Picromerus bidens (Heteroptera: Pentatomidae) as predator of the Checkerspot *Euphydryas aurinia* (Lepidoptera: Nymphalidae)

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The predatory bug *Picromerus bidens* is reported as a regular predator of the Marsh Fritillary *Euphydryas aurinia* from the region of western Bohemia, Czech Republic. Adult bugs attack pre-diapause larvae, either exposed or hidden in protective silken webs, and exhibit efficient behaviour, including returning to previously attacked webs. We observed predation in six out of 28 and eleven out of 21 local populations in 2003 and 2004, respectively. In addition, we observed two attacks by nymphs on handicapped adult butterflies. Predation of Melitaeinae by Heteroptera seems to be a widespread phenomenon, and *P. bidens* can act as a substantial mortality factor in small colonies of *E. aurinia*.

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1. Introduction

Checkerspot butterflies (Melitaeini) have become established as a model system for a wide array of ecological phenomena. Still, a recent synthesis by Ehrlich and Hanski (2004) points to some gaps in understanding their biology. One relatively unexplored field is the natural history of checkerspots' predators. In their review, Van Nouhuys and Hanski (2004) state that "general importance of natural enemies for the [checkerspot] population dynamics is largely unknown, or have been studied only at a few locations". The review mentions only two insect predators of the Marsh Fritillary *Euphydryas aurinia* (Rottemburg, 1775): *Poecilus versicolor* (Coleoptera: Carabidae) and a bug, citing Wilkinson (1907) for both records. This scarcity of information is surprising, because the ecology of *E. aurinia* has been intensively studied (e.g., Warren 1994, Wahlberg *et al.* 2002, Anthes *et al.* 2003, Konvicka *et al.* 2003, Wang *et al.* 2004). Clearly, there

still is a need "to further study the natural history and host ranges of the predators and parasitoids" (Van Nouhuys & Hanski 2004).

We report here our observations of predation by the bug *Picromerus bidens* (Linnaeus, 1758) on both pre-hibernation larvae and adult butterflies of *E. aurinia*.

2. