973, the reed bed created during the 1960's south of Horsey Mere and the reed bed south of Stubb Mill.

Most of the Thurne catchment area was farmed for profit and land use at any particular time was largely dependant on the economic climate. After a long period of neglect before the Second World War (Sainty *et al* 1939) the post war period saw an upsurge in farming, characterised by an increase in the area of arable land and a general intensification of farming methods (Hornby and Lambley 1976, Trist 1970).

This account of changes in land use in the Thurne catchment area summarizes a much larger unpublished report, copies of which are held at the Norwich Castle Museum and the Nature Conservancy Council Regional Office, Norwich.

Acknowledgements

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Table 1. Area of each of the five I.D.B. sub-areas studied in the Thurne catchment area.

I.D.B. sub-area	Area (hectares)*
Happisburgh — Winterton I.D.B. sub-area 1	632.835
Happisburgh — Winterton I.D.B. sub-area 2	711.035
Happisburgh — Winterton I.D.B. sub-area 3	1974.173
Smallburgh I.D.B. sub-area 1	1115.068
Smallburgh I.D.B. sub-area 3	183.339
Total	4616.450

*Figures do not refer to the actual area of each sub-area but only to the area of agricultural or potentially agricultural land contained in each, i.e. they exclude roads, tracks and land that remained built-up throughout the period covered by the four surveys.

Tables 2-6. Changes in land use in each of the five Internal Drainage Board sub-areas studied in the Thurne catchment area during the period 1931-32 to 1973.

Table 2. Happisburgh — Winterton I.D.B. sub-area 1.

	1931-32		1961		1967		1973	
Land use	hectares	%	hectares	%	hectares	%	hectares	%
Arable	116.685	18.44	119.223	18.84	170.108	26.88	129.850	20.52
Grassland	226.752	35.83	225.117	35.57	193.457	30.57	245.387	38.78
Natural and semi-natural vegetation	254.197	40.17	262.853	41.54	226.471	35.79	204.787	32.36
Woodland	35.008	5.53	25.641	4.05	42.799	6.76	52.811	8.34
Built-up*	0.193	0.03						
Total	632.835	100.00	632.835	100.00	632.835	100.00	632.835	100.00

Table 3. Happisburgh — Winterton I.D.B. sub-area 2.

	1931-32		1961		1967		1973	
Land use	hectares	%	hectares	%	hectares	%	hectares	%
Arable	190.082	33.89	172.145	30.69	201.551	35.93	166.857	29.75
Grassland	280.686	50.04	310.109	55.28	189.766	33.83	225.466	40.19
Natural and semi-natural vegetation	75.961	13.54	74.579	13.29	165.316	29.47	161.419	28.78
Woodland	12.524	2.23	4.115	0.73	4.315	0.77	7.006	1.25
Built-up*	1.693	0.30					0.200	0.04
Total	560.948	100.00	560.948	100.00	560.948	100.00	560.948	100.00

Table 4. Happisburgh — Winterton I.D.B. sub-area 3.

	1931-32		1961-62		1973	
Land use	hectares	%	hectares	%	hectares	%
Arable	1193.408	60.45	1154.497	58.48	1413.659	71.61
Grassland	412.250	20.88	614.995	31.51	348.507	17.65
Natural and semi-natural vegetation	333.518	16.89	120.443	6.10	96.340	4.88
Woodland	33.950	1.72	67.184	3.40	87.635	4.44
Built-up*	1.046	0.05	17.053	0.86	28.031	1.42
Total	1974.173	100.00	1974.173	100.00	1974.173	100.00

Table 5. Smallburgh I.D.B. sub-area 1.

	1931-32		1961		1967		1973	
Land use	hectares	%	hectares	%	hectares	%	hectares	%
Arable	515.745	46.25	508.649	45.62	532.261	47.73	519.040	46.55
Grassland	269.350	24.15	511.969	45.91	356.526	31.97	252.844	22.67
Natural and semi-natural vegetation	312.957	28.06	59.544	5.34	195.419	17.52	300.476	26.95
Woodland	15.551	1.39	31.420	2.82	27.500	2.47	32.359	2.90
Built-up*	1.465	0.13	3.485	0.31	3.362	0.30	10.348	0.93
Total	1115.068	100.00	1115.068	100.00	1115.068	100.00	1115.068	100.00

Table 6. Smallburgh I.D.B. sub-area 3.

	1931-32		1967		1973	
Land use	hectares	%	hectares	%	hectares	%
Arable			30.331	16.54	41.689	22.74
Grassland	183.339	100.00	150.380	82.02	137.848	75.19
Natural and semi-natural vegetation			2.628	1.43	3.801	2.07
Total	183.339	100.00	183.339	100.00	183.339	100.00

*Excluding land that remained built-up throughout the period covered by the four surveys.

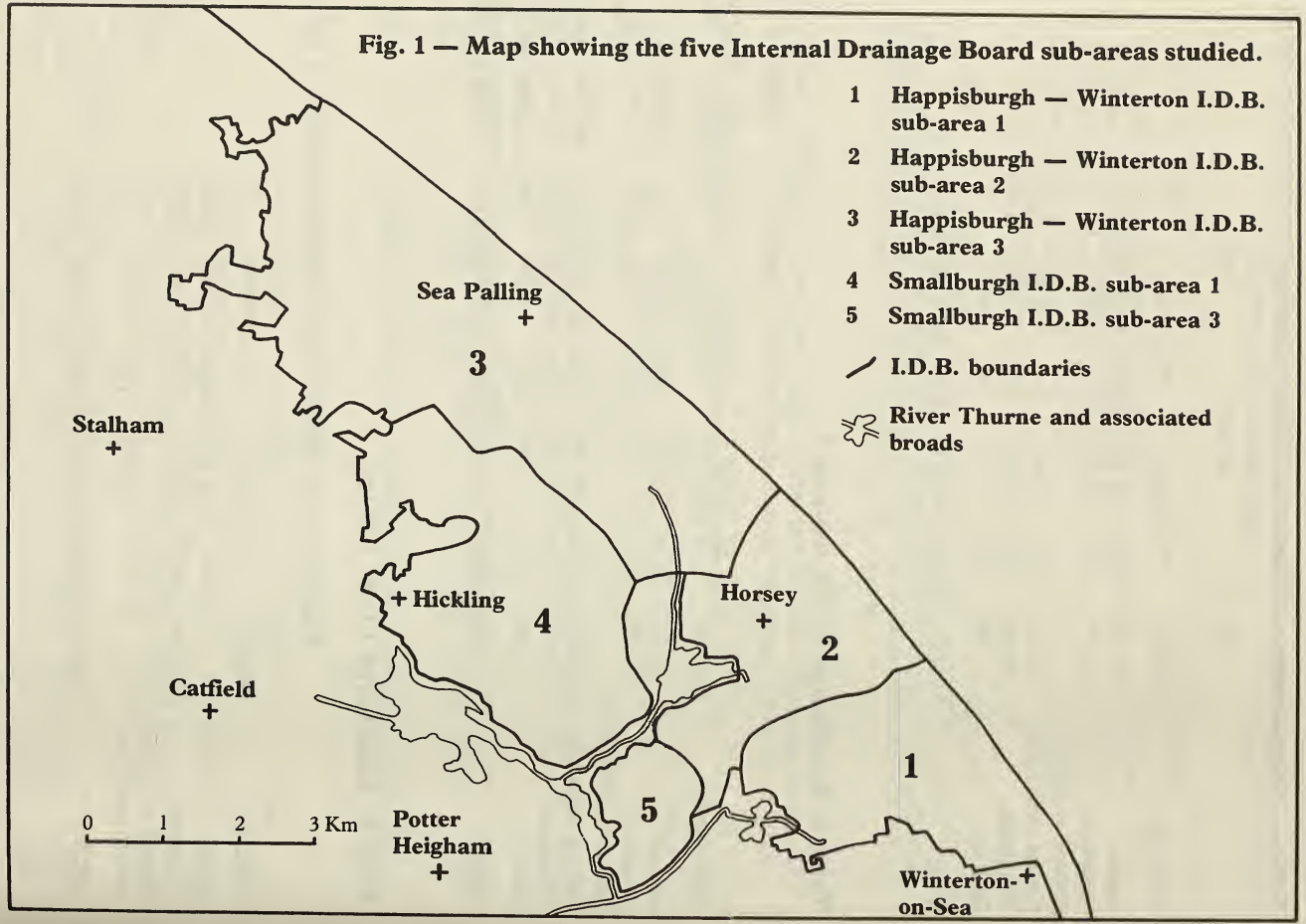

Fig. 1 — Map showing the five Internal Drainage Board sub-areas studied.

SESSILE OAK — *QUERCUS PETRAEA* Leibe in Norfolk

by E. V. Rogers

Seasons, Harling Road, Great Hockham, Thetford.

Introduction

My interest was aroused in late 1982 by an old, pollard Sessile Oak at the entrance to the Forestry Commission's Picnic Site at Bacton Wood near North Walsham. Consulting the 'Flora of Norfolk' (Petch and Swann 1968) I found that this location was not recorded and that Sessile Oak was not considered native to the county. This note is the result of one year's spare time study of roadside trees, woods and heaths, most of which are open to the public.

Survey Methods

It is perhaps surprising that one of the largest plants in the county should be under-recorded but, to most people, the two oaks appear alike. Many older keys were confused and there is still considerable debate on the status of the two species, whether they hybridise and whether the hybrids are fertile. (Jones 1968). The identification of the two oaks and their assumed hybrids and back-crosses has entered the realms of computer technology (Wigston 1974) (Rushton 1978), which can be daunting to a beginner, but for this study I used a simple key constructed to identify trees which are strongly sessile in character.

KEY

		Sessile Features Score 3	Pedunculate Features Score 0
Buds	(1)	Ciliate	Glabrous
	(2)	Pointed	Ovoid
Acorn Petiole			
	(3)	0 — 1 cm long	1 cm +
Leaf			
	(4)	Petiole. 9-20% of total length	0-8% of total length
	(5)	Auricles. nil — weak	strong
	(6)	Veins with stellate hairs on midrib and axils	Glabrous
	(7)	Lamina, with small stellate hairs	Glabrous
	(8)	Lobes, 5 or more	4 or less

Each feature 1-8, where present, was scored 0-3 and the total divided by the number of features to give an average score. Only trees scoring 2.5-3 have been considered to be sessile and recorded as such.

Results of the Study

Sessile Oak Woodlands

It has been notable that most of the woods containing sessile oak are on poor, well drained, acid soils, often podsolised. This is remarkably similar to the findings of Mr. Anderson in the New Forest (1950). The scattered nature of the sessile oak, among populations of oak which are mainly pedunculate, is also remarkably similar considering the very different proportion of woodlands in the two areas.

Swanton Novers Great Wood, which has N.N.R. status, has a very variable oak population and is well described by Rackham in 'Ancient Woodlands' 1980. The sessile oak appears to be dominant on the most acid soils. I have found a number of sessile oak hedgerow trees to the north of Swanton Novers village which may be an indication of much wider distribution in this area.

Edgefield Little Wood is another very acid wood which contains sessile oaks, which is recorded by Rackham. The flora of this wood is nowhere so rich as parts of Swanton Novers Great Wood. One is left wondering what delights are denied to us by the destruction of Edgefield Great Wood in the mid 19th century.

Bacton Wood was described by Grigor 1841 as stretching from North Walsham to the sea. Today the major relict is the Forestry Commission's Bacton Wood which lies half each in the parishes of Bacton and Witton. Such an excellent job was made of clearing this wood for planting with conifers that only two large oaks remain, both sessile. The hollow pollard tree at the entrance to the Picnic Site I estimate by ring counts of a nearby felled tree at 250 years old, the large tree in the centre of the wood slightly less. Throughout the wood, under the conifers, are stubs which are predominantly sessile and occasionally a younger tree which has grown up with the conifer, usually from a felled tree stump. Hedgerow trees can be found on roadsides especially to the north of the wood. It is unlikely that sessile oak would have been planted in this area. There is a considerable length of hedge within the western section of the wood which is almost exclusively sessile oak coppice. The woods of Upper Sheringham Hall are particularly interesting. Oak Wood, Cracking Hill, Wellborough Wood and the Rookery are predominantly sessile oak, at least 150 years old and there is evidence, especially in Oak Wood, of coppice origin. All these woods have been planted with rhododendron which makes access very difficult; sycamore and scots pine have been planted in gaps. The scots pine is now dying of old age. Further inland in The Dales occasional sessile oak can be found. One park land sessile oak girths 23' 2".

Further west at Holt Wood, which is called Old Pollard Wood in the first edition of the 1" OS map, is, I have no hesitation in saying, the purest sessile oak wood in Eastern, and probably Southern England. It is remarkable that it has not been recorded previously, but there are reasons for this.

I have only been able to carry out a superficial survey of half of the wood, but it would appear that it was all felled about 140 years ago and the occasional scots pine and sycamore may have been planted at this time, also possibly some of the beech, although there is a possibility that this too is natural. The whole wood has been blanketed with rhododendron, the only other trees being occasional birch and rowan which occurs naturally on these acid soils. Ground vegetation is very sparce due to the dense continuous double canopy of oak and rhododendron and the deep leaf litter, the most common species being willow herbs and bramble, but lily-of-

the-valley (*Convallaria*) occurs. Most of the sessile oak, I only saw one pedunculate tree, springs from coppice origins usually two or three trunks to a stool. Growth has been extremely slow and even, an average growth rate on 15 recently felled stems was 17 annual rings per inch of radius. The circumference of 4 stools averaged 18 ft 10" which at this slow growth rate would give an age approximately 600 years. One stool, possibly on better soil, was 30' 6" in diameter, there were 6 stems rising from the stool between 5' 10" and 8' in circumference at breast height. This stool alone must be well in excess of 600 years old and must establish the native status of sessile oak in the County of Norfolk. Holt Wood would repay much further research into its history and deserves careful preservation and regeneration, avoiding any planting of oak from any other origin.

Not far to the west is Smokers Hole, an area of wood pasture, most of the oak in the western two thirds are pedunculate, one old pollard in a low place girthing 31' 2". However, on the eastern edge, Hull Wood, on a steep hill of glacial origin, is predominantly of sessile oak, one tree of 19' 9" girth having exceptionally large glossy leaves.

Among the trees I have recorded later as hedgerow trees are a number which appear to be in small relicts of woodland and no doubt others could be established as such by the study of old maps, where all the wood and roadside hedge has now disappeared.

Parkland Oak

As parkland trees are often of greater antiquity than most woodland and fieldboundary trees, having been retained much beyond their economic life span for the visual amenity they provide, they would be a very interesting subject for study. Many park trees are the remains of woodpasture or field edge trees from former medieval farmland.

The only park I visited in this study was Blickling. There is a good old, ivy covered tree near the main road a short way to the west of the main drive to the house and I found two sessile oak among the parkland trees to the east of the lake, also a few trees in the amenity woods to the east of the hall which have been planted, possibly from local seed.

Hedgerow Sessile Oaks

Owing to the nature of this survey, the majority of my locations are roadside trees; these are usually in field hedge banks, but as mentioned previously a few are on the edge of natural or semi-natural woodland relicts. Foresters will often leave roadside trees or trees on boundary banks when felling a crop and planting economic conifer crops, and farmers would leave roadsides when clearing for agriculture. It was noted that the sessile trees were often older than most roadside pedunculate oak and also usually of pollard origin.

