

## **ARUM ITALICUM (ARACEAE) IS INVASIVE IN NEW YORK**

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### **ABSTRACT**

Spontaneous populations of *Arum italicum* (Italian Lords and Ladies) are documented from Bronx and New York counties in southeastern New York state. Three populations are documented from New York Co. (Manhattan): Inwood Hill Park with dozens of discrete clusters in an area of 2500 square meters of mostly spontaneous deciduous forest; Fort Tryon Park with dozens of discrete clusters in an area of 20,000 square meters of cultivated garden beds; and the Upper East Side of Manhattan, near Carl Schurz Park and the FDR Drive, with four discrete clusters in an area of about 60 square meters of open, highly disturbed, currently fallow ground. The Bronx Co. population, in the New York Botanical Garden, consists of two discrete clusters in an area of about 6 square meters of mostly native, deciduous forest. Each cluster consists of a few to dozens of plants. The Inwood, Fort Tryon, and NYBG populations are documented with herbarium specimens and DNA samples and the Carl Schurz population is documented by photographs in iNaturalist. Original observations on invasiveness, toxicity, control, management, and native alternatives are presented. The New York reports are new state records for the species. This report is an example of the developing and highly collaborative process of Early Detection and Rapid Response (EDRR) to invasive species, involving many individuals, both professional and private, contributing key elements in a short period of time.

The first spontaneous plants of *Arum italicum* Mill. at NYBG were noted in the Thain Family Forest in 2004, but were not reported in the NYBG flora of 2016 (Atha et al. 2016) because their status as cultivated or spontaneous was not clear and they did not appear to be spreading. With additional sighting of plants in Manhattan and the accumulated evidence for their invasiveness elsewhere, it became evident that the NYBG plants were indeed invasive, thriving in our region, and posed a significant threat.

The spontaneous NYBG population is located on the Ridge Trail along the western edge of the Thain Family Forest, approximately 100 meters east of the Rock Garden. The vegetation is a mature, deciduous forest with *Prunus serotina*, *Quercus alba*, *Carya glabra*, and *Carya tomentosa* dominant. Understory vegetation consists of *Eurybia divaricata*, *Lonicera japonica*, *Smilax rotundifolia*, *Viburnum prunifolium*, and *Aralia elata*. We found two discrete patches, one about 50 cm diameter consisting of dozens of plants. A second patch, about 1.5 meters away consists of just two young stems. According to NYBG gardeners, three small patches of *Arum italicum* have been observed between the Rock Garden and the Thain Family Forest.

The Inwood Hill Park site is located in the Inwood section of Manhattan, about 100 meters north of Dyckman Street on a south-facing slope bisected by two paved paths/roads. We surveyed an area of about 2,500 square meters, roughly centered about where the Inwood Hill Park collection was made. In this area we began counting patches and stopped at over one dozen when it became apparent that there were dozens and dozens more patches and individuals scattered throughout the survey area, almost too numerous to count. Virtually any square meter, randomly placed could harbor a solitary or juvenile colony of *Arum italicum*. The vegetation consists of *Prunus serotina*, *Celtis occidentalis*, *Rhus typhina*, *Ailanthus altissima*, *Ulmus americana*, *Lonicera* shrubs, *Rosa multiflora*, *Vitis* sp., *Carya cordiformis*, *Tilia americana* (possibly planted), *Alliaria petiolata*, *Galium aparine*, *Allium vineale*, *Lonicera japonica* and *Hedera helix*. For many years, the understory of the site was overgrown with a dense layer of *Lonicera* sp. and *Rhodotypos scandens*. In 2007, the shrub layer was cleared of invasives and *Quercus bicolor* and other trees were planted in the area. Clearing the shrub layer caused an explosion of invasive vines, particularly *Lonicera japonica* and *Hedera helix*. The *Arum italicum* plants were not noted by Park gardeners until this year, perhaps only after additional invasives, especially *Hedera helix* and *Lonicera japonica*, were removed and the ground layer exposed.

