

## A rhizomatous, perennial form of *Microstegium vimineum* (Trin.) A. Camus in New Jersey<sup>1</sup>

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EHRENFELD, JOAN G. (Dept. Ecology, Evolution, and Natural Resources, Rutgers Univ., New Brunswick, NJ 08901). A Rhizomatous, Perennial Form of *Microstegium vimineum* (Trin.) A. Camus in New Jersey. J. Torrey Bot. Soc. 126:352–358. 1999.—Populations of *Microstegium vimineum* (Trin.) A. Camus have been found in New Jersey containing individuals that have clusters of large rhizomes, and which evidently exhibit the perennial growth habit. This species, a major invasive exotic pest throughout the east coast, has previously only been known as an annual, both in the US and in its native geographical range in temperate and tropical Asia and India. Rhizomatous plants were observed in 6 populations, in sites ranging over a 100 km distance, and accounted for 8–15% of the culms in each population. Lower nodes of decumbent culms have on average 4 rhizomes (maximum 13 per node and 23 per culm were observed), which are 0.1 to 7 cm long (mean 1 cm). Significant differences in the number of rhizomes per culm and the size distribution of rhizomes were found among three sampled populations. Rhizomatous specimens had open, exserted terminal panicles which flowered 2–3 weeks before the non-rhizomatous specimens, which have cleistogamous spikelets within the leaf sheaths and a variably exserted, closed terminal panicle. Rhizomes sprouted in the greenhouse, after cold treatment, demonstrating their perennial capacity. This is the first reported occurrence of rhizomes in the genus, and also is the first apparent example of a trade-off between annual/perennial life history and cleistogamous/chasmogamous reproduction. In addition to the implications for the evolution of plant life history characteristics and breeding systems, the finding has important implications for control strategies for this invasive plant species; current recommendations for its control will not be effective against perennial forms.

Key words: *Microstegium vimineum*, Japanese stilt grass, rhizomatous perennial, cleistogamy.

*Microstegium vimineum* is an invasive exotic grass found throughout the east and Gulf coasts, from Texas, through Illinois, Ohio, and the coastal states to New York and Connecticut (Anon. 1998). It was first observed in Tennessee in 1919 (Fairbrothers and Gray 1972), and has become one of the worst weeds in many parts of its current range. Although it has been most frequently described from riparian and mesic sites (Hunt and Zaremba 1992; Redman 1995), it occurs in an extraordinarily wide range of habitats; in New Jersey, it ranges from saturated wetland soils to rocky, ridge-top areas in the Kittatiny Mountains. Although it has a C4 photosynthetic pathway (Winter et al. 1982), it is found abundantly under closed canopy forest, as well as along paths, ditches, and other open, disturbed areas. It has been described solely as an annual species throughout its introduced range in the US (Hitchcock 1951; Radford et al. 1968;

Gleason & Cronquist 1991) and its native geographic range in Asia and India (Steward 1958; Ohwi 1965; Walker 1976; Watson and Dallwitz 1992).

During sampling for studies of soil ecology in *Microstegium*-infested forest areas, I observed that some culms had abundant rhizomatous structures at the nodes in contact with the soil. In order to determine the extent and function of these structures, a preliminary study was undertaken of their distribution in New Jersey. While recording these observations, it was discovered that plants bearing rhizomes differed from non-rhizomatous plants in several morphological characteristics. This paper reports these preliminary observations and evidence that these plants are rhizomatous perennials.

**Materials and Methods.** Observation of the rhizomes was first made in the Jockey Hollow section of Morristown National Historical Park, Harding Township, NJ, in mid-August, 1998. It was noted at the time that individuals with rhizomes were flowering, whereas the dominant non-rhizomatous forms were not in flower. In mid-October (during the main period of flowering which is normally September to October), five additional populations in central and northern New Jersey were examined (Fig. 1). In each,