In the late 18th and early 19th centuries sessile oak was very much out of favour as a timber tree, (Grigor 1841) as it quite unjustifiably gained a reputation for being the originator of much of the rot in wooden warships. Sessile oak seed does not keep or travel easily compared with the larger pedunculate oak seed, so it is most probable that Norfolk's roadside oaks are of natural origin or from locally collected seed. The location of these trees is recorded in the schedule and on the map which follows.

Planted Sessile Oak

The only trees recorded in my survey were planted in 1936 along the north edge of Bintree Wood. Unfortunately the origin was not recorded, but the leaf form is unlike any other I have seen in Norfolk, it is possible that the seed or plants were imported.

Future Prospects for Sessile Oak

Sessile oak, in common with all the natural flora of Norfolk, continues to be reduced by intensive agriculture, forestry, road widening and urban expansion. Unlike pedunculate oak, which is in many areas invading heathland, the sessile oak is almost exclusively well past middle age and only a very few trees under 40 years old were seen which did not appear to be of coppice origin. Sessile oak is an infrequent mast producer, once every 5-7 years; the seed is small and does not survive to germinate as well as the more prolific pedunculate oak. 1983 was a very poor seed year. To hold its own in Norfolk sessile oak, produced from local seed, should be promoted by the organisations who are now doing such a good job in funding and encouraging farmers and landowners to plant. I believe there is a bonus in planting sessile oak on all but the wetter and heavier soils as it does make a much finer tree, even in areas where the poor soils and proximity of the sea reduce pedunculate oak to a very poor thing.

SCHEDULE OF *QUERCUS PETRAEA* LOCATIONS

Location	Map Reference All in 100 km square TG 63	Notes
Bacton Wood	300 300 etc	Includes Witton Heath. Coniferised old
Bacton Wood	310 300	oak bollings and stubs. Heath and
Bacton Wood	300 310	woodland. Stools mainly sessile. Old
Bacton Wood	310 300	hollow pollard by picnic site estimated 250 yrs + a strong sessile oak hedge in part of the wood.
Bacton	307 312	Large standard tree 120 years +.
Baconsthorpe	134 375	Roadside. Light green leaf.
Baconsthorpe	131 378	Very fine tree, strong sessile features, flushed early; another nearby.
Blickling	178 285	Ivy covered bole at roadside 20' 4" girth
Blickling	178 294	over ivy. Old trees in the park, possibly
Blickling	182 291	planted, or remains of wood pasture.
Blickling	157 289	In woodland with old beech pollars, chestnut and pedunculate oak.
Bintree	000 226	Planted 1936. Probably not of local origin.
Calthorpe	176 318	Roadside tree, old pollard.
Crostwight	329 297	Large roadside tree, much finer than nearby pedunculate.

Location	Map Reference	Notes
Edingthorpe Green	310 320	A number of trees with sessile features; some may be recent hybrids.
Edgefield	086 354	Roadside tree at Bunkers Hill
Edgefield	109 343	Little Wood
Frogs Hall	253 382	Large roadside tree with very hairy leaf. 12' girth.
Frogs Hall	253 373	Roadside tree.
Glandford	045 401	Hull Wood, mainly old sessile trees, one tree 19' 9" girth is very vigorous.
Glandford	044 402	Wood edge tree Banham Hill.
Glandford	050 396	Roadside tree on edge of planted wood.
Glandford	068 409	Roadside tree, Cley Park Wood.
Haveringland	160 216 150 210	Old Park, coniferised, most old bollings and stubs now dead, a range of leaf types, some strongly sessile.
Hevingham	202 212	Hevingham Park, now coniferised, strong old pollard on bank.
Hevingham	196 214	Hevingham Park, shoot from old coppice on bank.
Hempstead	105 358	Pond Hill Wood. Large tree on wood edge bank.
Holt	076 397	Holt Wood, old sessile oak coppice wood last felled about 140 years ago. Many stools of considerable age.
Itteringham	155 299	Roadside, fine glossy foliage.
Kelling	090 410	Roadside tree, ivy covered.
Kelling	085 426	Three roadside trees, windblasted.
Marsham	175 237	Coppice in hedge bank. Heathland.
Marsham	170 239	Old stub incorporated in Quakers Wood bank.
Marsham	171 239	A number of trees, one from old stool on edge of Quakers Wood.
Norwich	240 100	On Thorpe Heath.
Overstrand	234 401	Large roadside pollard 15' 4" girth; est. 180 yrs.
Overstrand	238 404	Large roadside pollard recently lopped, est. 200 yrs +.
Plumstead	128 359	Two old roadside trees.
Ringland	127 127	Winter leaf collection, actual tree not identified.
Sall	103 241	Roadside tree 16' 4" girth. Est. 180 yrs.
Salthouse	087 427	Roadside trees, 2 stems 6' apart.

Sheringham	158 415	Group of old trees, all sessile and over 150 yrs old.
Sheringham	151 416	Old deformed oak among new plantation trees.
Southrepps	255 375	Windblasted hedgerow tree.
Sustead	180 370	A group of roadside trees.
Swanton Novers	015 312	Great Wood, oak coppice N.N.R.
Swanton Novers	021 328	Roadside coppice.
Swanton Novers	009 323	Coppice stool in wood coniferised in 1930.
Swanton Novers	015 323	Roadside tree just east of church, unusual leaf form.
Trunch	283 343	Roadside tree in village, recovered staghead.
Trunch	272 348	Old coppice in roadside bank, in small area of old broadleaf woodland.
Upper Sheringham	134 425	Oak Wood, all sessile oak 150 yrs+, some from old coppice stools.
Upper Sheringham	133 422	Cracking Will Wood, all sessile oaks.
Upper Sheringham	137 422	Wellborough Wood, as above.
Upper Sheringham	135 418	The Rookery, scattered sessile oaks.
Upper Sheringham	131 419	Old Game Bay Wood, occasional sessile oaks.
Upper Sheringham	136 420	Fine old tree in pasture 23' 2" girth, est. 250 yrs.
Weybourne	122 419	Young natural tree in coniferised wood.
Weybourne	128 417	Two strong coppice trees in bank/parish boundary.

Conclusion

Sessile oak is considered to be native in three localities in Norfolk by Oliver Rackham (1980); these are Swanton Novers Great Wood, Edgefield Little Wood and Thorpe Wood. I submit that there are further woods at Holt, Glandford and Upper Sheringham which may be added to this list. Bacton Wood and Haveringland Park have bollings or stubs rather than coppice, but are probably sessile oak woods of considerable antiquity. It may be that where grazing by deer, sheep or cattle was practised bollings and stubs had a greater chance of survival after felling. Bracken would also smother regrowth from stubs on heaths. The scatter of roadside trees between the woods may be the remnants of the prehistoric distribution. It has been suggested that sessile oak was planted in Norfolk (Grigor 1841), but the present distribution which appears to be fairly restricted to well drained, acid soil conforms to the natural preference of the species.

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A NORFOLK ROAD VERGE

by E. T. DANIELS

41, Brian Avenue, Norwich.

Abstract

An account is given of halophyte and alien grass species colonising the A 146 road. The origin and method of spread of these is discussed. The nomenclature follows Clapham, Tutin and Warburg (1962).

Introduction

It has been known for some years that application of salt for de-icing main roads in Britain, northern Europe and North America has led to the colonisation of inland verges by maritime plant species. Recorders have found nearly continuous populations on the eastern side of Britain from the Scottish border to Bedfordshire along the main North-South trunk roads and motorways, with colonisations in Derbyshire, Kent and Norfolk (on the A 149 near King's Lynn). This situation exists in East Norfolk and in the autumn of 1982 I walked, in sections, most of the road verges along the A 146 between Norwich and Gillingham to record the maritime plants and alien grasses which were also present.

Observations

The effect of heavy salt applications is to create a zone immediately bordering the road surface within which the normal vegetation is drastically reduced or even killed off completely and it is in this strip that the maritime plants grew almost exclusively. Along the A 146 the width of the zone varies considerably but the average is about 1 metre.

The species of salt marsh plants (halophytes) which I found were as follows:

Hordeum jubatum (Fox-tail Barley). I found this very decorative grass on the south-west verge at Trowse as a large colony (200-300 flowering spikes) in September 1978. The colony was watched annually and it was still present in 1982 though much reduced (30 spikes).

Puccinellia distans (Reflexed Salt Marsh Grass). This is the most abundant and widespread of the maritime plants in our inland stations where I first saw it at Trowse in 1981 growing with *Hordeum jubatum* and also on the opposite verge. In 1982 it was very abundant along much of the A 146, being absent from only 1 section of the 16 which I walked. It was abundant in 9 sections, common in 4 and frequent to rare in the others. It occurred as a fairly narrow, often pure, strip up to 60 cms wide. The distribution is shown in the figure.

Other Norfolk inland records are along the A 47 for two miles from Easton to Hockering on the South side (A. L. Bull); for 180 feet along the South verge of the A 47 just beyond Thorpe; a few on the North-East side of the A 149 at Potter Heigham (R. P. Libbey and E. L. Swann); for 60 feet on the South-West verge of the A 1075 near Shipdham (A. L. Bull); a few on the South-West verge of the B 1332 at Poringland; on rubbish tips at Martham (P. G. Lawson) and Bergh Apton. It was also present in quantity at the Highway Authority sand/salt dumps on the B 1140 at Acle and the B 1149 at Haveringland.

Spergularia marina (Lesser Sea Spurrey). This common salt marsh species was present in 4 sites on the South-West side and in 1 station on the North-East. It was common to abundant and many seedlings were seen. All sites but one consisted of bare, compacted soil with no other vegetation, where heavy vehicles had driven along the verge. In the remaining site it grew mixed with the normal roadside grasses.

Sites on other roads were the sand/salt dumps at Acle and Haveringland, and one plant on the North side of the A 47 near East Tuddenham (A. L. Bull). At Acle it extended along 110 feet of road in one patch and 35 feet in another.

Juncus gerardii (Salt Marsh Rush). This grew at Arminghall as a roughly elliptical patch, 5 feet by 3 feet, on the verge immediately adjoining the road surface and spreading into the grass sward. It has been found in Kent, near Sevenoaks, during a similar roadside survey.

A very considerable surprise was the widespread occurrence of a number of alien grasses normally found only on rubbish tips where they arrive as bird seed introductions. They are native in warmer countries than ours and mostly they do not persist here. The species and their occurrence were:

Species	No. of section in which it grew (out of 16)
Panicum mileaceum (White Millet)	14
Panicum capillare (Witch Grass)	2
Digitaria sanguinalis (Hairy Finger Grass)	11
Setaria italica (Fox-tail Millet)	1
Setaria viridis (Green Bristle Grass)	2
Setaria verticillata (Rough Bristle Grass)	1*
Setaria spp. — not flowering and thus unnameable but probably *S. viridis*	4

*found in 1981

The two commonest of these grasses were preponderantly on the South-West/East side as shown below. The numbers relate to the frequency with which individuals were noted in successive sections.

	SW/W side	NE/N side		SW/W side	NE/N side
Panicum	4	—	Digitaria	4	—
mileaceum	8	—	sanguinalis	6	—
	1	—		2	2
	1	4		4	—
	1	—		1	—
	7	—		1	—
	1	—		—	1
	5	—		2	1
	3	1		1	—
	10	5		5	--
	20	—		11	—
	7	2			
	3	—			
	11	—			

Nearly all grasses were sufficiently mature in Sept./Oct. to allow identifications to be made. They grew in the denuded road verge areas, sometimes in the crack between the concrete shoulder and the asphalte surface and, rarely, on bare mud in drainage gulleys cut through the grass verge. Mostly they were singles, randomly scattered, but 4 plants of *Digitaria sanguinalis* were clustered in one station.

Questions as to origin and mode of spread of these plants arise. I cannot account for *Juncus gerardii*, and consider it to be a random isolated event. *Hordeum jubatum* has not spread or increased, is a salt marsh plant (at least in some areas, e.g. Newfoundland) and commonly arrives on British road verges as a contaminant of grass seed. This, I believe, explains its presence at Trowse. The other two halophytes, *Puccinellia distans* and *Spergularia marina*, are believed to come in with the salt used for de-icing. This is brought from inland salt workings in Cheshire and both species occur in such saline areas in that County. Moreover, they are found near Norfolk roadside salt/sand dumps. *Puccinellia distans* has very light seeds and once established spreads rapidly by seed carriage in vehicle slip streams. *Spergularia marina* has heavier seeds, but they stick to vehicle tyres and underparts. They have been found in mud washed from a lorry which had travelled along the M 1.

As to alien grasses, there is a remarkable site in Lowestoft alongside the docks and railway which is famous for its production of such aliens. They have been known since 1980, and in the case of *Digitaria sanguinalis* since 1975. They are well-established and appear from year to year (A. Copping). I visited the site on 22nd September 1982 and found —

Sorghum halepense (Johnson Grass)	— many fine clumps
Panicum mileaceum	— common
Panicum capillare	— frequent
Setaria viridis	— common
Digitaria sanguinalis	— common
Zea mays (Maize)	— occasional

Four of these species were found by me on the Norfolk stretch of the A 146. Most traffic on this road is going to or coming from Lowestoft and it seems the seeds are carried on lorries.
The evidence to support this is —

(a) I have been able to ascertain that seed for bird food is imported in bulk through Lowestoft, whence it is carried, sometimes sacked sometimes in bulk, on lorries;

(b) the preponderance of individuals on the lorries' near sides (SW/W side) coming from Lowestoft;

(c) the tendency which I noticed for them to be commoner in places where lorries could be expected to jerk their loads, e.g. at bends or at the top of hills where gear changing occurs;

(d) the presence, often very commonly, of grain or grain seedlings by the edge of the road in similar places, presumably also shed by lorries carrying bulk grain.