The Fort Tryon population consists of at least four separate infestations scattered over an area of roughly 20,000 square meters. There are several patches of *Arum italicum* in the Heather Garden, which consists of *Erica* species and numerous perennial herbaceous and woody ornamentals. There are several patches northwest of the New Leaf Cafe in mixed beds of native and exotic trees and shrubs. In the mixed beds the plants are often growing with *Hedera helix*. We found one plant growing in the dense shade of *Taxus baccata* shrub where the ground was densely covered by fallen *Taxus* needles.

Adjacent to Carl Schurz Park and Gracie Mansion, on the Upper East Side of Manhattan, the species has colonized an area of waste ground which is approximately 7 meters vertically below the promenade. This narrow strip of land, about 30 meters in length, is situated between the FDR tunnel and the East River. In February 2017 there were four separate colonies of plants; one was a large cluster, over 1 meter across. In summer this area of waste ground is completely overgrown with spontaneous vegetation, much of it tall and bushy, including *Phytolacca americana* and *Rumex crispus*. Numerous smaller plant species are present, including *Hedera helix* and *Taraxacum officinale*. Young trees of *Ailanthus altissima* were cut down from this patch of ground a number of years ago. A tall ladder and more than one worker would be required in order to access this area. A member of the Carl Schurz Conservancy commented that this strip of land was originally owned by the Department of Transportation, but was subsequently deeded to the NYC Parks and Recreation Department. In March 2017, a small cluster which may be a volunteer was photographed less than 100 m away from the piece of waste ground, in a gardened area next to the footpath that runs around the north side of Gracie Mansion.

In 2012, the species was reported on iNaturalist as growing near the northwestern corner of Ward's Island in the East River. This was planted as an ornamental in a challenging location where nothing else would grow; the gardeners are aware that the plant can spread aggressively. Currently there are no records of occurrences in the natural areas of Ward's Island and Randall's Island.

**Voucher specimens and iNaturalist observations. New York. Bronx Co.:** New York City, New York Botanical Garden, W of the Bronx River and N of Waring Avenue, Thain Family Forest, Ridge Trail, ca 100 m E of the Rock Garden, 40.864567°, -73.877209° (WGS84, ±25m), ca 36 m elev, 24 Feb 2017, *Atha 15915* (NY); Conservatories, 13 Apr 1906, *Taylor s.n.* (NY). **New York Co.:** New York City, Inwood Hill Park, N of Dyckman Street and W of Payson Avenue, N of the Payson Playground, 40.867920°, -73.928427° (WGS84, ±25m), ca 16 m elev, 28 Feb 2017, *Atha & Thornbrough 15916* (NY); Fort Tryon Park, between the Cloisters and Margaret Corbin Circle, E of the Henry Hudson Parkway, W of Margaret Corbin Drive, 40.861159°, -73.933071° (WGS84, ±25m), ca 67 m elev, 10 Mar 2017, *Atha & Kelly 15917* (NY); Carl Schurz Park and Gracie Mansion, E of the Promenade and adjacent to the East River, 40.775968°, -73.942207° (WGS84, ±15m), 20 Feb 2017, *Hewitt* (iNaturalist observation 5144676); 40.775962°, -73.942213° (WGS84, ±16m), 2 Mar 2017, *Hewitt* (iNaturalist observation 5211672); 40.775987°, -73.942184° (WGS84, ±5m), 8 Mar 2017, *Hewitt & Seltzer* (iNaturalist observation 5253692); W of the Promenade, 40.77656°, -73.942968° (WGS84, ±16m), 8 Mar 2017, *Hewitt & Seltzer* (iNaturalist observation 5254116); Wards Island, Harlem River Pathway, 40.790757°, -73.930551° (WGS84, ±52m), 7 Jun 2012, *kgall* (iNaturalist observation 2909338).

