Journal of the Lepidopterists' Society
48(2), 1994, 171–172

IMPLICATIONS OF INTRODUCED GARLIC MUSTARD (*ALLIARIA PETIOLATA*) IN THE HABITAT OF *PIERIS VIRGINIENSIS* (PIERIDAE)

Additional key words: host expansion, conservation.

Pieris virginiensis (W. H. Edwards) (Pieridae) is an uncommon and local univoltine member of the *P. napi* (L.) group from eastern North America, confined to forest understory habitats where its primary hosts, *Dentaria* spp. (Brassicaceae), have relatively dense populations (Opler & Krisek 1984). Most other populations of the *napi* group are multivoltine, as are other *Pieris* species (*brassicae* [L.], *rapae* [L.], *manni* Mayer, etc.). The other univoltine *napi*-group members are confined to habitats with short growing seasons, and typically hybridize in ecotones with multivoltine races (Petersen 1963; my unpubl. data). Allozyme data confirm that *virginiensis* is very close to other North American *napi*-group taxa (Geiger & Shapiro 1992). Univoltinism in *P. virginiensis* is presumed to be a derived adaptation to early senescence of *Dentaria* because summer generations would not have adequate host resources to complete larval growth (Shapiro 1971).

Garlic mustard, *Alliaria petiolata* (M.B.) (Brassicaceae), is an aggressive forest-edge and understory plant that was introduced into northeastern North America from Europe, and has become widespread in the midwestern U.S. since around 1950; there is interest in control of its spread (Willis 1992). *Alliaria* germinates in the spring and summer and forms a large, overwintering rosette, which then bolts in the early spring and blooms from late March to July. Plants with edible foliage can thus be found throughout the year.

At the Cedar Bluffs Nature Preserve in Monroe Co., Indiana, *Dentaria laciniata* Willd. is native and patchily distributed, whereas *Alliaria petiolata* is more widespread on the site. On 1 May 1993, *Dentaria* had already set seed, but the *Alliaria* were still in bloom. At approximately 1400 h, I observed a female *P. virginiensis* while she laid 6 eggs over a 10 minute period. Host-searching behavior was typical for *Pieris*: she flew slowly and frequently contacted leaves and flowers of a variety of plant species, but flew up immediately after contact with non-cruciferous leaves. When she contacted an *Alliaria*, sometimes by diving at the flower (suggesting visual cues were involved), she began searching and alighting on the lower leaves, ~1–2 dm above the ground. In most cases, she would lay a single egg on the underside of a leaf at this height, but several plants were rejected. After oviposition, she always flew at least several meters before searching for the next host. She did not contact any *Dentaria* during this time. After collecting this female as a voucher (retained in my personal collection), I searched *Dentaria*, and occasional *Arabis* (Brassicaceae) plants for 10 minutes, and did not find any eggs or larvae. The female subsequently laid eggs on *Alliaria* in captivity; these eggs were reared into the second instar with moderate mortality before fieldwork overseas terminated the study.

There are three possible outcomes of the use of *Alliaria* as an oviposition site by *P. virginiensis*, and they depend on the palatability of the plant to the larvae. If the plant is toxic, then there are two possible outcomes: the *virginiensis* populations will decline because females waste eggs on *Alliaria*; and/or there will be selection on females to avoid *Alliaria* together. However, if *Alliaria* is palatable, even to some larvae in the population, then *virginiensis* will probably evolve a broader host range because *Alliaria* is a more widespread and reliable resource than *Dentaria*.

Isolated populations of *virginiensis* are likely to be in danger of extinction if *Alliaria* is toxic to the larvae. *Pieris virginiensis* maintains relatively small and localized populations, and does not often fly outside the forest understory. *Alliaria* is likely to be much more apparent than *Dentaria* in *virginiensis* habitat, both because *Alliaria* reaches high abundance over larger areas than *Dentaria*, and because *Alliaria* have larger plants with a longer flowering season. Female *virginiensis* searching for crucifers are likely to encounter and oviposit on *Alliaria* more often than *Dentaria*, and perhaps be prone to fly

out of *Dentaria* patches while continuing to discover *Alliaria* plants. The resulting decline is likely to lead to extinctions of already small *virginiensis* populations before the ability to discriminate can evolve. Even if the ability to discriminate does evolve locally, it is unlikely to spread rapidly and "rescue" other populations because of the philopatric tendencies of *virginiensis*.

On the other hand, it would be a welcome development if *P. virginiensis* were to expand its host range to include *Alliaria*. It would give *P. virginiensis* a better foothold where it does live, and perhaps allow it to expand its range of suitable habitats. In Europe, *Alliaria petiolata* is a common host of *Pieris napi* (Petersen 1963, Bowden 1971; my unpubl. data), but in North America, *P. napi oleracea* Harris has reportedly been unsuccessful on *Alliaria* (Bowden 1971), although I have frequently found *P. rapae* to use it (unpubl. data). Incipient host-range expansion is also of interest to population and community ecologists: because *Alliaria* foliage can be found in abundance throughout the year, natural selection would favor the return of *Pieris virginiensis* to its ancestral, multivoltine life cycle.

Population studies following the historical progress of the interactions between *Alliaria* and *P. virginiensis*, regardless of the outcome, would be quite relevant to our understanding of how host selection and host use evolves in natural populations. For example, *Rhagoletis pomonella* (Diptera: Tephritidae) is presumed to have switched from hawthorn to apple in New York State, whereupon the apple-feeding race spread over the northeastern U.S. (Bush 1968). Even though this case is among the best studied, the evidence for this scenario is weak because historical data are scant, and the switch may as easily have occurred more or less simultaneously in several parts of the species' range. Courant et al. (1994) independently report interactions between *Alliaria* and *P. napi oleracea* and *Alliaria* and *P. virginiensis* in New England, with similar observations to mine from Indiana; notably, New England populations have been in the presence of *Alliaria* longer than midwestern populations and may have had an evolutionary "head start." Strong selection by *Alliaria* is probably occurring over much of the range of *virginiensis*, and simultaneous observations of the interactions in geographically separated populations are needed to help understand processes involved in the evolutionary response to this selection.

This note has benefitted from discussions with Francie Chew and Art Shapiro, and two anonymous reviewers' comments. Francie was kind enough to send me her unpublished manuscript. Thanks are due to Mark Dybdahl and Lynda Delph for accommodations in Bloomington, and to Lynda for identifying the *Dentaria*.

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Received for publication 8 May 1993; revised and accepted 20 November 1993.

Date of Issue (Vol. 48, No. 2): 17 May 1994