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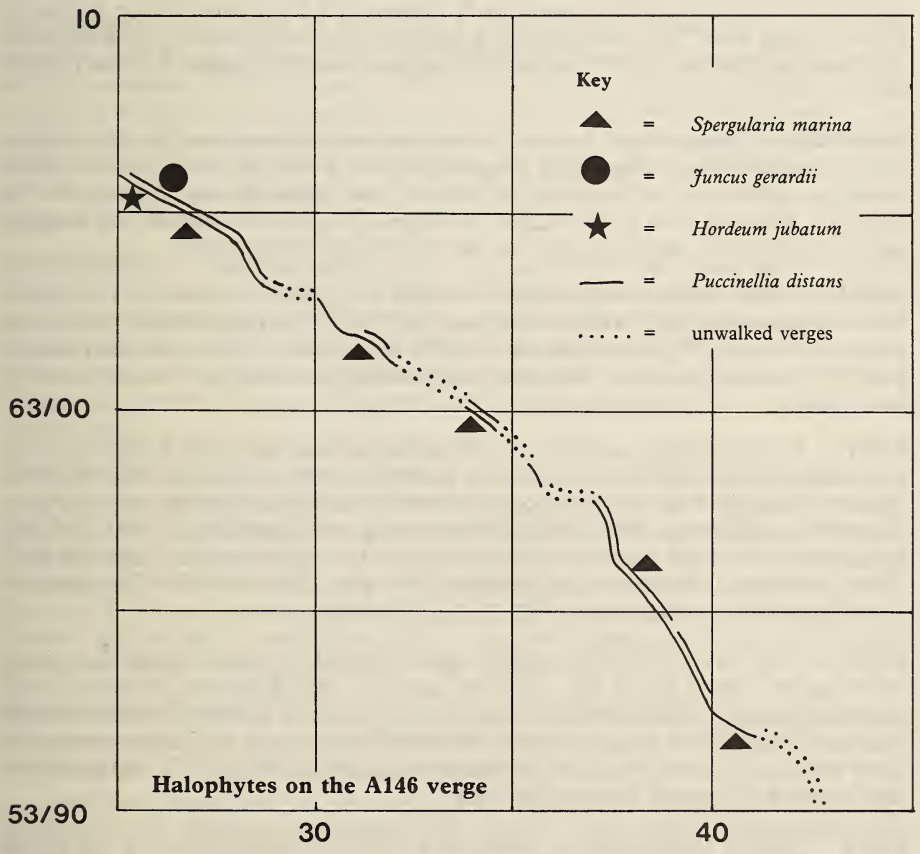

1983 WEATHER SUMMARY

by T. B. NORGATE

Quarry Lane, Lyng, Norfolk.

JANUARY — Sunshine hours were about 33% above normal and it was the 5th consecutive January to be so. More significant was the increase in mean temperature by nearly 3°C (5°F) and was even above the March average. It was the warmest January by 0.1°C for 8 years, though very light snow fell on 3 days.

Rainfall was slightly on the low side, particularly on the coast and in Fenland.

FEBRUARY — Temperatures this month were nearly as much below normal as they were above in January. There were more frosts than usual, the sharpest one being -10.4°C (13.3°F) on the ground on St. Valentine's Day. Snow fell on 5 days lying to a depth of ½" on the 9th, but it was a fairly dry month especially in the middle. Sunshine was nearly 50% on the high side and was the sunniest February for 13 years.

MARCH — Though there were only 5 sunless days the total number of sunshine hours was 10% down. The mean temperature was 0.7°C above normal and there were fewer air frosts but more on the ground than usual, the lowest being -5.2°C (22.6°F). The first half of the month was almost dry, but the second half brought totals almost up to normal, except in the SE corner of the county.

APRIL — Wet weather continued throughout the month and most of the county had nearly double their average, there were only 4 or 5 days with none to measure and over 100mm (4") was measured in half a dozen places. The mean temperature was 0.7°C above average. Sunshine hours almost reached normal with only 4 sunless days.

MAY — It was a chilly month, over 1°C below normal, with only 4 days reaching more than 16°C (60.8°F) or over. There were 4 days with ground frosts, which is 5 times as often for May. It was also a dull month with less sunshine than in April. There was a deficiency of 60 hours and was the lowest figure for 16 years. Rainfall was again on the high side with about 20 places having an excess of 100mm (4"). There was thunder on 8 days and this instability gave uneven rainfall. The frequency of thunder was about 4 times the normal for May.

JUNE — This was a much drier month, especially in the extreme west of the county where under 10mm (0.4") fell. The one and only thunderstorm produced heavy rain on the night of 22nd/23rd in a band from Blakeney to Wymondham where over 25mm (1") fell. Mean temperature for the month was almost 1°C below average — there were only 4 days when the temperature exceeded 21°C (70°F) and there was even a touch of ground frost on the 16th.

JULY — Several thunderstorms produced a variable rainfall pattern, a few places escaped them, Fritton recording only 3.3mm (0.13"). Despite unstable conditions the barometer was 30.00" (1016mb) or above every day except two. Hours of sunshine were 50 above with no sunless days. The mean temperature for the month was more than 2.5°C (4.5°F) higher than the average. There were 26 days warmer than 21°C (70°F), 4 of which reached 30°C (86°F), a 'hot summer's day'.

AUGUST — Though the mean temperature was more than 1°C above average, maxima in the shade failed to exceed 29°C (84.2°F). However, there were 20 days above 21°C (70°F), just over a comfortable room temperature. Rainfall was very low throughout the county and especially in the King's Lynn area, there being 14 places with 3mm, (0.12") or less. A thunderstorm early in the month produced 14mm (over 0.5") in the Wymondham area. Sunshine was 7% above average.

SEPTEMBER — The pattern of rainfall was irregular, the driest parts being in the north-west with average amounts while the eastern side had nearly double. Very little rain fell in the last 9 days. Sunshine was 33% below normal with 7 completely dull days. The mean temperature slightly above average with a maximum of 24.9°C (almost 76°F) on the 1st, after which it was mostly between 15° and 18°C (59° and 64°F).

OCTOBER — Despite 3 air frosts and 7 on the ground, the mean for the month equalled the 20 year average of 10.5°C (51°F). The first few days were quite warm with a maximum of 24.5°C (almost 76°F). Sunshine hours were 21% above normal with only 4 sunless days. It was a rather dry month with a little thundery rain in the middle, which brought some places up to their normal. On the east coast only 30-40 mm. (1.25-1.5") was recorded. An exceptionally high barometer reading of 30.74" or 1041 mb, was recorded on the 22nd, followed by a maximum ground temperature of -6.4°C or 20.5°F.

NOVEMBER — This was another dry month with 75% of it falling on the night of 26th-27th, when up to 40 mm (1.5") fell in 15 hours over much of the county. The mean temperature was 7.2°C (45°F), which is 0.6°C (1°F) above average. The lowest temperature was -4.3°C (24.3°F) in the air and -8.6°C (16.5°F) on the ground, twice. Sunshine hours were only just over 38, which is just over 40% of a 20 year average and it was the lowest November figure since 1968 and 12 days had none at all.

DECEMBER — The mean temperature was over 1°C above average but seemed even more as the week around Christmas was 3°C above this figure, i.e. 8.2°C (46.5°F). The highest mean temperature was 10.5°C (almost 51°F) on Christmas Day, the same as the average figure for October and nearly that for May. Rainfall was highest in West Norfolk, but still a little below average; there were no heavy falls and flurries of snow occurred on only 2 days. Sunshine was 30% in excess of normal and helped to make December a pleasant month. Over half of the total number of hours was recorded in the first 11 days.

THE YEAR — Only February, May and April (in that order) had mean temperatures below average, and for the year the mean was 0.5°C above normal due mainly to the warm months of January and July.

Sunshine hours were the lowest since 1978, but only 1% below normal. July, February and October were especially sunny, while May, September and November were dull.

There was no clear pattern to the rainfall, though the extreme north-west and south-east of the county were drier. The wetter areas were mostly confined to higher ground from Sandringham to Edgefield. Thunderstorms were 50% more frequent than usual, but not as frequent as in 1982.

1983 WEATHER

	MEAN TEMPERATURE °C		NO. OF AIR AND GROUND FROSTS		SUNSHINE HOURS	
	1983	Avg.	1983	Avg.	1983	Avg.
Jan.	6.1	3.6	3/13	11.3/18.6	62.1	47.2
Feb.	1.5	3.4	18/23	11.1/18.2	89.5	61.5
March	6.1	5.4	4/20	6.7/16.1	93.4	105.4
April	6.8	7.5	5/21	3.1/12.6	141.2	145.1
May	9.8	11.0	—/4	0.7/5.1	131.7	191.0
June	14.1	14.0	—/1	0.1/0.8	182.9	191.8
July	18.5	15.9	—	—/0.2	236.3	184.3
August	17.2	16.0	—/1	—/0.1	192.0	180.4
Sept.	14.0	13.9	—	0.1/0.9	101.8	151.4
Oct.	10.5	10.5	3/7	0.6/6.4	127.1	105.3
Nov.	7.2	6.6	3/8	5.2/12.0	39.6	65.1
Dec.	5.2	4.0	8/19	9.6/17.8	61.2	46.9
Year	9.8	9.3	44/117	48.6/108.9	1458.8	1475.4

	RAINFALL mm		DAYS WITH SNOW/HAIL		DAYS WITH THUNDER	
	Lyng 1983	Taverham Avg.	1983	Avg.	1983	Avg.
Jan.	47.8	58.4	3/1	4.9/0.7	—	0.1
Feb.	47.7	45.0	5/—	4.1/0.7	—	0.2
March	48.3	42.7	1.5/4	2.9/1.0	2	0.5
April	78.8	39.9	1.5/2	1.3/1.4	2	1.1
May	70.8	41.7	—	0.1/0.3	8	2.0
June	28.9	43.2	—	0.1/0.4	1	3.0
July	44.7	57.9	—/1	—	4	2.7
August	9.3	54.9	—	—/0.1	3	2.5
Sept.	74.8	53.6	—	—/0.1	2	1.7
Oct.	38.9	62.5	—	—/0.4	—	0.6
Nov.	57.3	71.1	—	1.8/1.1	—	0.4
Dec.	38.5	57.7	2/1	3.4/1.0	—	0.2
Year	585.8	628.6	13/8	18.6/7.2	22	14.9

BOTANICAL RECORDERS' REPORT

by E. L. SWANN

282, Wootton Road, King's Lynn.

Recorders

A.C. — A. C. Copping
A.C.W. — A. C. Wilson
A.L.B. — A. L. Bull
C.G.H. — C. G. Hanson
C.P.P. — C. P. Petch
E.A.E. — E. A. Ellis
E.L.S. — E. L. Swann
E.T.D. — E. T. Daniels
F.R. — F. Rose
G.C. — Mrs. G. Crompton
G.D.W. — G. D. Watts
J.A.N. — J. A. Newbould
J.E.G. — Mrs. J. E. Gaffery
J.W.W. — J. W. Wells
K.A.B. — Mr. & Mrs. K. Beckett
M.A.B. — Mrs. M. A. Brewster
M.B. — Mrs. M. Baxter
M.H. — M. Hyde
P.G.L. — P. G. Lawson
P.W.L. — P. W. Lambley
R.C.L.H. — R. C. L. Howitt
R.J.D. — R. J. Driscoll
R.J.P. — R. J. Pankhurst
R.M.L. — R. M. Leaney
R.P.L. — R. P. Libbey
R.S. — R. Stevenson
S.G. — Ms. S. Goodfellow
T.G.E. — T. G. Evans

The writer is much indebted to the many recorders particularly to Mr. Ernest Daniels who supplied the largest number closely followed by Mr. Alec Bull.

Aconitum napellus L. agg. Monkshood. Est. Alien.
E30, Strumpshaw Fen; 31, S. Walsham Broad, 1982, E.T.D.

Agrimonia procera Wallr. Scented Agrimony.
E22, Tuttington, disused railway, 1979, A.L.B.

X Agropogon littoralis (Sm) C. E. Hubbard.
A rare intergeneric hybrid between *Polypogon monspeliensis* and *Agrostis stolonifera*
E30, Cantley Sugar Beet Factory, 1983, E.T.D.

Agropyron caninum L. Beauv. Bearded Couch-grass.
W78, Weeting Castle moat, 1981, A. C. Leslie.

Agropyron pungens var. *setigrum* Dum.
E20, Whitlingham Reach, by the river, 1983, E.T.D.

Agrostemma githago L. Corncockle.
Now very rare, these two occurrences are possibly due to seed germinating from impure grain intended for wildfowl.
W59, Welney Wildfowl Reserve, 1980, JEG. E30, Strumpshaw, on dredged mud by river, 1980, M. George.

Alchemilla vestita (Buser) Raunk. Lady's Mantle.
W62, Wolferton Wood, 1983, C.P.P. E01, Tuddenham, 1980, A.L.B.

Allium vineale L. Crow Garlic.
E21, Salhouse, 1978, E.T.D.

Amaranthus bouchonii Thell. Pigweed. Est. Alien.
W69, Wissington, in carrot field but no drills, 1981, R.P.L. & E.L.S.

Amaranthus retroflexus L. Pigweed Casual.
W89, Bodney, disused airfield, 1983, M.B.

Ambrosia trifida L. Great Ragweed. Casual.
E20, Lakenham, Norwich, 1983, E.T.D.

Amsinckia intermedia Fischer & C. A. Meyer. Tarweed. Est. Alien.
E30, Limpenhoe, 1982, P.G.L.

Anacamptis pyramidalis L. L. C. M. Rich.
E10, Marlingford, 1983, S. Paston.

Anagallis arvensis L. sub sp. *foemina* (Mill.) Schinz. & Thell.
Occasionally found as a garden weed.
W89, Mundford, in garden amongst carrots, 1983, M.B.

Angelica archangelica L. Angelica.
E20, Bramerton, 1982, E.T.D.

Antirrhinum majus L. Snapdragon. Casual.
E01, N. Tuddenham, on ballast, 1980, A.L.B.

Aster lanceolatus Willd. Michaelmas Daisy. Casual.
E20, Old Lakenham, 1983, E.T.D.

Aster novae-anglica L. New England Aster. Casual.
W61, Blackborough End Tip, 1981, R.P.L. & E.L.S.

Aster simplex Willd. Casual.
W99, Thompson, hedgerow, 1979, R.P.L. & E.L.S.

Atriplex lacinata L. Frosted Orache.
W63, Snettisham, foredunes, 1982, E.L.S.; 74, Holme & Thornham, 1982, CPP; 84, Gun Hill, Burnham Overy, 1982, P.W.L.

Atriplex littoralis L. Shore Orache.
Another inland site for a halophyte.
E20, Trowse Newton, abundant on road side verge, 1983, E.T.D.

Betonica officinalis L. Betony.
E21, Ling Common, Coltishall, 1977, R.M.L.

Bidens cernua L. Nodding Bur Marigold.
E10, U.E.A., by the lake, 1982, E.T.D.; 12, Blickling, 1982, R.C.L.H.; 13, Lake at Felbrigg, 1983, E.T.D., (var *radiata* DC).

Blysmus compressus L. Panz ex Link. Broad Blysmus.
E01, Badley Moor, 1981, P.W.L.; 23, Southrepps Common, 1981, R.C.L.H., R.P.L. & E.L.S.

Bupleurum tenuissimum L. Slender Hare's-ear.
E50, bank of Breydon Water, 1981, P.G.L.

Calystegia pulchrum Brummit & Heywood. Great Bindweed. Est. Alien.
E14, West Runton Common, 1979, E.T.D.

Campanula latifolia L. Giant Bellflower.
E22, Buxton, large colony in the Dell, casual, 1981, R.M.L.

Campanula portenschlagiana Schultes Casual, garden escape.
E20, Norwich, scattered localities, 1983, E.T.D.

Campanula poscharskyana Degen. Casual, garden escape.
E20, three stations in Norwich, 1983, E.T.D.

Campanula rapunculoides L. Creeping Bellflower Casual, probably now naturalised.
W98, W. Harling, T.G.E.

Cannabis sativa L. Cannabis. Casual.
E12, Blickling, 1982, R.C.L.H.

Carex acutiformis Ehrh. × *riparia* Curt.
E20, Norwich, in River Wensum, 1979, E.T.D.

Centaurea solstitalis L. Yellow Star Thistle. Casual.
E29, Shotesham, in an inverted copper, 1983, D. Hedges.