## Description

Italian Lords and Ladies (*Arum italicum* Mill.) is a perennial herb native to parts of Europe, North Africa, and western Asia (Prime 1981; Boyce 1993; Verloove 2017). Four infraspecific taxa may be distinguished on the basis of life cycle, morphology, and geographic distribution (Boyce 1993). Three of the subspecies are narrowly restricted and only *A. italicum* subsp. *italicum* has escaped cultivation in North America (Yatskievych 1999). It is characterized as having leaves that are winter-emergent, monomorphic, variegated or bicolorous with acute, hastate and divergent lobes and a spathe that is greenish-white to pale yellow (Boyce 1993). Cultivars with strongly variegated leaves including 'Chameleon', 'Cyclops', 'Gold Dust', 'Marmoratum', 'Tiny' and 'White Winter' are derived from *A. italicum* subsp. *italicum* (Boyce 1993). Flowering stage is reached in 4–7 years, generally after the plants accumulate a minimum biomass (Boyce 1993; Mendez & Obeso 1993; Meeuse 1989) and like many other Araceae, the inflorescences of *A. italicum* are capable of endogenous heat production and can generate as much as a 15° C temperature differential between the inflorescence and its surroundings. Metabolism of isobutyl amine produces odors similar to urine and dung, which is volatilized by the heat and attracts mainly olfactory, dung-breeding midges or flies (Meeuse 1989; Albre et al. 2003). In three sites in France, flies were the most abundant visitors, representing nearly 90% of the insects attracted to inflorescences of *A. italicum*. Psychodidae flies and some Sciaridae, Chironomidae, and Sphaeroceridae were the main Diptera groups trapped (Albre et al. 2003). Exclusion and artificial pollen transfer experiments show that cross-pollination is necessary for *A. italicum* to set seed (Albre et al. 2003). Birds are apparently unharmed by the berries and readily feed on them, especially ground-feeding birds and other than humans, are thought to be the primary seed dispersal agents (Boyce 1993; Prime 1981; Meeuse 1989; Verloove 2017). In Europe, birds reported to feed on *Arum* fruit include mistle thrush, song thrush, European blackbird, starlings, pheasant, common wood pigeons, finches, sparrows, and yellowhammers (Prime 1981; Meeuse 1989). In Seattle, quail and American robins are reported to eat the fruit and disperse the seed (Meeuse 1989). Young plants are pulled deeper by contractile roots by up to 5 cm per week (Meeuse 1989).

New York City plants are herbs forming circular patches 1 m or more in diameter, the plants densely crowded (Figure 2), sometimes consisting of dozens of individuals with the largest plants generally toward the center; stems erect from deeply buried rhizomes/tubers (Figures 3–5);

rhizomes/tubers dark brown outside and white inside (Figures 5–6); plants dividing by production of ovoid bud-tubers ca 1 cm diam (Figures 5 and 8); rhizome/tubers forming roots and shoots from the same point, so that the shoot must grow plagiotropically before becoming erect (Figure 4); older stems white at the base where buried, then becoming reddish near ground level (Figures 3–4); petioles green, strictly erect and crowded; new leaves forming from center of plant; older leaves large and fleshy, the veins and adjacent tissue white, the posterior lobes obtuse to rounded; inflorescences forming in late winter (Figure 7). In New York City today, the leaves emerge in late summer or early fall and stay green and lush-looking through the winter, despite occasional periods of cold and snow (Figure 9). During the summer the foliage dies back and only the inflorescences with their bright red and orange fruits remain, possibly hidden among other vegetation that has leafed out for the season.

In England, the species is most often associated with *Hedera helix*, which is thought to provide winter protection (Prime 1981). In Europe, the species prefers light shade, some shelter and slightly basic soil (Meeuse 1989) and in Belgium, the plants are said to prefer disturbed soils high in nitrogen (Verloove 2017).

Toxic compounds attributed to *Arum italicum* include (1) arin, a saponin which, as a class of compounds is hemolytic and very common in diverse lineages of plants, (2) a coniine-like alkaloid and nerve toxin similar to the toxin in *Conium maculatum*, (3) calcium oxalate, an irritant and calcium uptake blocker also very common in plants, and (4) cyanogenic glycosides, which can be transformed into the highly lethal hydrocyanic acid (HCN) (Prime 1980; Meeuse 1989). Mammals, including guinea pigs, rats, mice, dogs, badgers, and pigs, will starve to death rather than eat *A. italicum* (Prime 1981). Calcium oxalate is destroyed by heat and like other members of the family Araceae, especially *Colocasia esculenta* (taro), the tubers of *A. italicum* have been boiled and eaten in time of famine (Meeuse 1989).

