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NATIVE PIERINE BUTTERFLY (PIERIDAE) ADAPTING TO NATURALIZED CRUCIFER?

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Native butterflies encounter naturalized plants related to their hosts as one consequence of Palearctic weeds spreading throughout North America. Sometimes these plants are incorporated into the butterfly diet and permit a longer flight season (e.g., *Pieris napi microstriata* on watercress: Shapiro 1975; *Papilio zelicaon* on sweet fennel: Sims 1983, Tong & Shapiro 1989, Shapiro in press). In other cases, females do not lay eggs on the naturalized plant so that it is not used, even though it can support complete larval development (e.g., *Colias philodice* and crown vetch: Karowe 1990). A third alternative is that females lay eggs on naturalized plants, but larvae die before completing development (e.g., *Pieris napi oleracea*, *P. n. marginata* and *P. virginiensis* on garlic mustard: Bowden 1971; *P. n. macdunnoughii* and *P. occidentalis* on pennycress: Chew 1977; *P. napi oleracea* on wintercress: Chew 1981).

Where naturalized plants are attractive to ovipositing females but larvae fail to develop successfully on them, the plants can function as a population sink so that eggs laid on these plants are lost from the population. If appropriate genetic variation exists in the population, selection favors both females that discriminate against the unsuitable plant, and feeding larvae that are able to develop on it successfully (Chew 1977). We report here on a population of *P. napi oleracea* Harris that may be adapting to a biennial weed of Palearctic origin, garlic mustard, *Alliaria petiolata* (Bieb.) Cavara & Grande (Brassicaceae) (nomenclature follows Gleason & Cronquist 1991).

Pieris virginiensis and *P. napi oleracea* fly together in beech-maple-hemlock woods near Lee and Dalton (Berkshire Co., Massachusetts) and Sandgate (Sandgate Co., Vermont). At Lee, Roger W. Pease, Jr. (RWP) previously observed both species ovipositing on garlic mustard and found eggs and small larvae of *P. n. oleracea* on this plant in July (RWP in litt. and pers. comm.). Rearing these eggs on garlic mustard produced adults with summer brood *P. n. oleracea* phenotypes (RWP pers. comm.). Garlic mustard stands are dense and extensive at this locality and large stands of toothwort, *Cardamine diphylla* (Michx.) A. Wood also are present. Occasional plants of watercress, *Rorippa nasturtium-aquaticum* (L.) Hayek, and cuckoo-flower, *Cardamine pratensis* L., also occur. This site is 17 km from the Dalton site, where both butterflies fly together (Chew 1980) and utilize *C. diphylla*. At Dalton, on 19 August 1993, we observed garlic mustard only in two very small stands near a parking lot; one stand lacked rosettes, indicating that no seeds germinated on this spot during the past spring—a probable indication of recent establishment. To our knowledge, garlic mustard has not been reported previously at the Dalton site. At both sites, toothwort is present above-ground in the spring, but by mid-July its leaves are severely yellowed and unsuitable as *Pieris* food. By contrast, garlic mustard flowering stalks remain green in mid-July, and rosettes remain green throughout the summer.

We confirmed RWP's observations of *P. virginiensis* and *P. n. oleracea* females ovipositing on garlic mustard in 1992 and 1993. On 7 May 1993 we collected a single female *P. n. oleracea*. We attempted to rear some of this female's offspring on garlic mustard. Of 34 newly hatched first instar larvae reared on this plant, 14 pupated (8 female, 6 male). Pupal weights for both sexes were not significantly different from weights for sibs reared on hare's-ear mustard. However, larval developmental times (days from egg hatch to pupation) differed significantly for individuals reared on garlic mustard compared to sibs reared on hare's-ear mustard (range on garlic mustard = 16–30 d compared to 14–17 d for hare's-ear mustard; mean $\pm$ SD for females on garlic mustard = 23.4 $\pm$ 3.54 d compared to 15.5 $\pm$ 1.64 d on hare's-ear mustard; mean $\pm$ SD for males on garlic mustard = 19.0 $\pm$ 2.90 d compared to 14.3 $\pm$ 0.58 d on hare's-ear mustard). All 14 pupae emerged after 6–8 days. Whether these adults were fertile is not known, because they were then placed in a common cage with sibs reared on hare's-ear mustard. The collective cage produced fertile eggs but we cannot be certain whether any came from individuals reared on garlic mustard.

Garlic mustard is a widely used and highly suitable host of *P. napi* and many related species in Europe (Bowden 1971, A. Porter in litt.). But previous attempts to rear North American pierines on garlic mustard have failed, usually in the first or second instar (Bowden 1971; our unpubl. data). F_1 hybrids between North American and English pierines develop successfully on this plant (Bowden 1971). Our only previous success involved 5 *P. n. oleracea* (3 females, 2 males) derived from a combined breeding stock from Lee and central Vermont (near Hancock, Hancock Co., Vermont). These individuals took longer to develop from egg hatch to pupation, but their pupal weights were similar compared to other members of the colony reared on hare's-ear mustard.

Recent work on the behavior of ovipositing *P. n. oleracea* from central Vermont shows that these butterflies are more strongly stimulated by alkenyl glucosinolates such as allyl glucosinolate (sinigrin) than by some other glucosinolates (Chew & Renwick in press). Because allyl glucosinolate is prominent in the glucosinolate profile of garlic mustard leaves (Chew, F. S., unpubl. data; Renwick, J. A. A., unpubl. data), this plant's attractiveness to ovipositing *P. n. oleracea* is not surprising. Individuals that develop successfully on garlic mustard would be able to use extensive stands of this naturalized host in addition to their toothwort host, and the two hosts together presumably could support a larger butterfly population. Whether the observed variation in larval success on garlic mustard is a remnant of genetic heritage from a pierine ancestral to both North American and European *P. napi* lineages, or whether it is newly arisen in the Berkshire Co., Massachusetts region, is unknown.

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