Centaurium pulchellum (Sw.) Druce. Lesser Centaury.
E29, Brooke Wood, 1981, A.L.B., R.P.L. & E.L.S.

Chenopodium suecicum J. Murr. Casual.
E14, West Runton, base of the cliff, 1983, E.T.D.

Chrysosplenium alternifolium L. Alternate-leaved Saxifrage.
W93, Barney Wood, 1979, S.G.

*Colutea arborescens*L. Bladder Senna. Est. Alien.
W62, Gayton Road, King's Lynn, 1981, R.P.L.

Consolida ambigua L. Hall & Heywood. Larkspur. Casual.
E01, Lyng, in field of wheat, 1981, P.W.L; 41, W. Caistor, nine plants in sugar beet, 1978, E.T.D.

Coronilla scorpioides Koch. Casual.
W88, Kilverstone Wildlife Park, 1978, E.A.E.

Corydalis lutea L. DC. Yellow Fumitory. Est. Alien.
W80, Holme Hale Churchyard, with two albinos, 1982, R.P.L. & E.L.S.

Crataegus × *lavallei* Hermcq. Hybrid Cockspur Thorn. Casual.
W98, W. Harling, 1979, T.G.E. det. A.L.B.

Crocosmia × *crocosmiflora* (Lemoine) A.E.Br. Montbretia. Casual, garden escape.
E10, Wymondham, disused tip, 1981, E.T.D., R.P.L. & E.L.S.

Cucubalus baccifer L. Berry-bearing Campion.
W89, Tottington in grassland, 1983, A.L.B., (first seen here in 1933).

Cynara scolymus L. Globe Artichoke. Casual, garden escape.
E10, Wymondham, disused tip, 1981, E.T.D., R.P.L., & E.L.S.

Dactylorhiza fuchsii (Druce) Soó × *D. praetermissa* (Druce) Soó. Hybrid Marsh Orchid
E23, Southrepps Common, 1980, J.A.N.; 24, Cromer, 1980, J.A.N.: 41, Thurne, J.A.N.

Dactylorhiza incarnata L. Soó. Early Marsh Orchid.
W81, Castle Acre, 1980, P.W.L.; Thompson Common, 1981, R.P.L. & E.L.S.; E01, Lyng Easthaugh, 1978, P.W.L.

Dactylorhiza traunsteineri (Sauter) Soó. Narrow-leaved Marsh Orchid.
W81, Castle Acre, P.W.L., 1981; E03, Spout Common, Holt, 1981, P.W.L.; 20, Norwich near River Wensum, 1983, E.T.D.

Doronicum pardalianches L. Leopard's Bane. Nat. Alien.
W73, Bagthorpe, v. abundant on roadside, 1983, E.T.D.; E31, How Hill, Ludham, 1983, E.T.D.

Dryopteris borreri Newm. Golden-scaled Male Fern.
W98, West Harling, 1982, A.L.B.

Elodea nuttallii (Planch.) St. John. Est. Alien.
E20, Carrow Bridge in R. Wensum, 1983, E.T.D.

Epilobium hirsutum L. Great Hairy Willowherb.
E20, Whitlingham Reach, two large colonies of the white flowered form, 1983, E.T.D.

Epipactis helleborine L. Crantz. Broad-leaved Helleborine.
W89, Two Mile Bottom, Thetford, 1983, P.W.L.; E10, Hethel Wood, 1978, S.G.; 49, Gillingham, 1978, S.G.

Erigeron mucronatus DC. Casual
W84, Burnham Deepdale, churchyard wall, 1983, E.T.D.

Euphorbia cyparissias L. Cypress Spurge.
E01, E. Tuddenham, 1981, A.L.B.

Festuca longifolia Thuill. Hard Fescue.
E01, E. Tuddenham, 1981, A.L.B.; 12, N.E. of Reepham, 1981, A.L.B.; det. by P. J. Trist as *F. guestfalica* Boenn.

Frankenia laevis L. Sea Heath.
E04, Salthouse, 1977, J.A.N.

Fritillaria meleagris L. Fritillary.
W92, Stanfield, status uncertain, but long known at this site, 1983, A.L.B.

Fumaria officinalis sub sp. *wirtgenii* (Koch) Arcangeli. Fumitory.
W91, Beetly Pit, 1978, R.P.L. & E.L.S.

Galega officialis L. Goat's Rue. Casual.
E10, Colney Wood, 1982, A.L.B.; 20, Keswick, 1982, E.T.D.

Genista hispanica L. Spanish Gorse. Casual.
E20, U.E.A. Broad, Norwich, 1982, E.T.D.

Geranium endressii Gay. Casual, garden, escape.
E02, Hindolveston, 1978, E.T.D.

Geranium lucidum L. Shining Cranesbill.
W82, E. Rudham churchyard, 1983, R.P.L. & E.L.S.; E01, Welbourne, 1982, A.L.B.; 03, Brinton, E.T.D.; 12, Heydon, 1982, E.T.D.

Geranium rotundifolium L. Round-leaved Cranesbill. Nat. Alien.
W72, Gt. Massingham, 1978, E.L.S.; 91, Beetly Pit, 1981, R.P.L. & E.L.S.; 01, Lyng, 1982, P.W.L.

Geranium sanguineum L. Bloody Cranesbill Casual, garden escape.
W91, Hoe near disused sandpit, 1978, A.L.B.

Geranium columbinum L. Long-stalked Cranesbill.
E12, Corpusty, 1981, M.A.B.

Guizota abyssinica (L.f.) Cass. Niger. Casual.
W61, Blackborough End Tip, 1981, R.P.L. & E.L.S.

Helianthus annus L. Annual Sunflower. Casual.
E12, Irmingland Pits, 1980, M.A.B.; 32, Honing Tip, 1979, E.T.D.

Helianthus tuberosus L. Jerusalem Artichoke. Casual, garden escape.
E10, Wymondham, disused pit, 1978, E.T.D., R.P.L. & E.L.S.

Helichrysum monstrosum L. Everlasting Flower. Casual.
W84, Burnham Overy Tip, 1982, R.P.L. & E.L.S.

Helleborus foetidus L. Stinking Hellebore.
E39, Hedenham Wood, 1978, S.G.

Heracleum mantegazzianum Somm. & Lev. Giant Hogweed. Est. Alien.
W51, Tilney All Saints, 1983, R.P.L. & E.L.S.; 71, Gayton, R.P.L. & E.L.S.

Herniaria glabra L. Glabrous Rupturewort.
W7608-09, Swaffham Forest, 53 plants; 7592-7692, Methwold Warren, 205 plants; 7694, Methwold Warren, 75 plants; all counted by J.E.G. 1980; 7793, Cranwich Heath, 422 plants in 1981, J.E.G.; Cranwich Camp, 1982, G.C.

Hieracium exotericum Jord ex Bon. Hawkweed.
E22, Felmingham, 1979, E.T.D.

Hieracium perpropinquum (Zahn) Pugsl.
E22, Felmingham, Tuttington, 1979, E.T.D.

Hieracium strumosum (W. R. Linton) A. Ley.
W74, Holme Dunes, 1978, C.P.P. det E.L.S.

Hieracium umbellatum L.
E13, Saxthorpe-Corpusty, 1978, M.A.B.; 23, E. Ruston & N. Walsham, 1979, R.M.L.

Hordeum jubatum L. Foxtail Barley. Casual.
E20, Trowse, 2-300 plants, 1978, E.T.D.

Hordeum leporinum Link. Casual.
W91, Beetley Tip, R.P.L. conf. C. E. Hubbard, 1977.

Iris foetidissima L. Gladdon.
W74, Thornham, 1983, R.P.L. & E.L.S.; E08, North Lopham, 1978, S.G.

Iris germanica L. Flag Iris. Casual, garden escape.
E20, Norwich rail embankment, 1983, E.T.D.

Iris sibirica L. Garden Escape.
E30, Strumpshaw Tip, 1983, E.T.D.

Juncus tenuis Willd.
E22, Felmingham, E.T.D. & R.M.L.

Lactuca serriola L. f. *integrifolia* (S. F. Gray) Prince & Carter.
W62, South Lynn Plain, 1983, E.L.S. conf. Dr. Prince.

Lathyrus latifolius L. Everlasting Pea. Est. Alien.
W91, Beetley Pit, 1979, R.P.L. & E.L.S.

Lavatera arborea L. Tree Mallow. Casual
E01, Lyng, E.T.D.; 04, Bilsey Hill Tip, Langham, 1981, E.T.D. & E.L.S.

Lavatera trimestris L. Casual.
E20, Arminghall, edge of potato field, 1981, E.T.D.; 33, Happisburgh cliffs, 1978, C.G.H.

Lepidium heterophyllum Benth. Smith's Cress.
E32, betweem Honing and Burgate, 1981, R.M.L.

Leucojum aestivum L. Summer Snowflake. Casual, now est. alien.
E19, Talcolneston, roadside spinney, 1983, E.T.D.

Linaria purpurea L. Mill. Purple Toadflax. Casual, garden escape.
W84, Burnham Overy tip, 1978, R.P.L. & E.L.S.; 94, Stiffkey, 1978, R.M.L.

Linum bienne Mill. Pale Flax.
E30, Blofield Bypass, 1983, E.T.D.

Linum usitatissimum L. Cultivated Flax.
W61, Blackborough End Tip, 1981, R.P.L. & E.L.S.

Lithospermum officinale L. Gromwell.
E29, Hardwick, abundant, 1981, P.G.L.

Lolium temulentum L. Darnel.
E13, Saxthorpe, Briston, 1980, M.A.B.

Lonicera caprifolium L. Perfoliate Honeysuckle.
E12, Great Witchingham, 1983, E.T.D.

Lupinus arboreus Sims. Tree Lupin. Est. Alien.
W84, Holkham, J.A.N., 1979.

Lupinus polyphyllus Lindl. Garden Lupin. Est. Alien.
E12, Aylsham, disused railway, 1979, R.M.L.; 20, Norwich, disused railway, E.T.D.

Lysimachia punctata L. Casual, garden escape.
W92, Stibbard, 1980, E.T.D.; 99, Thompson Common, hedge, 1979, R.P.L. & E.L.S.; E20, Norwich near river, 1979, E.T.D.

Lythrum junceum Banks & Sol. Casual.
E30, Strumpshaw Tip, 1983, E.T.D.

Marrubium vulgare L. White Horehound.
W89, Bodney Lodge, 1980, P.W.L.

Matricaria recutita L. Wild Chamomile.
E18, Rushall, on clay arable, 1981, A.L.B., R.P.L. & E.L.S.

Mentha × *verticillata* L. Whorled Mint.
E11, Taverham, 1977, E.T.D.; 31, Salhouse, J.A.N.

Milium effusum L. Millet-grass.
W99, Shakers Furze, 1981, A.L.B.; E10, Hethel, 1978, R.P.L. & E.L.S.

Mimulus guttatus DC. Monkey Flower. Nat. Alien.
E12, Aylsham Mill, introduced c. 1950, E.T.D.; 13, Aldborough, M.A.B.

Misopates orontium L. Raf. Weasel's Snout.
E01, Lyng, Allotments & in sugar beet, 1981, P.W.L.; 13, Itteringham, M.A.B.; 21, Horstead, R.M.L.; Salhouse, 1978, E.T.D.

Monotropa hypopitys L. Yellow Bird's Nest.
E11, Houghen Plantation, Felthorpe, 1976, P.W.L.; 12, Marsham Heath, 1978, P.W.L.

Myosotis sylvatica Hoffm. Wood Forget-me-not.
E01, E. Tuddenham, marsh, 1981, A.L.B.

Narcissus pseudonarcissus L. Wild Daffodil.
E01, Mill Street, Elsing, 1977, P.W.L.; 10, E. Carlton Manor, 1983, E.T.D.; 11, Weston Park, 1981, A.L.B.; 12, Ingworth Woods, 1982, E.T.D.; 22, Aylsham, 1982, E.T.D.

Neottia nidus-avis L. Rich. Bird's-nest Orchid.
W99, Wayland Wood, D. Holt, 1979; E01, Hethel Wood, 1978, S.G.; 03, Holt Hall Woods, 1980, Mrs. Hems.

Nicandra physalodes L. Gaertn. Apple of Peru.
W78, Weeting, 1981, R.J.P.; Brandon Timber Yard, 1979, C.P.P., R.P.L. & E.L.S.

Nymphoides peltata (S. G. Gmel) Kuntze. Fringed Waterlily.
E23, pond near Felbrigg, 1978, G. F. W. Hart; 42, Winterton in toad pool, known to have been introduced, 1983, R.J.D.

Oenanthe lachenalii C. C. Gmel. Parsley Water Dropwort.
W07, Blo' Norton Fen, 1977, E.T.D.

Ophrys apifera Huds. Bee Orchid.
W61, Leziate sandpit, 1977, J.W.W.; 62, North Wootton, 1983, C.P.P.; E01, E. Tuddenham, 1977, A.L.B.; 12, Aylsham, 1981, E.T.D.; 14, Weybourne, J.W.W.; 19, Aslacton, 1981, P.W.L.; Denton, D.H.

Orchis morio L. Green-winged Orchid.
W64, Holme, 1976, C.P.P.; 79, Northwold, 1979, R.P.L.; 91, Abram's Meadow, 1978, R.P.L., & E.L.S.; 92, Stanfield, 1983, A.L.B.: 93, Hindringham, P.W.L. & F.R.; 99, Thompson Common, 1979, P.W.L.; E03, Corpusty, 1978, M.A.B.; 28, Tivetshall, 1983, P.W.L.; 29, Hardwick, 1977, P.W.L.

Origanum vulgare L. Marjoram.
W88, Croxton with albino, 1980, C.P.P. & E.L.S.; 89, Bodney, disused airfield, 1983, M.B.

Ornithogalum umbellatum L. Star of Bethleham.
W89, Langford, 1983, Lt. Col. I. MacKinnon; 94, Cockthorpe Common, abundant on the valley floor, adjacent to chalk grassland, 1981, C.P.P., E.L.S. & P.W.L.

Orobanche rapum-genistae Thuill. Greater Broomrape.
W99, Hills and Holes, Great Hockham, parasites on broom in a large forestry clearing. The first record for 60 years, 1983, E. J. Campbell & E.A.E.

Oxalis articulata Savigny. Est. Alien.
W84, Holkham, 1977, R.P.L. & E.L.S.; E13, Saxthorpe-Corpusty, 1978, M.A.B.; 31, Horning, 1979, J.A.N.; Thurne & Acle, 1978, J.A.N.

Oxalis europaea Jord. Upright Yellow Sorrel. Casual, garden escape.
E13, Corpusty, 1978, M.A.B.

Panicum capillare L. Witch Grass. Est. Alien.
E20, Arminghall, Framingham Pigot, 1982, E.T.D.

Panicum miliaceum L. Common Millet. Casual.
W63, Heacham Tip, 1978, R.P.L. & E.L.S.; 84, Burnham Overy Tip, 1978, R.P.L. & E.L.S.; Wymondham disused tip, 1978, E.T.D., R.P.L. & E.L.S.