### Cultivation

The species has been cultivated in outdoor gardens throughout the USA at least since the mid-Twentieth century (Bailey 1942). Escaped populations in North America are reported with increasing frequency and spontaneous populations are now documented from Washington, Oregon, California, Illinois, Missouri, Alabama, Tennessee, Maryland, Virginia, Washington, D.C. (EDDMapS 2017, Figure 1), and now New York. Municipal, state, and federal efforts are underway to address the threat posed by this species (Briefel & Frey 2012; King Co., Washington 2016; City of Portland, Oregon 2017; Maryland Invasive Species Council 2017). *Arum italicum* is listed as a Class C noxious weed by the Washington State Noxious Weed Control Board (WSNWC 2017). A 2-acre infestation on Lopez Island, San Juan Co., Washington “worsened after it was repeatedly mowed, dug, torched (in winter), and then covered with a heavy tarp” (WSNWC 2017). In New Zealand, the species is regulated as a surveillance species to minimize further spread by preventing the sale, propagation, distribution, and exhibition of the species (Biosecurity New Zealand 2012).

Italian Lords and Ladies is valued by gardeners for its lush, winter foliage, attractive fruit and because it adds novelty to the Garden, in the sense that is relatively uncommon and nothing else looks quite like it. It is shade-tolerant, is extremely hardy and tolerates diverse edaphic conditions including a wide range of soil moisture, texture, etc. Gardeners in Westchester County, New York, report that it is not eaten by deer. These same traits also make it a very problematic invasive. The following quote from a gardener in Kentucky echos many contemporary gardeners’ experiences and highlights the negative aspects of cultivation:

“About 45 years ago, my parents planted a small clump of *Arum italicum* in a large wooded area of their central Kentucky yard. Over the years they also planted 30–40 species of native wildflowers that now blanket this grove every spring. For about 30 years, the *Arum* charmed everyone. Now? Not at all. In fact, *A. italicum* has become such a menace that in another 20

years none of those native wildflowers will be left. It will be a pure stand of *Arum*. I've tried digging it out but it's deeply rooted and it's impossible to capture the 100's of small bulbs. Weed-eating hasn't worked. Spraying with Glycophosphate [sic] hasn't worked. Our State forester researched the problem and gave me several articles but concluded there was not a known method of killing it. Another commenter mentioned Speedzone: I'll give that a try. I regard this plant as a sinister threat. It now pops up in far distant corners of this beautiful 10-acre yard. If you value native flora, I suggest not EVER planting *Arum italicum*" (Dave's Garden 2017).

In 1901 the NYBG obtained seed of *Arum italicum* from the Lyon Botanical Garden in France, grew them in a greenhouse, and in 1906 the plants were vouchered by Norman Taylor (*Taylor s.n.*). There is a record of another NYBG accession from 1931, but there is no information on location or current status. No specimens of *A. italicum* were noted or collected from cultivated or wild populations at NYBG between 1931 and 1989. Our experience has been that the species was not hardy outdoors in Cold Spring, New York (about 50 miles north of New York City), and there were no attempts to grow the plants outdoors at NYBG until very recently. However, beginning in 1989, the NYBG began accessioning plants for outdoor gardens (see Table 1).

| <i>Arum italicum</i> subsp. <i>italicum</i>                |      |   |
|--|------|---|
| Accession  | Year | Location at NYBG                                    |
| 2060/2004*A  | 2004 | Perennial Garden - Shade Room (General)             |
| 1541/2005*A  | 2005 | Home Gardening Center - Rodney White Country Garden |
| 1519/2009*A  | 2009 | Rock Garden - Meadow                                |
| 2349/2010*A  | 2010 | Azalea Garden - North 2                             |
| 2403/2010*A  | 2010 | Rock Garden - Heath                                 |
| 2403/2010*B  | 2010 | Rock Garden - Heath                                 |
| <i>Arum italicum</i> subsp. <i>italicum</i> 'Marmoratum'   |      |   |
| 445/89*A   | 1989 | Rock Garden - Woodland                              |
| 1781/2012*A  | 2012 | Rock Garden - Woodland                              |
| <i>Arum italicum</i> subsp. <i>italicum</i> 'White Winter' |      |   |
| 769/2009*A   | 2009 | Perennial Garden - Shade Room (General)             |

Table 1. *Arum italicum* subspecies *italicum* and cultivars accessioned at NYBG since 1989.