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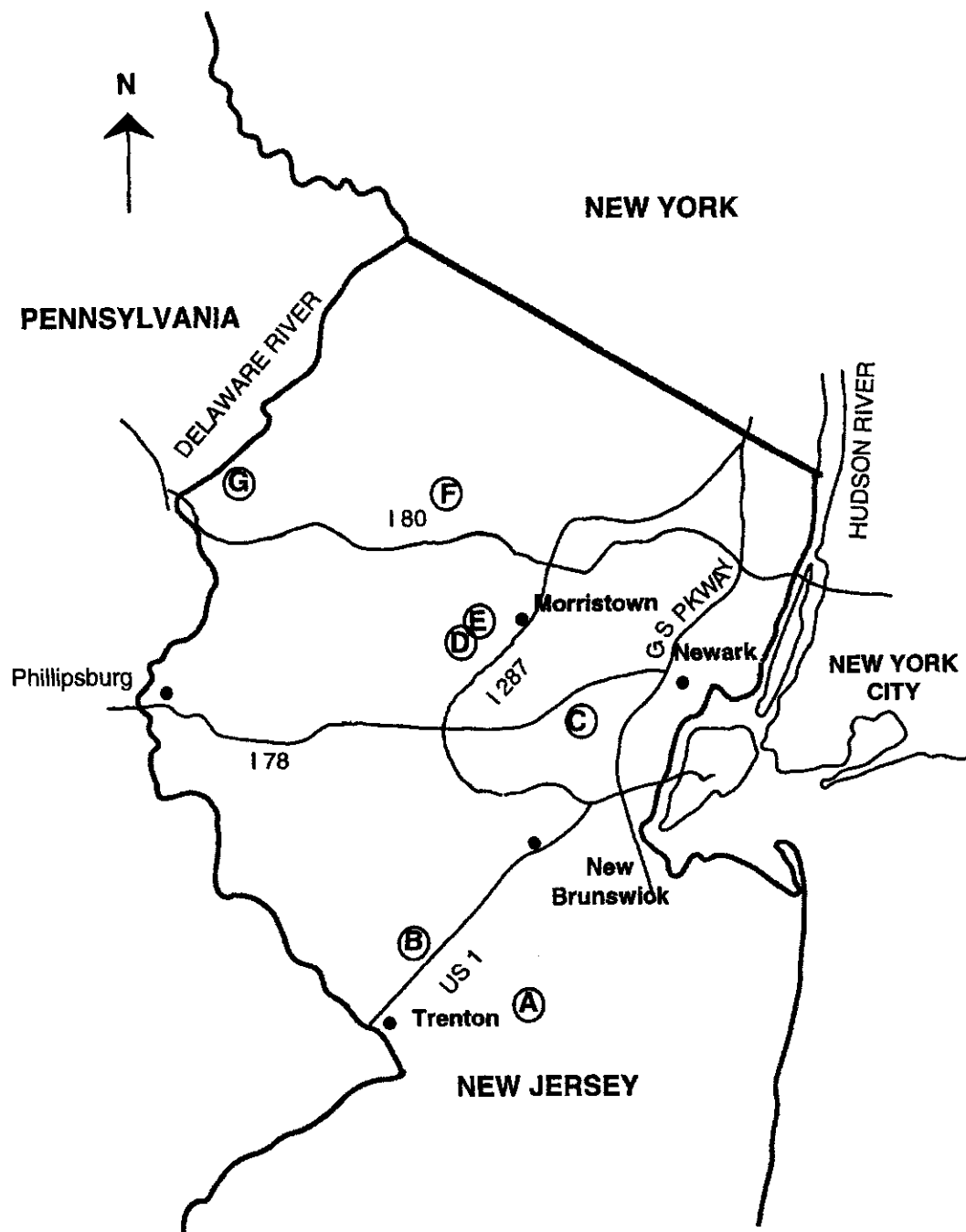


Fig. 1. Map of central and northern New Jersey, showing locations of sites at which rhizomatous plants were observed. Five sites (A, D, E, F, G) were sampled for frequency of occurrence and three (E, F, G) for quantitative characters.

a sample of approximately 150 culms was collected from dense *Microstegium* "lawns" within forested areas. The samples were returned to the laboratory, and 130–150 separate culms were tallied for the presence or absence of rhizomes. Individuals were randomly harvested within areas of 10–20 m<sup>2</sup>. Populations from three of the sites (Morristown National Historical Park