Papaver argemone L. Long Rough-headed Poppy.
W78, near Emily's Wood, Weeting, 1978, T.G.E.; E12, Corpusty, 1977, M.A.B.; 13, Aldborough, Itteringham, 1977, M.A.B.

Papaver lecoqii Lamotte. Babington's Poppy.
E19, Wacton, 1982, R. Maidstone.

Papaver somniferum L. Opium Poppy. Casual, garden escape.
W72, Harpley, 1983, P.W.L.; 84, Burnham Overy, 1978, R.P.L. & E.L.S.; E39, Ditchingham, 1978, M.H.

Paris quadrifolia L. Herb Paris.
E01, Hethel Wood, S.G., 1978; 39, Hedenham Wood, 1978, S.G.

Parnassia palustris L. Grass of Parnassus.
E23, Southrepps Common, 1981, R.C.L.H., R.P.L. & E.L.S.; Shotesham Common, 1975, D.H.

Petroselinum segetum L. Koch. Corn Parsley.
E01, E. Tuddenham, abundant, 1982, A.L.B.

Platanthera chlorantha (Custer) Rchb. Greater Butterfly Orchid.
W60, Barton Leys Wood, 1980, R.P.L., & E.L.S.; 92, Eastfield Wood, 1981, R.P.L., & E.L.S.; E29, Becketts Wood, Woodton, S.G., 1978; 39, Bond's Wood, Stockton; Hedenham Wood; Hempnall Little Wood, all 1978, S.G.

Polygonatum multiflorum L. All. × *P. odoratum* (Mill.) Druce. Hybrid Solomon's Seal.
E04, Salthouse Heath, 1980, P.W.L. det E.T.D. & P.G.L.

Polygonum bistorta L. Bistort.
E12, Heydon Churchyard, 1978, E.T.D.

Polygonum mite Shrank. Lax-flowered Persicaria.
E10, Cringleford, dampwood, 1981, E.T.D.

Polystichum aculeatum L. Roth. Hard Shield Fern.
W62, Reffley Spring Wood, 1983, R.S.

Polystichum setiferum (Forsk.) Woynar. Soft Shield Fern.
E20, Thorpe St. Andrew, 1978, E.T.D.

Populus nigra var *betulifolia* (Pursh) Torrey. Black Poplar.
W83, North Creake, E. Milne-Redhead; 93, Binham, 1970, K.A.B,; E08, South Lopham, E. Milne-Redhead; 10, Bawburgh, 1972, P.W.L.; 11, Taverham, A.L.B.

Potamogeton coloratus Hornem. Fen Pondweed.
E18, Roydon Fen, Diss, 1977, E.T.D.; 42, near Horsey Mere in dyke, 1982, R.J.D.

Potamogeton × *zizii* Koch ex Roth.
E31, Horning Fen, 1979, A.L.B.

Potamogeton friesii Rupr. Flat-stalked Pondweek.
W88, Santon Downham, 1977, E.T.D.; 31, Horning Fen, 1979, A.L.B.

Potamogeton × *sparganifolius* Larst.
E42, dyke near Somerton Staithe, 1982, M. Jackson, det R.J.D. & N. T. Holmes.

Potentilla erecta L. Rausch × *P. reptans* L.
W99, Stow Bedon, 1980, R.P.L. & E.L.S.

Primula elatior L. Hill. Oxlip.
E32, Dilham Wildfowl Centre, known to have been introduced at this site, 1983, M. Moy conf. E.T.D.

Prunus cerasus L. Sour Cherry. Nat. Alien.
E10, Wymondham, 1980, E.T.D.

Puccinellia maritima (Huds.) Parl. Common Saltmarsh Grass.
E01, E. Tuddenham, abundant along the A47, presumably because of road salting, 1982, A.L.B.

Quercus petraea (Matt) Liebl. Sessile Oak.
E13, Edgefield Little Wood, managed in the past as oak coppice, 1978, P.W.L.; 21, Coltishall; 31, Horning, last two in 1978, J.A.N.

Ranunculus peltatus Schrank. Water Buttercup.
E12, Heydon, A.L.B.

Ranunculus arvensis L. Corn Buttercup.
W62, King's Lynn, St. Margaret's Church, 1981, R.P.L.; E01, Welbourne, 1980, R. Evans.

Ranunculus ficaria L. sub sp. *ficaria*
E03, Brinton, pure white variant, 1983, E.T.D.

Ranunculus penicillatus var *calcareus* (R. W. Butcher) Cook. Water Buttercup.
W71, R. Nar, Westacre, 1979, R.P.L.; 81, R. Nar, Castle Acre, 1979, E.L.S.; E04, River Glaven, Glandford, 1979, P.W.L.,

Rapistrum rugosum L. All. Casual.
W91, Beetley Pit, 1980, R.P.L. & E.T.D.; E50, Gt. Yarmouth, 1978, E.T.D.

Rorippa amphibia L. Bass. Greater Yellow Cress.
W59, Welney, 1979, J.E.G.; E12, Heydon, M.A.B.

Rosa multiflora Thunb.
E02, Great Witchingham, abundant in hedge, 1983, E.T.D. & P.W.L.

Rubus armipotens Barton ex A. Newton *R. pseudobifrons* sensu Watson.
W78, Emily's Wood, Weeting, 1983, A.L.B. New to Norfolk.

Rubus sulcatus Vest.
E12, Hevingham Park, 1983, A.L.B. New to Norfolk.

Rumex maritimus L. Golden Dock.
E10, Wymondham, gravel pit, 1978, E.T.D., R.P.L. & E.L.S.; 30, Coldham Hall, 1979, E.A.E.

Rumex palustris L. Marsh Dock.
W59, Welney Washes, abundant, 1979, R.P.L. & E.L.S.; 78, Weeting Castle in moat, 1981, R.P.L. & E.L.S.

Rumex pulcher L. Fiddle Dock.
E03, Spout Common, Holt, 1977, R.P.L. & E.L.S.; 09, entrance to Old Buckenham Fen, 1976, E.T.D. & P.W.L.

Rumex tenuifolius (Wallr.) Löve.
E03, Corpusty area, 1979, M.A.B.; 12, Corpusty, 1979, M.A.B.

Ruscus aculeatus L. Butcher's Broom.
E12, Corpusty, 1980, M.A.B.

Sagina ciliata Fr. Ciliate Pearlwort.
E12, Corpusty, 1979, M.A.B.

Salix acutifolia Willd. Violet Willow. Est. Alien
W62, Friar's St. playground, King's Lynn, 1982, E.L.S.; 94, Stiffkey, 1981, R.C.L.H.

Salix alba var *vitellina* L. Stokes. White Willow.
W91, Worthing, 1979, R.C.L.H., R.P.L. & E.L.S.

Salix alba L. × *S. fragilis* L.
W91, margin of pit, Worthing, R.C.L.H., R.P.L. & E.L.S., 1979.

Salix basfordiana Scaling ex Salter.
E14, W. Runton, 1981, R.C.L.H.

Salix calodendron Wimm. Grey Willow.
W61, King's Lynn, 1982, R.S.; 71, Gayton, 1977, R.C.L.H.; E30, Brundall, 1977, R.C.L.H.

Salix caprea L. × *S. cinerea* L.
W84, Holkham, 1978, R.P.L. & E.L.S.

Salix caprea L. × *S. viminalis* L.
W91, Worthing, 1979, R.P.L. & E.L.S.

Salix cinerea L. × *S. purpurea* L. × *S. viminalis* L.
E30, Thurton to Hellington, 1979, R.C.L.H.; Surlingham by the river, 1979, R.C.L.H.

Salix daphnoides Vill. Nat. Alien.
E20, Mulbarton, 1980, R.C.L.H.

Salix decipiens Hoffm. Welsh Willow.
W02, Guist by River Wensum, 1979, R.C.L.H.

Salix purpurea L. Purple Willow.
W02, Guist, by R. Wensum, 1979, R.C.L.H.

Salix sachalense F. Schmidt cult. *Sekka* Nat. Alien.
E23, Southrepps Common, 1981, R.C.L.H., R.P.L. & E.L.S.

Salix triandra L. × *S. viminalis* L.
W81, Castle Acre by R. Nar, 1979, R.C.L.H., R.P.L. & E.L.S.; E08, Bressingham Common, 1979, R.C.L.H.

Salvia nemorosa L. Casual
E18, Diss in former garden, R.P.L. & E.L.S., 1978.

Salvia viridis L. Casual, garden escape.
W91, Beetley Pit, 1980, R.P.L. & E.L.S.

Saponaria ocymoides L. Soapwort. Casual, garden escape
W61, Blackborough End Pit, 1981, R.P.L. & E.L.S., first record.

Scrophularia umbrosa Dum. Broad-winged Figwort.
W79, Langford, 1981, R.P.L. & E.L.S.; E11, Costessey, bank of Wensum, 1979, A.L.B.; Norwich by Wensum, 1978, E.T.D.

Sedum reflexum L.
E01, Hockering, abundant, 1978, A.L.B.; 31, Hoveton, 1978, J.A.N.

Sedum telephium L. sub sp. *purpurascens* (Koch) Syme. Orpine.
E11, Costessey, 1978, abundant, E.T.D. & G.D.W.; 12, Heydon, 1978, M.A.B.; 21, Frettenham, 1977, R.M.L.; 28, Pulham Market, 1977, R.M.L.

Sempervivum tectorum L. House Leek.
E03, Brinton; 20, Norwich, 1983, E.T.D.

Senecio squalidus L. × *S. vulgaris* L.
W91, Wellington Road, Dereham, 1983, A.L.B.

Silaum silaus L. Schinz & Thell. Pepper Saxifrage.
E19, Aslacton, 1981, P.W.L.; 31, Horning, 1978, J.A.N.

Silene conica L. Striated Catchfly.
W79, Cranwich Camp, 1982, R.P.L. & E.L.S.; E13, Saxthorpe-Corpusty, 1976, M.A.B.

Silene gallica L. English Catchfly.
W61, Blackborough End Pit, 1977, R.P.L. & E.L.S.; E02, Hindolveston, 1978, E.T.D.; 12, Cawston, 1976, E.T.D.; 13, Saxthorpe-Corpusty, 1976, M.A.B.

Silybum marianum L. Gaertn. Milk Thistle.
W71, Westacre Church, 1981, R.P.L. & E.L.S.; E01, Mattishall, 1978, E.A.E.; 20, Thorpe, 1978; Caistor St. Edmund, many thousands, E.T.D.

Sison amomum L. Stone Parsley.
E01, E. Tuddenham, 1982, A.L.B.

Solidago gigantea Ait. Golden-rod. Est. Alien, garden escape.
W61, Bawsey, 1980, R.P.L.; 89, Ickburgh, 1977, E.L.S.

Sorbus intermedia (Ehrh.) Pers. Est. Alien.
W79, Feltwell Fen, 1982, E. Secker; E20, Mousehold, between Norwich & Hellesdon, both, 1976, E.T.D.

Sorbus × *thuringiaca* (Ilse) Fritsch. Casual.
E20, Norwich, 1983, E.T.D., first record.

Sorbus torminalis L. Crantz. Wild Service Tree.
E29, Hempnall Little Wood, 2 trees, 1978, S.G.

Sorghum bicolor L. Moench. Sorghum.
W61, Blackborough End Tip, 1981, R.P.L. & E.L.S.

Spiraea douglasii Hook. Est. Alien.
E14, West Runton Common, 1979, E.T.D.; 20, Mousehold Heath, 1979, E.T.D.

Symphytum grandiflorum DC.
W91, Podmore Farm, Scarning, 1983, A.L.B.

Thalictrum minus L. ssp. *minus* Lesser Meadow Rue.
E10, Colney, 1979, E.T.D. & E.L.S.; Wymondham, disused tip, 1981, E.T.D., R.P.L. & E.L.S.; 23, Felbrigg, 1981, M.A.B.

Thelypteris oreopteris (Ehrh.) Slesson. Mountain Fern.
W60, Broadmeadow Plantation, Runcton Holme, 1980, A.L.B.

Tragopogon hybridum L. Casual.
W80, Swaffham, garden weed, 1977, A.C.W. det. E. Clement, first record.

Turritis glabra L. Tower Mustard.
E10, Marlingford, 1983, S. Paston; 21, Frettenham, 1979, R.M.L.; 49, Haddiscoe, 1981, P.G.L.

Ulex minor Roth. Dwarf Gorse.
E20, Mousehold Heath, a few plants, 1977, E.T.D., first definite E. Norfolk record.

Utricularia vulgaris L. Bladderwort.
W61, Wormegay Fen, 1977, E.L.S.; 99, Thompson Common, 1979, R.P.L. & E.L.S.

Veronica filiformis Sm. Slender Speedwell. Est. Alien, increasing in frequency.
W63, Ingoldisthorpe, 1983, R.P.L. & E.L.S.; E08, Quidenham, 1979, J.E.G.; 11, Taverham Mill; Old Costessey, 1983, P.W.L.; 12, Heydon, 1978, E.T.D.; Booton, E.T.D.; 20, How Hill, 1982, E.T.D.; 29, Thwaite St. Mary, 1982, P.W.L.

Veronica praecox All.
W78, Weeting Heath, introduced, 1976, G.C.; 79, Feltwell, 1977, E.L.S.; 98, Garboldisham, 1977, G.C.

Viola palustris L. ssp. *palustris* Marsh Violet.
E41, Potter Heigham, v. abundant in acid pasture, 1982, P.W.L.

Viscum album L. Mistletoe.
E13, Corpusty on apple, 1975, M.A.B.; 50, Breydon on poplar, 1974, E.T.D.

Vitis vinifera L. Grape Vine.
W91, Beetley Pit, 1980, R.P.L. & E.T.S.

BRYOPHYTES

Mosses

Bryum gemmiferum Wilcz. & Demar.
W51, West Lynn Church, 1982, R.P.L. & E.L.S.

Fissidens exilis Hedw.
W62, Reffley Spring Woods, 1983, R.S., new to Norfolk.

Hedwigia ciliata (Hedw.) P. Beauve.
W61, Blackborough End pit, 1983, R.S., new to Norfolk.

Hypnum jutlandicum Holmen & Warncke.
W62, Wolferton, sandy cliff, 1983, R.P.L. & E.L.S.

Schistidium apocarpum (Hedw.) Br. Eur.
W51, Wiggenhall St. Mary the Virgin, 1982, R.P.L. & E.L.S.

Ulota ciliata (Hedw.) Brid.
W71, Green Hill, Gayton, 1983, R.S.

Ulota crispa var. *norvegica* (Groenvall) Smith & Hill.
W71, Green Hill, Gayton, 1983, R.S.

A NEW FLEA FOR NORFOLK

by Ian Simmons

c/o Natural History Dept. Castle Museum, Norwich.

The flea *Orchopeas howardi* Baker, was introduced into Britain with the Grey Squirrel, its true host. In areas where the Grey has replaced the Red Squirrel, *Orchopeas* is often replaced by the Red Squirrel flea *Monopsyllus sciurorum* Schrank. This has been the case in Norfolk where the only fleas recorded from the squirrel population have been *Monopsyllus*. However, two female *Orchopeas* were collected from a Grey Squirrel at Howe, East Norfolk (TG 2800) on 18th September 1982 (*leg* A. Irwin) and although it is established in most of Britain (George 1974) I believe these are the first specimens to be found in Norfolk.