### Early detection and rapid response

The Early Detection and Rapid Response (EDRR) network of the Lower Hudson Partnership for Regional Invasive Species Management (LH PRISM) was mobilized to validate and document the occurrence of spontaneous populations of *Arum italicum* in two of New York City's important natural areas: the woodlands of Inwood Hill Park (New York county) and the Thain Family Forest of the New York Botanical Garden (NYBG) (Bronx county). Communication within the PRISM network and gardening community led to the identification of additional populations in Fort Tryon Park (spontaneous) and Wards Island (cultivated). Research on iNaturalist led to the addition of the population in Carl Schurz Park.

According to New York state's framework for Rapid Response for Invasive Species (NYS DEC 2016), the EDRR process should begin when a new infestation is reported to an agency or organization whose mission includes responding to invasions. Reports of probable spontaneous *Arum italicum* were recently brought to the attention of Steve Young, the state botanist with New York Natural Heritage, Program who shared the information on February 22, 2017, with the coordinator of the LH PRISM and NYBG botanists. Specific locations were indicated by New York City Parks botanists including Our first

step was to verify the report with onsite visits and voucher specimens. Once authenticated, the LH PRISM coordinator informed local resource managers via an alert sent out on the public listserv for the Lower Hudson PRISM on February 24. As suggested in the EDRR framework, we then performed rapid assessment of the extent of the infestation in New York City. Further assessment of the extent of the populations has begun and additional surveys of nearby properties are underway to delineate the full extent of the infestations. Following this assessment possible responses will be evaluated so that management plans can be drafted. The New York occurrences have also been entered into the New York iMapInvasives database.

### **Risks, control, eradication and garden alternatives**

On 24 February 2017, the first author dug the NYBG specimens with a small trowel and by hand without gloves. After 48 hours, both hands began itching intensely as though exposed to Poison Ivy. By day four (28 Feb.) the itching had increased considerably (Figure 10). On 28 February, the split stem and rhizome/tuber in Figure 6 was experimentally applied to Atha's unaffected inner forearm (Figure 11). By 8:00 pm on 2 March, the area showed no sign of irritation. How to account for this differential reaction in the same person exposed to the same plant but on a different part of the body and from a different part of the plant is unknown. Perhaps the stems and rhizome/tubers do not possess the same toxin or concentration of toxin as that exposed by digging the plants and handling the roots. Perhaps the underground parts of the plant were growing with *Toxicodendron radicans* roots. Further research is warranted.

The plant is extremely difficult to eradicate. It is not possible to pull it up because the stems break off above the tubers. Herbicides can kill the foliage, but the plants grow back from the tubers. When trying to dig up the plants, it is usually impossible to retrieve all the tubers, and so digging often simply results in spreading the plant. Planting in pots is not a good option either because the fruit would still be available to birds who could disperse seeds elsewhere.

Winter is the best time to search for and identify the plants as they are among the only herbaceous vegetation that is persistently green at this time. Other vegetation has generally lost its leaves, making it easier to spot among other plantings. As in England, the most common associate in New York appears to be *Hedera helix*, which was observed at all New York sites. The *Hedera* could be providing winter insulation as well as camouflage. Like *Arum italicum*, *H. helix* is evergreen and persistent through the winter, forms dense colonies on the ground and has ovate, dark green, variegated leaves (Figure 12). *Arum italicum* could go undetected for quite some time, blending in with the *H. helix*.

There are native alternatives to *Arum italicum* suitable for cultivation in southeastern New York. *Asarum canadense*, *Cardamine diphylla*, and *Mertensia virginica* are low-growing ground-covers that are hardy, shade-tolerant and thrive in the urban environment in and around New York City. In wetter spots, *Arisaema triphyllum* could be used.