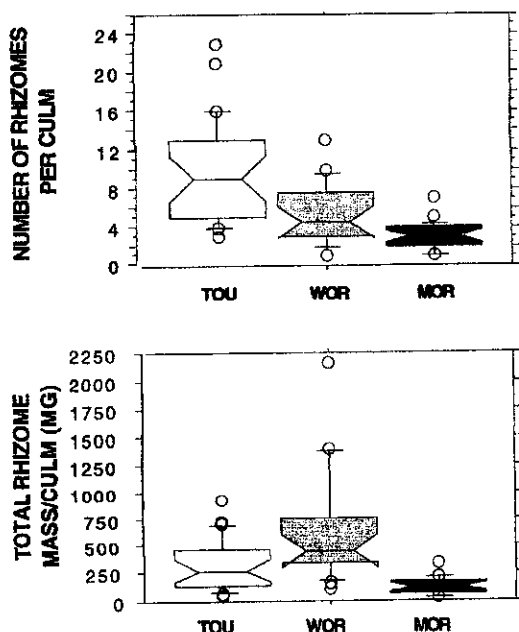


Fig. 2. Number of rhizomes per culm and rhizome mass per culm for three populations. Sample sizes (number of culms with rhizomes observed in each population) are TOU(Site F) = 30, WOR (Site G) = 20, MOR (Site E) = 22. Figures give the median (central line), 25th and 75th percentiles (top and bottom of figure), 90th percentile (bar), and individual values beyond the 90th percentile.

ping, striate scales (Fig. 3), ranging from dark grey to purple in color. In a few specimens, the rhizomes were branched. On some culms at all sites, the plant base was clearly attached to an old rhizome, identified by the weathered light brown spreading scales, lack of firm tissue within the rhizome, and often with the scales facing towards the stem, rather than away, as in the fresh rhizomes. The presence of these old rhizomes complements the observation (noted above) that rhizome-bearing stems often were found growing adjacent to each other in patches. Together, these observations strongly suggest that the plant had spread clonally through sprouting from rhizomes over several years.

The rhizomes are 0.2–0.3 cm wide, but vary greatly in length from 0.1 cm to > 6 cm (Fig. 4). A comparison of the lengths of a sample from each of two sites (Fig. 4), again revealed significant differences between the sites (Mann-Whitney  $Z = -5.325$ ,  $P < 0.0001$ ). Culms at WOR bear fewer, but longer rhizomes than culms at TOU, which bear numerous short rhizomes. The differences in number of rhizomes per culm and rhizome length contribute to the



Fig. 3. Line drawing of a node, showing the typical size, number and pattern of attachment of several rhizomes. (4× magnification).

significant differences among the sites in total mass per culm (Figs. 2, 4; Kruskal-Wallis  $H = 22.842$ ,  $P < 0.0001$ ).

The rhizomatous and non-rhizomatous plants differ in a variety of reproductive characteristics (Table 2). The first individuals observed to have rhizomes (in MOR) were observed in mid-August, at which time they were in flower; non-rhizomatous plants were not yet flowering. By early October, when the regional survey was undertaken, it was observed that rhizomatous plants had shed most of their seed, whereas non-rhizomatous plants were at the peak of flowering. Rhizomatous plants were also not found in the population in which they were first observed, although they were found elsewhere at MOR;

rious, as annual life history is usually thought to be derived from perenniality. As mentioned above, although perennial life histories are known among other species of *Microstegium*, none have been described as rhizomatous. If the perennial specimens are thus a reversion to a more primitive perennial habit, the novel presence of rhizomes would require a separate explanation. Cheplick (1995) noted that in *Amphibromus scabrivalvis*, allocation of biomass to rhizomes was (weakly) negatively correlated with allocation to caryopses, but did not observe a complete lack of rhizomes and an annual life history in any form of this species. Clearly, the patterns of resource allocation to rhizome production, vegetative tissues, and different forms of inflorescences, under varying environmental conditions, warrant further study.

The presence of a perennial form of this exotic weed will have important implications for its control. Currently, the recommended method of control is to mow plants at the time of flowering, in order to prevent seed formation or to apply herbicide late in the growing season (Anon. 1998). Mowing will be ineffective if rhizomatous plants are present, and probably would favor the survival and spread of perennial individuals. Furthermore, the timing and concentration of herbicide applications would have to be re-evaluated to determine their effectiveness in preventing rhizomes from sprouting. If the perennial form of this weed becomes widespread and/or dominant within populations, it is likely to make control of this plant even more difficult than it already is. Because the plant is considered a serious weed throughout its range (Anon. 1998), the presence and abundance of rhizomatous forms throughout its native and introduced ranges should be a high priority for future research.

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