Also worthy of note are two further records of fleas. Firstly a male *Spilopsyllus cuniculi* Dale, the rabbit flea, was recorded as a straggler on a Grey Squirrel at Whitlingham, Norfolk (TG 265076) on 8th March 1977 (*leg* J. Goldsmith). It has been found previously as a straggler on cats, hares and foxes, but there are no records of any collected from squirrels. Secondly, a female *Dasypsyllus gallinulae* Dale, a parasite of birds nesting near the ground, was found in debris from a small mammal trap at Ellingham Hall, Norfolk (TM 349929) on 22nd February 1977 (*leg* J. Goldsmith). It probably came off the small mammal captured by the trap. Unfortunately the mammal species is not known. It is possible, however that the flea was introduced when the straw was placed in the trap.

All specimens mentioned above are to be found, mounted on slides, in the collections of the Norwich Castle Museum.

Reference

George, R. S. 1974. Siphonaptera, *Provisional Atlas of the Insects of the British Isles* Part 4 Inst. Terr. Ecol. Huntingdon.

ADDITIONS TO THE FLORA OF BLAKENEY POINT, NORFOLK-3

by D. J. B. White and K. Taylor

Department of Botany and Microbiology, University College London.

Introduction

A number of species were added by White (1972) to the annotated list of the flowering plants and ferns found on Blakeney Point (White, 1967). Recently, a few additional species have been identified and these are listed below.

DICOTYLEDONES

Rubus fruticosus agg. Blackberry

Known for some years as an occasional plant on the dunes. In the summer of 1980, the following species included in the aggregate were collected by us and kindly identified by Mr. E. S. Edees.

Sub-sect. Discolores
Rubus ulmifolius Schott
Vigorous specimens occur on the Hood, the Long Hills and on the dunes at the head of Great Sandy Low.

Sub-sect. Appendiculati
Series Vestiti
Rubus boreanus Genev.
Found growing with *R. ulmifolius* on the Hood. A local and rather variable species in Norfolk.

Sub-sect. Caesii
Rubus caesius L. Dewberry
A few plants present for some years are now spreading extensively on the Beacon Hills.

A possible hybrid between *R. caesius* and a plant from the subgenus Rubus which is referred to *'Rubus corylifolius'* occurs on the dunes between the laboratory and the plantation.

MONOCOTYLEDONES

Festuca rubra subsp. *arenaria* (Osbeck) [Syn *F. arenaria* Osb., *F. rubra* var. *arenaria* Fr.]

Common throughout the dune system. Two divergent types occur; one is restricted to the main dune ridges where wind-blown sand is actively accreting, the other is widespread on the semi-fixed and fixed dunes (Anderson and Taylor, 1979). There are measurable morphological differences between the two forms, which are accentuated by rabbit grazing; on the mobile dunes the fescue grows to a height of 20-90 cm, whereas on the fixed dunes it attains a height of between 8-16 cm. They also show different morphological and physiological responses to sand accretion. Plants of both types are Octaploids (2n = 56).

The fescue forming a band-like zone on the seaward edge of the main dune ridge was previously described as *Festuca arenaria,* whereas the fescue occurring on the consolidated dunes behind, was included with *Festuca rubra L. subsp. rubra.*

References

ANDERSON, CLARE and TAYLOR, K., (1979). Some factors affecting the growth of two populations of *Festuca rubra* var. *arenaria* on the dunes of Blakeney Point, Norfolk. *Ecological Processes in Coastal Environments.* (Ed. R. L. Jefferies and A. J. Davy) pp. 129-143. Blackwell Scientific Publications, Oxford.

WHITE, D. J. B. W., (1967). 'An annotated list of the flowering plants and ferns on Blakeney Point, Norfolk', 2nd Edition. National Trust.

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A FOLLOW UP NOTE ON THE FLORA OF NORTH AND SOUTH WOOTTON

by C. P. PETCH, M.D., F.R.C.P.

The Manor House, Wolferton, Norfolk.

In 1970 (*Trans. Norf. & Norwich Nats* **22** 43) I reported changes seen in the Flora of the two parishes of North and South Wootton, in West Norfolk, during the previous 45 years. At no time during this period was the Bee Orchid, *Ophrys apifera,* seen or recorded. In June 1982 however I was told that various orchids had appeared on an abandoned arable field in North Wootton which had been sold for building and was awaiting development. A visit showed a number of plants of *Dactylorhiza praetermissa,* which occurs in several other places nearby, plus seven large flowering spikes of a new comer, *Ophrys apifera.*

I had known the field for over 50 years and had often walked over it after harvest. Although the soil was sandy, bordering as it did on the Greensand of Ling Common, the southern part was wetter and badly drained, and it was here that the orchids grew. Cultivation had been abandoned some 15 years previously, a few years before the farm was sold and the rest of the field left. The whole was then colonised by coarse grasses (*Arrhenatherum elatius, Dactylis glomerata*) and perennial arable weeds, e.g. *Cirsium arvense,* and the wetter part invaded by scrub. In 1982 the orchids were associated with the following plants:

Angelica sylvestris	o	*Medicago lupulina*	a
Arrhenatherum elatius	a	*Mentha aquatica*	o
Cerastium vulgare	f	*Poa trivialis*	f
Cirsium arvense	a	*Potentilla anserina*	a
Crepis capillaris	f	*Quercus robur* (saplings)	r
C. taraxacifolia	r	*Rhinanthus minor*	a
Dactylis glomerata	f	*Rosa canina*	r
Dactylorhiza praetermissa	o	*Rubus fruticosus* agg.	r
Epilobium angustifolium	o	*Salix caprea*	o
E. hirsutum	o	*Senecio jacobea*	r
Festuca rubra	f	*Stellaria holostea*	r
Holcus lanatus	f	*Trifolium repens*	f
Juncus inflexus	o	*Tussilago farfara*	r
Lathyrus pratensis	r	*Vicia angustifolia*	f

Visiting the site again in June and July 1983, I found the vegetation essentially the same, but the Bee Orchids had increased. I counted 32 flowering spikes widely scattered over the south part of the field. Their arrival, and establishment, in so isolated a locality after so many years is of interest. The nearest source of seed might have been a colony on a patch of Boulder Clay on Grimston Warren 4 km to the south east, but since 1965 this has been gradually suppressed by a plantation of *Pinus nigra,* and I have not seen orchid flowers here since 1968. The only permanent populations of Bee Orchids in West Norfolk are those of the coastal sand dunes, which have persisted in varying numbers throughout the period of my observations at Holme, 21 km to the north and Scolt Head, 29 km to the north east.

No building has yet been started in the orchid area, but the plants are of course doomed. Even if development were deferred indefinitely the growth of scrub would

render the site unfavourable for them. Their occurrence here is a further illustration of their wide seed dispersal and ability to occupy any possible habitat.

FRESHWATER RECORDER'S REPORT

by R. J. DRISCOLL

Nature Conservancy Council, P.O. Box 6, George Street, Huntingdon.

The most interesting records in 1983 were all of dragonflies. Despite the current interest in odonata the dragonflies of Norfolk are still relatively underworked and a great deal of basic recording remains to be done (three of the records included here were obtained during a single day's recording!).

Aeshna juncea (L.)

Although *Aeshna juncea* is widely distributed throughout the British Isles it has seldom been recorded from East Anglia. Between 1974 and 1983 *A. juncea* was recorded on a few occassions in the Horsey area but no specimens were retained for confirmation. On 27 July 1983 W. Urwin found several exuviae in the artificial natterjack toad pond at Winterton Dunes N.N.R. (Grid Ref. TG 4821). The exuviae were identified by R. Merritt.

Aeshna isosceles (Müller)

An adult *Aeshna isosceles* was seen on the wing at Woodbastwick (Grid Ref. TG 3316) on 9 July 1983 by M. J. R. Howat. This was the first recent record of *A. isosceles* from Bure Marshes N.N.R. and came from a part of the reserve where management by the Nature Conservancy Council after years of neglect had led to a recovery of the dyke vegetation.

Anax imperator Leach

A large number of *Anax imperator* was recorded in a flooded gravel pit near Leziate Heath (Grid Ref. TF 6618) by W. Urwin on 16 July 1983.

Sympetrum scoticum (Leach in Donovan) and
Sympetrum sanguineum (Müller)

On the same day he recorded *A. imperator* W. Urwin also recorded *Sympetrum scoticum* from another pit near Leziate Heath (Grid Ref. TF 6618) and *Sympetrum sanguineum* from a pool near Leziate Fen (Grid Ref. TF 7019).

RARE AND INTERESTING FUNGI — 1983

by R. E. Evans

Chanterelle, Welbourne, Norfolk.

During the year forays carried out by the Fungi Group were well attended and many good finds were made.

A first for many beginners was a small group of *Geastrum fornicatum* under Yew trees in Narford Hall grounds. Along the disused railway track near Attlebridge the rare *Plectania melastoma* was found growing on dead twigs. A century ago this was considered common, but recent finds indicate that it is now a rarity. At Holme, specimens sent to me by a friend proved to be *Poronia punctata,* this was found growing on horse dung. In the literature it is described as rare but apparently not extinct. A truffle, *Tuber excavatum* was found in the soil of a greenhouse at Barnham Broom by Mr. and Mrs. Geeson. The presence of a beech hedge close by may be of significance.

Other fungi of note were: *Lyophyllum semitale* — Swanton Novers, *Gyroporus castaneus* — Felthorpe, *Mycenella lasiosperma* — Lenwade Pits, *Melanoleuca iris* — Wells Dunes, and *Spathularia flavida* — West Harling.

BUTTERFLIES OF NORFOLK IN THE 19th AND 20th CENTURIES

by E. A. Ellis

Wheatfen, Surlingham, Norfolk.

Introduction

The second half of the 18th century saw the beginning of a renaissance in the study of insects in Norfolk and local entomologists contributed records which became embodied in the major works on the British insect fauna in the early part of the following century. These contain some of the earliest references to the county's butterflies. The first catalogue of particular regional interest was given by C. J. and James Paget in their *Sketch of the Natural History of Yarmouth* published in 1834, which included thirty-one butterflies. We next come to C. G. Barrett's annotated list of Norfolk Lepidoptera published as a supplement to the *Transactions of the Norfolk and Norwich Naturalists' Society,* 1873-4, in which most of the significant records up to that time were embodied. Only a few additions were made in Barrett's subsequent lists in the same *Transactions,* III, 683, 1884; IV, 691, 1889 and VI, 553, 1899. In the present century there has been a scatter of miscellaneous observations pertaining to butterflies in the *Transactions*, the *Entomologists' Monthly Magazine, The Entomologist*, the *Entomologists' Record* etc., while many useful records were published in a series of consecutively numbered notes entitled Norfolk and Suffolk Wild Life, in the *Eastern Evening News*, from 1932 to 1938. Popular interest in our butterflies has been reflected in the correspondence columns of the *Eastern Daily Press* in the last fifty years and this also has been examined during the preparation of this account. Old collections, several of which are now in Norwich Castle Museum, are important in helping to verify past records, but also bear witness to instances of over-collecting in the case of some rare and local species. In

recent years county entomologists have given much attention to mapping the distribution of our butterflies, both in connection with a national survey and for the biological records centre at Norwich Museum. A Norfolk branch of the British Butterfly Conservation Society is now active in undertaking habitat surveys and taking practical steps to ensure the survival of these insects.

Norfolk's extensive coastal dunes have been least affected by environmental threats and continue to afford sanctuary for their butterflies, while the grass heaths and forest rides of Breckland have been increasingly important refuges for many species which have lost ground elsewhere through agricultural pressures. The surviving relics of our formerly extensive heaths suffer only too commonly from fires, but many commons provide varied terrain favourable to butterflies of grassland and scrub, as do derelict railway tracks, some country churchyards and old meadows. The fact that the greater part of the fens flanking the Broads is in the ownership of conservation bodies has so far ensured the survival of the indigenous Swallowtail, while some other species also benefit in a variety of habitats provided within the reserve boundaries. Wayside banks and hedges have tended to suffer from pollution inimical to butterflies and their larvae as road traffic has increased and the management of farmland, involving hedge destruction, the use of pesticides and heavy machinery and the substitution of seeded grasses for former, herb-rich hay meadows and pastures, has virtually eliminated resident butterflies from large parts of the countryside. Finally, we have seen the decimation of most of the county's old deciduous woodlands in the 19th century and this has resulted in the near or total disappearance of their special butterflies, such as the Silver-washed Fritillary and Purple Emperor.

Climatic influences commonly determine the fortunes of butterflies from year to year and the effects of unfavourable weather can be disastrous for species whose residual population is small. On the other hand, we have seen great increases in some species take place following hot summers. When dull, rainy weather persists in the breeding season, butterfly activity is halted and there are few opportunities for mating. Hibernating species suffer losses through premature restlessness in very mild winters.

The effects of predation by birds and mammals on our butterfly larvae have not been evaluated, but could be significant in the case of rare and severely localised species. We have evidence of many butterflies being taken on the wing by Swallows, Spotted Flycatchers, Wagtails, Warblers and House Sparrows and occasionally by Great Tits, Robins, Kestrels and Jays. The most spectacular slaughter of these insects is witnessed among the butterflies attracted in large numbers to the flowers of *Buddleja davidii* in gardens where Swallows abound. Predation by insects appears to be fairly minimal except when Hornets concentrate attention on Small Tortoiseshells, Red Admirals and Peacocks at buddleja flowers and slaughter hundreds in some instances. Dragonflies, common wasps and the flower-haunting crab spider, *Misumena vatia* also attack butterflies and hibernating Peacocks have been reported killed by house spiders and mice. The effects of hymenopterous and dipterous parasites on butterflies in local habitats have not been studied in any depth, although almost total decimation of Large White larvae by the braconid *Apanteles glomeratus* is commonly witnessed. Viruses, bacteria and moulds take toll of eggs, larvae and pupae from time to time.

Butterflies are prone to be dispersed widely by strong winds and through the

operation of thermals in hot summers. We have also seen some evidence of intentional movements away from local haunts by male Brimstones while the females remain behind, a habit which promotes out-breeding.

It is not uncommon to see Small and Green-veined White butterflies assembling to imbibe moisture from lakesides, wet sand on the seashore and liquid manure in farmyards. The Green-veined White will sometimes find honeydew from aphids attractive and I have twice found numbers of this species trapped by round-leaved sundews on Buxton Heath, Hevingham. The Red Admiral may often be seen drinking sap oozing from old trees and visiting Camberwell Beauties have been noticed behaving in this way, while these two species, along with the Comma, are much attracted by rotting fruit.

Except in the Swallowtail, no endemic local race has been detected here, although it was at one time held that the Chalk-hill Blue population formerly existing at Ringstead Downs differed slightly from others in Britain. Early and late broods of several species tend to differ in their colouring here as elsewhere and aberrations tend to occur most frequently in hot summers. As populations of once common and widespread species become fragmented and isolated they could well develop differences and this aspect of future behaviour deserves attention, even in respect of still common, but declining species as the Meadow Brown.

The order and naming of species in the following list is in accord with Kloet and Hincks *Check List,* Part 2, *Lepidoptera*, revised edition, 1972.