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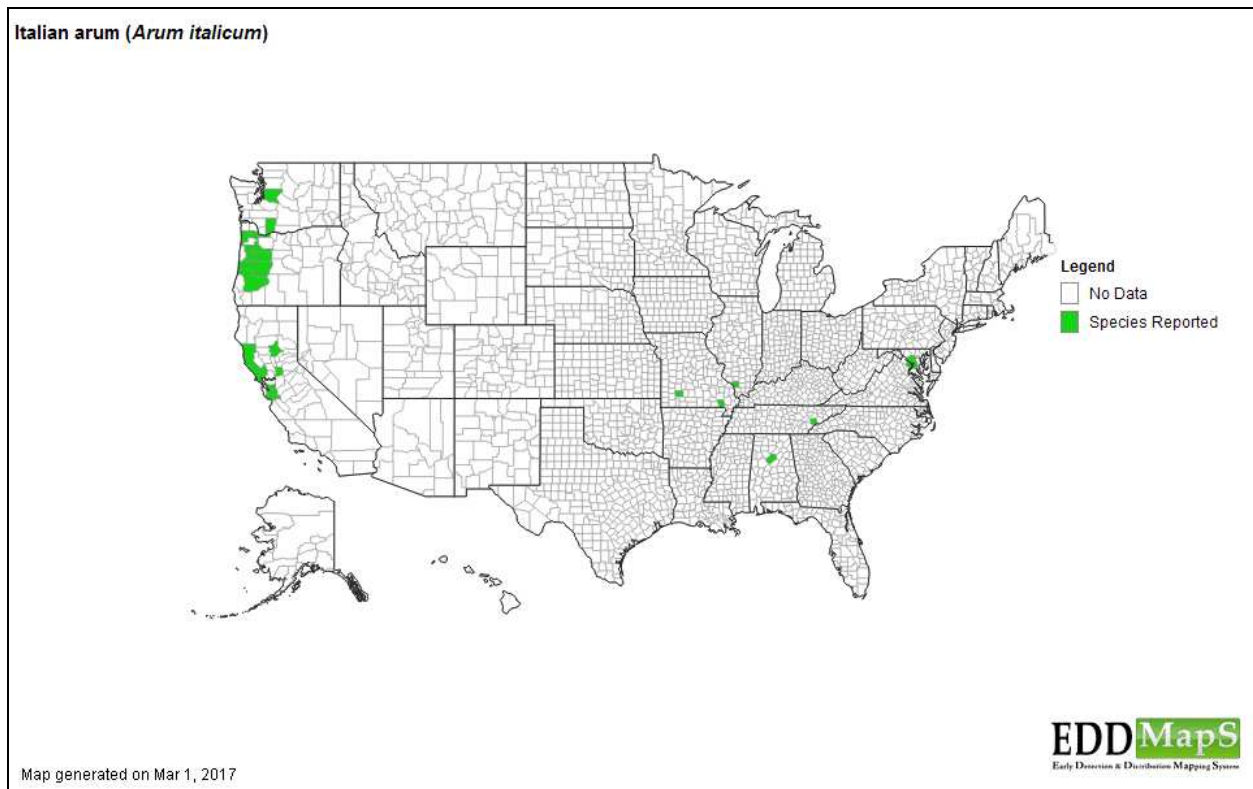


Figure 1. Distribution of *Arum italicum* (EDDMapS, 2017).



Figure 2. *Arum italicum* at Inwood Hill Park showing clusters, each consisting of dozens of plants. Note variation in leaf variegation. Photographed on 28 February 2017.





Figure 3. *Arum italicum* whole plant showing above and below ground parts. Atha & Thornbrough 15916.



Figure 4. *Arum italicum* showing whole plant. Note plagiotropic growth of stem from tuber. Atha & Thornbrough 15916.



Figure 5. Fresh *Arum italicum* showing tubers and contractile roots (note rings on thicker roots). Atha & Thornbrough, 15916.



Figure 6. Fresh *Arum italicum* plant showing cross-section of rhizome/tuber, bud-tuber and stem. Note embryonic shoot in center (yellow-green), Atha & Thornbrough 15916.

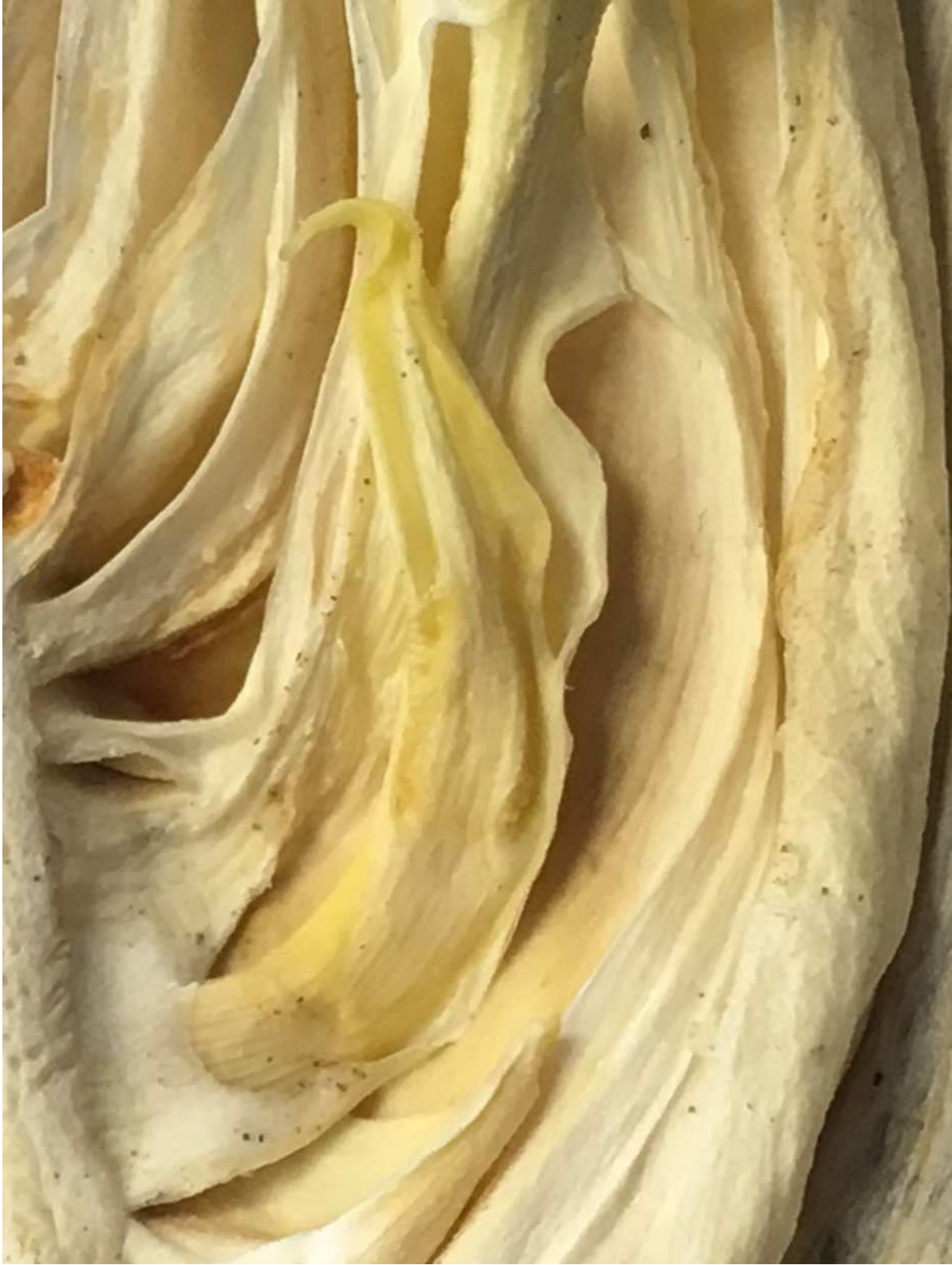


Figure 7. Dried rhizome/tuber and stem in cross section showing embryonic inflorescence. Atha & Thornbrough 15916.



Figure 8. Dried rhizome/tuber and bud-tuber in cross-section, showing tuber with protective scales. *Atha & Thornbrough 15916.*



Figure 9. *Arum italicum* at Inwood Hill Park. Photographed on 10 March 2017.



Figure 10. Affected area five days after digging whole plant especially soil and roots from NYBG population *Atha 15914*.