ANNOTATED LIST OF SPECIES

Chequered Skipper *Carterocephalus palaemon* (Pall.)

A single record of the capture of a specimen by William Cole, at Croxton, vouched for by Rev. H. Williams, who was present on the occasion (B. 1884).

Small colonies of this species, associated chiefly with Wood False Brome grass, occurred formerly in several neighbouring counties from which it has vanished in recent years.

Small Skipper *Thymelicus sylvestris* (Poda)

Barrett (1874) lists several localities without commenting on the status of this species. It is now common and widespread in dry, grassy places, both on the coast and inland, from late June to the end of August, although numbers fluctuate noticeably from time to time.

Essex Skipper *Thymelicus lineola* (Ochs.)

F. W. Frohawk (*British Butterflies,* 1934) states that he acquired specimens originally in a Norfolk collection made in 1820-30.

In recent years it has been found very locally in grassy places on the coast near Great Yarmouth and the Wash, the Breck-Fen margin and (in 1972) on the site of a former airfield at Hardwick.

Silver-spotted Skipper *Hesperia comma* (L.)

Barrett (1899). "A single specimen secured by E. A. Atmore on the verge of the Chalk district a few miles from Lynn". H. J. Thouless, *Trans. Norf. & Norw. Nat. Soc.,* vii, 425, 1902, includes this species in a list of insects collected by him at Narborough and Walton Common on 5 August, 1901.

Large Skipper *Ochlodes venata faunus* (Turati)

Barrett (1874). Common in woods. Now widespread, abundant in some years (e.g. 1936 and 1970) and rather scarce in others. Its frequent association with the Wood False Brome grass as a food plant helps it to escape the effects of the recent changes in grassland management affecting butterflies of former hay meadows.

Dingy Skipper *Erynnis tages* (L.)

Barrett (1874) cites early 19th century references to its occurrence in Norfolk by Haworth and Stephens and gives Ditchingham, Cawston and Ketteringham as localities. It can now be met with locally in all quarters of the county, especially on dry grassland of heaths and chalk and in some derelict railway cuttings, where Bird's-foot Trefoil is its main food plant. Flying in May and June, it sometimes gathers in clusters on tall grasses.

Grizzled Skipper *Pyrgus malvae* (L.)

Barrett (1874): local; Ditchingham, Woodton, Ketteringham, Cawston, Horning. Recorded from Felthorpe and Haynford in the 1930's; Roydon Common, 1974 (A. Johnson) and since 1980 at Foulden Common and very locally elsewhere in Breckland, flying in May and June. The most usual food plants are Wild Strawberry and *Rubus* spp.

Oberthur's Grizzled Skipper *Pyrgus armoricanus* (Oberthur)

Barrett (1899), as *Syrichthus alveus* Hubn. records the taking of several specimens in a damp valley, bordered by a wood, near Cawston, by the Rev. T. H. Marsh about twenty-five years previously.

The claim to the inclusion of this continental European species on the British List rests mainly on these specimens, which are now in Norwich Castle Museum. On critical examination they have been determined as *P. armoricanus*.

Apollo *Parnassium apollo* (L.)

A fine specimen of this mountain butterfly frequented a derelict lime kiln at Catton, near Norwich, from 23 to 26 July, 1947, by A. Hudson, who confirmed its identification on consulting collections in Norwich Castle Museum at the time. It spent much time visiting flowers of Ragwort and other yellow composites. The arrival of this vagrant coincided with that of a great swarm of immigrant Large Whites.

Swallowtail *Papilio machaon britannicus* Seitz

Barrett (1874) recorded its occurrence only in the Broads district, on all fens of the Yare, Bure and their tributaries. Its present status is similar, chiefly conditional on the presence of Milk Parsley which its preferred larval food plant, although it has been observed that caterpillars of the partial late summer brood also occur on Angelica not infrequently and occasionally on cultivated Carrot on sites adjacent to fens. The population fluctuates markedly, depending on weather factors from year to year, but most of the essential haunts of this butterfly lie within the bounds of nature reserves. The increased incidence of tidal flooding in the Yare fens appears to have had an adverse effect on the population in recent years, by drowning the pupae in winter. In 1959 the insects were favoured by fine, sunny weather from May onwards and were on the wing from that month until August, when there was a big emergence, followed by the production of very numerous larvae, many of

which failed to pupate as a result of inclement weather in the autumn. A marked recession in the species generally in the Broads area was observed in the following year, but recovery followed and the insects were again generally abundant in 1964.

Melanistic examples have appeared on several occasions from 1921 onwards, chiefly at Ranworth Broad where, by 1934 no less than seventeen were taken by collectors. Six were seen on one day by an angler there. A 'smoky' example was reared by R. I. Hooke from a Hickling larva in May, 1933.

I encountered a black Swallowtail sunning itself on sedge alongside Ranworth Dyke on 17 May, 1936 and another at Wheatfen Broad on 29 May, 1944. Peter Clarke saw one at Stalham in 1955; Frank Pigg saw a dusky specimen at Martham Broad in August, 1973 and Anya Bertholdt saw a black one at Horsey in June, 1979; so it would seem that the genes determining melanism still linger in the native stock.

Stray swallowtails have appeared well away from their breeding grounds at times, reaching Norwich, Dereham and Swaffham when strong easterly winds have been blowing; wanderers have turned up at Weybread and Bungay to the south and in north Norfolk (one was washed up on Sheringham beach in July, 1958). I have yet to see an undoubted Norfolk-caught specimen of the Continental subspecies *bigeneratus* Verity which appears in southern England as an immigrant occasionally.

Pale Clouded Yellow *Colias hyale* (L.)

An irregular immigrant seldom numerous on arrival in this county.

Recorded as 'very rare' in the neighbourhood of Great Yarmouth by C. J. and J. Paget, 1834. Barrett (1874): 'Very irregular; common in 1868.' Very few have been reported in the county in the past fifty years, the most recent being two at Shouldham Thorpe, 31 July, 1983 (G. A. Williamson) and one on *Phlox* at Overstrand, 15 August, 1983 (Mrs D. Whittingham). Berger's Clouded Yellow, *C. australis* Verity has not yet been detected here.

Clouded Yellow *Colias croceus* (Geoff. in Fourcr.)

Immigrant and summer resident (on clover and lucerne).

Barrett (1874) noted that it was sometimes of general occurrence, but irregular in its appearances, the var. *helice* being rare. Although this species arrives on the south coast of England in varying numbers in most summers and occasionally in very large numbers (as in 1947 and 1983), the proportion spreading to Norfolk tends to be relatively small. It appeared widely in the county from June to August in 1983, from Breckland to the coast.

The Pagets (1834) reported that it was not uncommon about Great Yarmouth in some years.

Brimstone *Gonepteryx rhamni* (L.)

A widely distributed and common resident, the single brood emerging in July or August and reappearing in early spring after hibernation (usually in the shelter of evergreens). Its status has varied little since records began. The yellow males tend to wander widely whereas the females usually remain near their home sites where Common or Alder Buckthorns are present to feed the larvae. Buckthorns flourish in Broadland fens and in the chalkier parts of Breckland, while the occurrence of chalky boulder clay elsewhere favours their appearance quite frequently in thickets and the older hedges.

Black-veined White *Aporia crataegi* (L.)

The sole evidence for this species having occurred in Norfolk lies in a statement made in Curtis's *British Entomology*. Formerly resident in several parts of southern England until its extinction in the present century, it can now be expected to appear only as a sporadic vagrant.

Large White *Pieris brassicae* (L.)

Long recognised as common (Pagets, 1834; Barrett, 1874), the first local reference to its migratory habit was made by Barrett in 1887, when 'great multitudes' (with *P. rapae*) invaded Hunstanton at the end of May and were thought to have freshly arrived from the sea, on a bright, sunny day with a cold N.E. wind. In August, 1902, also at Hunstanton, E. A. Atmore saw them coming in from sea like a snowstorm from mid-morning to 6.0 p.m. On 4 June, 1925 Miss E. L. Turner saw clouds of them flying west at Scolt Head 2.0 p.m. to dusk. Further major migratory influxes occured in 1933, 1936, 1937, 1940, 1943 ('snowstorm'), 1947, 1950 and 1958, since when the numbers arriving have been much reduced and in some years almost nil, e.g. in 1960.

The caterpillars are almost always heavily parasitised by a braconid wasp, *Apanteles glomeratus* (L.); but in 1963, following a very severe winter, autumn larvae experienced a marked respite from the attentions of this enemy. Caterpillars have been found active on brassicas occasionally in January and February. It is not unusual for a few butterflies to emerge in spring from pupae sheltered in greenhouses and other buildings, but the species relies chiefly on fresh influxes of migrants to maintain its position as a common summer butterfly. I have been informed by Mr. A. Rix (Norwich) that a local name used for this butterfly, c. 1912, was 'The Doctor'.

Small White *Pieris rapae* (L.)

Generally abundant in the 19th century (Pagets, 1834; Barrett, 1874) and still common in most years as a permanent resident, normally double-brooded, appearing from April to September and occasionally October. Major immigrations have been noted in 1887, 1932, 1937, 1943 and 1958, usually with *P. brassicae*.

Green-veined White *Pieris napi* (L.)

Abundant and widespread in the 19th Century (Pagets, 1834; Barrett, 1874) and continuing so as a permanent resident and occasional immigrant. Appearing with great regularity in a variety of situations, this species clearly gains some advantage in laying eggs singly on many common wild crucifers. Damage to brassicas from its caterpillars is much less than that caused by *P. brassicae* and *P. rapae*.

Bath White *Pontia daplidice* (L.)

An irregular immigrant, chiefly to the south-west of England, rarely in other than small numbers, this insect has been recorded in Norfolk, on each occasion singly, at Harford Bridges, Norwich, 17 July, 1912 (G. H. Gurney) (specimen in Norwich Castle Museum); at Kelling, July, 1914 (K. Bagnall-Oakeley) and visiting flowers of *Reseda lutea* at Cold Harbour, Didlington, 20 June, 1974 (Miss Vivien Leather).

Orange-tip *Anthocharis cardamines* (L.)

As now, evidence suggests that this species has long been consistently widespread and common with us, the single brood being on the wing between April and June, emergence being regulated by the prevailing weather from year to year. Survival in a variety of habitats, both wet and dry, is facilitated by the choice of several alternative plants as hosts for the larvae, including Lady's Smock, Garlic Mustard, Honesty and sundry cresses.

Green Hairstreak *Callophrys rubi* (L.)

Appearing between March and June, colonies of this species occur chiefly where gorse and broom flourish on a number of our surviving heaths, notably in north Norfolk, Breckland and to the north of Norwich. Its general pattern of distribution is much the same as in the last century, although many of its former haunts have been destroyed and its survival tends to be threatened by recurrent heath fires.

Brown Hairstreak *Thecla betulae* (L.)

Barrett (1874) quotes T. H. Marsh's report of having met with this species at Sall. I have come across no other record of its occurrence in the county, although the Blackthorn thickets on many of our commons would appear to offer suitable habitats for it.

Purple Hairstreak *Quercusia quercus* (L.)

Associated rather locally with oaks, in the Broads district, the country round Norwich, north Norfolk and westwards into Breckland, its recorded distribution appears to have changed little since early in the 19th century. Doubtless it is often overlooked owing to its habit of flying about the tops of the trees in July and August. On 2 June, 1971, at Wheatfen, I found a larva of this species feeding on green holly berries, like those of the Holly Blue, and being 'milked' by red ants. Presumably it had made an adaptive change of diet after falling from an adjacent oak. In due course it produced a male butterfly.

White-letter Hairstreak *Strymonidia w-album* (Knoch)

Barrett (1874) refers only to his belief that he had seen a number at Newton St. Faith's in August, 1872. Confirmation of its occurrence in the county came when H. J. Thouless met with it at Stoke Holy Cross on 10 July, 1881 and Barrett recorded it from Lynn in July, 1888.

Although associated with elms, which have suffered widespread decimation in recent years, this butterfly still maintains a presence, very locally, notably in Breckland, but also here and there in the north, east, south and centre of Norfolk.

Black Hairstreak *Strymonidia pruni* (L.)

A male discovered at Shropham on 16 July, 1974 by Mrs. N. Bagnall provides the sole evidence of its occurrence here. One can only speculate as to the manner of its arrival many miles from its regular haunts in Northamptonshire.

Small Copper *Lycaena phlaeas* (L.)

Formerly very common and widespread, the population of this species has declined overall in recent times. Although still appearing widely, with a good deal of irregularity as to its numbers, it now thrives most successfully in Breckland, where

there is plenty of Sheep's Sorrel. Its disappearance from many old meadows can be blamed on the eradication of Sorrel by herbicides and other modern practices in the treatment of grassland.

In the long, hot summer of 1921 it achieved phenomenal abundance and produced an extra brood in the autumn in which aberrant individuals appeared in unusual number and variety. In the vicinity of Great Yarmouth I encountered several in which the copper of their wings was replaced by gold or white, while many of the females had conspicuous blue crescent spots on their hind wings.

Large Copper *Lycaena dispar dispar* (Haworth)

This endemic race, discovered in the fenlands about Ely by W. and F. Skrimshire in the last decade of the 18th cenutry, occupied sites in Cambridgeshire and Huntingdonshire and was recorded also from Bardolph Fen in west Norfolk and at Benacre on the coast of Suffolk. Until recently it was believed that it became extinct by 1851 and a report of its occurrence in the Broads district at Ranworth by W. Winter in 1858 had been discounted. However, Dr. A. G. Irwin (*Entomologist's Record*, 1984), having examined the credentials of two specimens in a Norfolk butterfly collection (a male, Ranworth, 1860 and a female, Woodbastwick, 1864, both taken by William Bolding) sees no reason to doubt their authenticity.

Large Copper *Lycaena dispar batavus* (Oberthur)

Following the establishment of this Dutch endemic at Woodwalton Fen, near Huntingdon, eighty of the butterflies were liberated at Wheatfen Broad, Surlingham, in late June and July, 1949. These laid many eggs on scattered, conspicuous water docks and larvae over-wintered successfully, producing a large and thriving population of adults in the summer of 1950.

Although there was some predation by whitethroats, egg-laying was again extensive and many young larvae went into hibernation; but just after these had shed their protective hairy skins and begun to appear on newly sprouting foliage they became submerged and drowned in an April flood. The few survivors then faced little chance of successful reproduction because water docks in the area were virtually eliminated by feral coypus in the Yare Valley fens in that year, bringing the experiment to an end.

Large Copper *Lycaena dispar rutilus* Werbebury

Five hundred and fifty butterflies of this Continental race, from north of Berlin, were liberated on Woodbastwick Fen in July, 1926. Eggs laid on water docks gave rise to a sizeable population of adults in the following summer; but this stock died out soon afterwards, due, it was believed, that most of the food plants failed to attract ovipositing females owing to the fact that they were largely surrounded by tall vegetation.