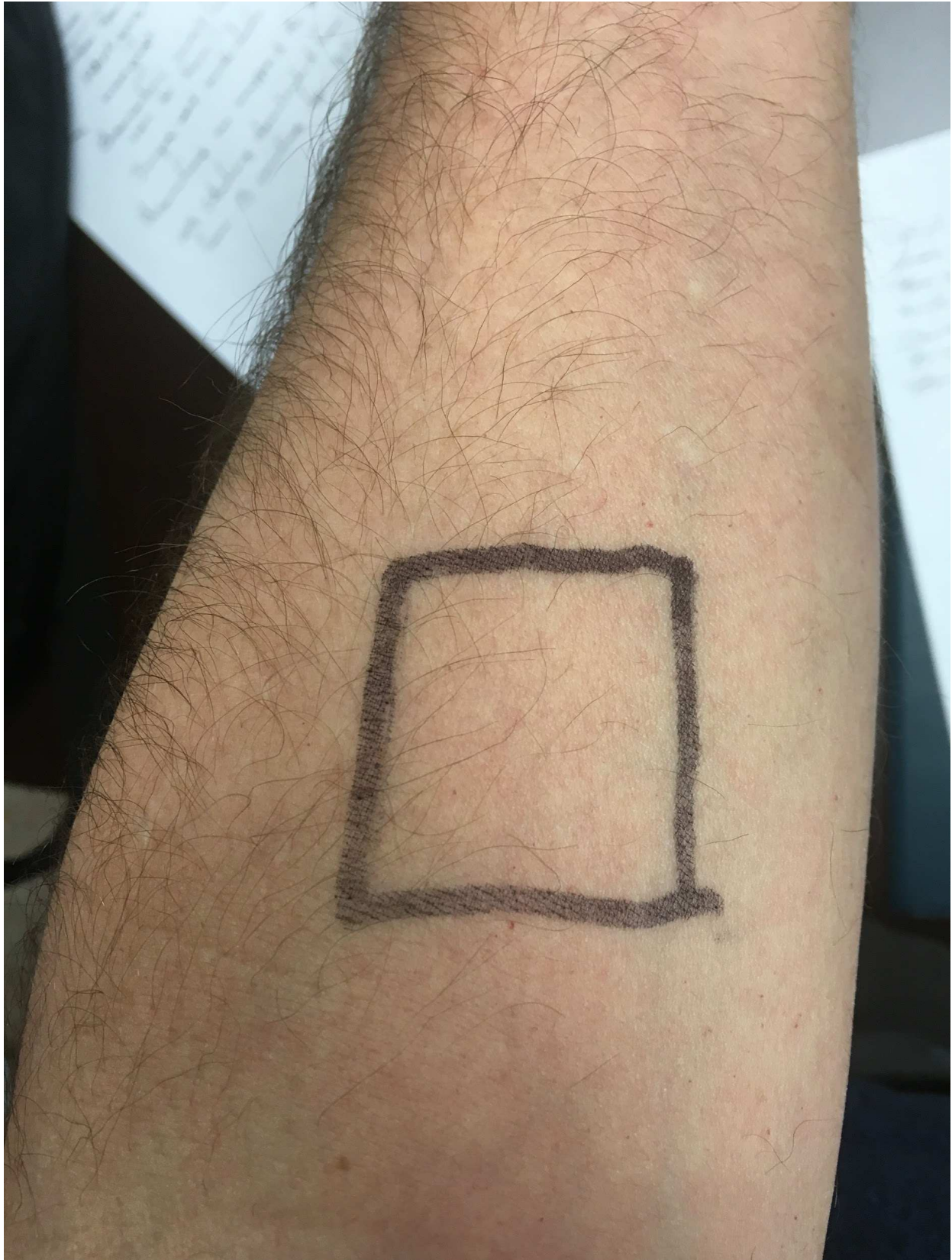


Figure 11. Exposed area apparently unaffected 48 hours after application of sap from cut rhizome/tuber and stem, from Figure 6.



Figure 12. *Arum italicum* growing together with *Hedera helix* at Fort Tryon Park, Atha & Kelly 15917.