Little Blue *Cupido minimus* (Fuessly)

Barret (1874) records this chalkland species from South Creake, Cromer and Ketteringham. E. A. Atmore found it commonly near Swaffham in 1898. In the drought summer of 1921 I caught one from a pavement outside my house at Gorleston and this specimen was exhibited in Yarmouth's Tolhouse Museum for the next twenty years; its mysterious appearance so far from the nearest regular habitats to the west, in Cambridgeshire, suggested that it had been air-borne at a

time when the hot weather was giving rise to thermal activity on many days. The chief food plant, Kidney Vetch, though typically inhabiting chalk grassland, also occurs on outcrops of chalky boulder clay and this may have accounted for the butterfly's former presence at Cromer.

Silver-studded Blue *Plebejus argus* (L.)

Barrett (1874) recorded this as 'on all heaths'. It is now very local, but may still be seen on some of the heaths within a few miles of Norwich and in the north and west of the county.

Brown Argus *Aricia agestis* (Den. & Schiff.)

Barrett (1874) regarded this as common about Norwich, Lynn, Hunstanton, Merton, Thetford and Broome. It is now to be seen mainly in sandy places near the coast, especially in the north-west and most commonly in Breckland, where its food plant, Hemlock Storksbill flourishes.

Common Blue *Polyommatus icarus* (Rott.)

As in the past, this species occurs widely on our dunes, heaths, brecks and grassy commons, chiefly associated with Bird's-foot Trefoils and rest-harrows, appearing from late May to September, being most plentiful in fine, warm summers.

Chalk-hill Blue *Lysandra coridon* (L.)

Barrett (1874) recorded this as very local on chalk grassland in the vicinity of Snettisham, Hunstanton and Ringstead. The indigenous stock, essentially associated with Horse-shoe Vetch, is now believed extinct in its last stronghold at Ringstead Downs. A small colony became established at Warham Camp following the introduction of fifteen males and six females from Portland, Dorset, by David Ruthven in 1970. The nearest colony of any significance is situated along the Devil's Dyke, near Newmarket.

Mazarine Blue *Cyaniris semiargus* (Rott.)

Haworth, in *Lepidoptera Britannica*, records this now extinct British species as having been taken by the Rev. J. Burrell in Norfolk. Barrett (1874) queries this; but Burrell (1761-1825), born at Letheringsett, when elected a Fellow of the Linnean Society in 1800, was described as a good entomologist and during the time he lived in the county, though of very local occurrence and quixotic in appearance, the Mazarine Blue had a wide distribution in the southern half of England.

Holly Blue *Celastrina argiolus* (L.)

Periodically numerous and widespread but in some years scarce or absent. Barrett (1874) considered it 'not common', listing five localities. Years of plenty here have included 1927, 1933, 1935, 1936, 1959 to 1961, 1970 and 1971. In the autumn of 1971 larvae and newly formed pupae of the second brood on ivy blossom were subjected to three nights and days of persistent rime frost and it may have been this which accounted for the total lack of Holly Blue sightings in the county in the following year, after which the species was slow in re-establishing itself.

White Admiral *Ladoga camilla* (L.)

Evidence suggests that the hot, dry summer of 1921 initiated the spread of this but-

terfly from its old territory in the New Forest until, in the 1930's it had colonised most English counties up to the latitude of the Wash. Its first recorded appearance in Norfolk was at Ellingham in 1933; in the following year it was observed in the vicinity of Norwich, Haynford and Cromer, soon afterwards becoming established widely in the county, in woods where the food plant, Honeysuckle, was available. In the 1960's it vanished from many sites, but has continued to survive and occasionally appear in large numbers in both the east and west of the county, though much more locally than before.

Purple Emperor *Apatura iris* (L.)

Barrett (1874) listed sites for this at Foulsham, Dersingham and Foxley Wood and stated that it had occurred earlier at Whitlingham. In its chief stronghold, Foxley Wood, its survival has been menaced by unsympathetic management in recent years and it may well have become extinct there since 1974. There have been reports of its presence in two other localities in the north of the county, but its future here must now be very uncertain.

Red Admiral *Vanessa atalanta* (L.)

This reaches us in varying numbers almost every spring or early summer from S. Europe. Locally produced offspring often linger as late as October, though sometimes vanishing so suddenly as to suggest a mass departure as emigrants. Large influxes have been noted in 1892, 1893, 1899, 1900, 1914, 1920, 1924, 1928, 1933, 1935, 1936, 1938, 1945, 1964, 1966 and 1973 (autumn). The occasional appearance of this species here in March (e.g. several in 1965 following a year of abundance) supports the belief that some of the insects succeed in hibernating in local woods from time to time.

Painted Lady *Cynthia cardui* (L.)

Long familiar as an immigrant from the south in varying numbers (May to September) and breeding here, this butterfly does not overwinter successfully. Major influxes have occurred in 1818, 1879, 1888, 1903, 1920, 1923, 1926, 1931, 1939, 1945, 1947, 1948, 1966 and 1980. An unusually early example was taken on the beach at Kelling by Geoffrey Todd on 28 March, 1964. The larvae feed most frequently on Creeping Thistle but K. C. Durrant found a number of them on the Cotton Thistle (*Onopordum* acanthium) at Foulden in July, 1970.

Small Tortoiseshall *Aglais urticae* (L.)

A common and widespread resident, but its numbers fluctuate markedly over the years. Following hibernation (chiefly in buildings), a fresh brood emerges in June and July, when some individuals immediately take up sleeping positions in dark places while others remain active and produce a second brood flying from the end of August to October before hibernating. There is some evidence of at least internal migration in this species which would account for the replenishment of local stocks following periods of scarcity. Several have appeared on light vessels up to thirty miles off the Norfolk coast on various occasions. The name 'King Goerge' is applied to this butterfly very widely, but I have also heard it called 'King Charles' and 'King William' in East Anglia.

Large Tortoiseshell *Nymphalis polychloros* (L.)

Barrett (1874) listed seven stations for this insect, remarking that it had been formerly common, but then scarcer for some years until 1873, when it again appeared commonly. Since that time it has enjoyed periods of considerable abundance alternating irregularly with periods of scarcity. It was recorded as present quite widely in E. Norfolk, from Cromer in the north to Ellingham in the south, from 1929 to 1948 (when it was also seen at Dereham and Wells) but then disappeared except at Ellingham in the Waveney Valley, where a colony survived up to the autumn of 1961. At Wheatfen Broad it appeared annually until 1948 and then not for the following eighteen years; a single specimen was observed there, visiting flowers of scarlet runner beans, on 23 July, 1967 and I know of no certain records of its occurrence in the county since that time.

Camberwell Beauty *Nymphalis antiopa* (L.)

While it is not improbable that Norfolk received immigrants of this species when it appeared commonly in Suffolk in 1819, our first notice of its occurrence is that of the Pagets, who mention the capture of one at Yarmouth on 27 August, 1834. Barrett (1874) wrote that its visits were very occasional until a huge influx occurred in August, 1872, a few found to have hibernated here successfully in the ensuing winter, but not breeding. Smaller numbers have appeared at irregular intervals and a further major immigration took place in August, 1976, almost equalling that of the previous century. These migrants originate in Scandinavia. While here they have been found attracted by rotten apples, pears, plums and blackberries and by sap oozing from tree trunks; only a few have been seen visiting flowers.

Peacock *Inachis io* (L.)

Since records began this has been generally common here, appearing in late July or August according to the prevailing weather and hibernating in dark recesses including those offered by buildings, hollow trees, overturned boats and even tussock sedges in fens, either singly or in groups arranged in circular formation with heads facing inwards. On rare occasions they have been encountered in flocks estimated to number thousands in late August, as witnessed by Mrs. B. Cole between Methwold and Weeting 1977; when the spot was revisited a few days later not one was to be seen. In mid-August, 1973, twenty-one were observed flying east over open marshland at Halvergate. Drowned specimens have been found washed up on our beaches occasionally and there is clear evidence of fairly extensive wandering by this species, although it is not known to be a long-distance migrant.

Comma *Polygonia c-album* (L.)

This was a rare insect in 1874 when Barrett recorded that single specimens had been noted at Stradsett in 1858 and 1861 and that it had occurred sporadically at Great Yarmouth and Walpole. It appears to have vanished from the county by the end of the 19th century. After 1915 it became apparent that this butterfly was steadily spreading from its western retreat into the Midlands and southern counties, and subsequently it extended its range further north and east. It made its appearance in Breckland in the hot summer of 1933 and had spread to a number of localities farther east by 1935, becoming widespread by 1938. Since then it has continued to range throughout the county, being common in some years and less so in others, thus indicating its ability to survive hard winters (e.g. 1947 and 1963) and a

wide range of climatic variation over the years. Following hibernation, fully exposed on trees, it produces a summer brood which features a proportion of the ab. *hutchinsonii* and a further emergence takes place in autumn. A white variety was photographed near Norwich a few years ago. Besides visiting a wide range of flowers at different season, it is partial to the juices of ripe blackberries and windfall orchard fruits. In July, 1970, K. C. Durrant saw two imbibing fluid from the eyes of a dead roe deer at Foulden.

Small Pearl-bordered Fritillary *Boloria selene* (L.)

Barrett (1874) referred to this as of local occurrence, at Horstead, Cawston, Stratton Strawless, Hoveton St. John and Hethel in the eastern half of the county and at Wootton in the west. It is now very local and in the last fifty years has been found chiefly in the east: Cromer area, Melton Constable, Hainford, Irstead, Brumstead, Happisburgh and between Waxham and Winterton and to the west in Breckland. Larvae in dune habitats feed on Dog Violet (*Viola canina*).

Pearl-bordered Fritillary *Boloria euphrosyne* (L.)

Barrett (1874) gives records from Horstead, Stratton Strawless, Hockering and Ditchingham. This woodland insect is now rare and very local in both east and west Norfolk. It occurred at Alderfen Broad in 1934 and Haveringland (H. J. Howard) in 1946.

Queen of Spain Fritillary *Argynnis lathonia* (L.)

A rare immigrant. The Pagets recorded the capture of one at Caister, north of Gt. Yarmouth, in August, 1834 and Barrett (1874) mentions single occurrences at Plumstead, Booton and Beechamwell. There have been no recent records. There is a resident population of this species in Norway, so individuals reaching East Anglia could come either from there or southern Europe.

High Brown Fritillary *Argynnis adippe* (Den & Schiff.)

Barrett (1874) described this as local, in east at Horsford, Stratton Strawless, Cawston and Ditchingham and in west at Middleton and Runcton. In the last fifty years it lingered in some heath woodlands to the north of Norwich, e.g. Felthorpe, Station Strawless in the 1930's, but the lack of recent records suggests that it may now be extinct here.

Dark Green Fritillary *Argynnis aglaja* (L.)

The Pagets (1834) knew this at Caister and Barrett (1874) called it 'excessively local', at Caister and Whiteslea. E. T. Daniels found it on Yarmouth North Denes in 1936 and it was still present at Caister in 1956; it still occurs on the Horsey-Winterton dunes and has been met with sporadically along the coast near Wells on several occasions in the last fifty years and as recently as 1980.

Silver-Washed Fritillary *Argynnis paphia* (L.)

Barrett (1874) described this as widely distributed but not common. Its chief haunt in the 19th century was Foxley Wood. In the 1940's it occurred at West Runton and Wheatfen Broad and J. Gane recorded it at Felthorpe in 1971, but it would not appear to have become extinct in this county, apart from some recent attempts at its re-introduction in the Waveney Valley.

Marsh Fritillary *Euphydryas aurinea* (Rott.)

Barrett (1874) recorded this in marshy meadows: (east) Norwich, St. Faith's, Cawston, Horning and Aldeby amd (west) Beachamwell. Up to 1974 it flourished in one locality near Norwich, but has vanished since the area was planted with poplars (A. E. Johnson).

Speckled Wood *Pararge aegeria tircis* (Butler)

Barrett (1874) recorded this as not very common: (east) Norwich, Ditchingham, Sparham and (west) Merton and Thetford. The Pagets (1834) knew it sparsely near Great Yarmouth and I was shown two specimens taken at Gorleston in 1915. In the 1930's it occurred regularly at West Runton and near Hunstanton and was recorded at Downham Market in 1933 and 1935. In 1960 it was found to be flourishing at Great Hockham in afforested Beckland and has since spread widely and successfully in west Norfolk and reappeared in neighbouring Suffolk after a long absence.

Wall Brown *Lasiommata megera* (L.)

As in the past this grassland butterfly is common and widespread, from May to early September, but has proved relatively scarce in some years recently. Nowadays it has come to be associated particularly with sunny hedge banks and the walls of estuaries and saltmarshes and often flourishes beside derelict railway tracks.

Marbled White *Melanargia galathea* (L.)

Said to have been plentiful at Ellingham in 1857 and recorded at nearby Kirby Cane by Crowfoot at about that time, it no longer occurs in this county.

Grayling *Hipparchia semele* (L.)

Barrett (1874) recorded this as generally common on heaths and coast sandhills and the same applies now, although there are fewer open heaths than formerly. It is most plentiful at the coast and on open brecks. Individuals are sometimes carried some distance from their usual haunts by strong winds, as happened in mid-August, 1944, when some appeared in the middle of Norwich and one reached Wheatfen.

Gatekeeper or Hedge Brown *Pyronia tithonus* (L.)

As in earlier times, this is abundant and widespread from late June to September in most years, frequenting heaths and hedgerows. Rather mysteriously its numbers can be low in one season and high in the next, e.g. 1956-57 and 1965-66. It is exceptional among our butterflies in continuing flight when gentle rain is falling.

Meadow Brown *Maniola jurtina* (L.)

Although, as in the past, a common and widespread grassland species, on the wing from late June to September, it has suffered considerably from the loss of old pastures and hay meadows in recent years.

Small Heath *Coenonympha pamphilus* (L.)

As formerly, common and widespread chiefly on the drier grasslands and notably plentiful in the Breck district.

Ringlet *Aphantopus hyperantus* (L.)

Barrett (1874) regarded this as sufficiently local to list localities for it, though

enough to indicate a wide distribution from north to south and east to west. It frequents the more sheltered grassy waysides, rough meadows in valleys, and woodland clearings, from late June to early August and may be described as common in suitable habitats.

Monarch *Danaus plexippus* (L.)

While it is uncertain that this North American vagrant has reached Norfolk as a true wanderer from across the Atlantic, one seen by Peter Clarke at Sheringham in 1947 and another by Mrs. Williamson and a friend in a Ditchingham garden on 7 September 1969 may have been such; however, breeders have released some of these insects in the county on occasion, e.g. at Roydon, near Diss in 1979.

NOTES TO CONTRIBUTORS

1. All manuscripts submitted for publication should be sent to P. W. Lambley, Castle Museum, Norwich.

2. Manuscripts should be typed double spaced on one side of the paper. Latin names of genera and species should be underlined. Dates should be in the form 1 January 1972. Text figures should be referred to as Fig. 1, etc.

3. All Latin names should be followed by the authority when the name is first mentioned in the text or table.

4. References should be in alphabetical order at the end of the paper, in the form of:

Bloomfield, E. N., 1905. Fauna and flora of Norfolk.
Trans. Norfolk & Nor. Nat. Soc., 8. 117-37.

5. Tables should be set on separate sheets and numbered in arabic numerals.

6. Drawings should be in jet-black indian ink. Shading should be in lines or dots but not in half-tone washes.

7. Page-proofs only will be sent. They should be returned with the least possible delay, and the minimum of essential correction should be made.

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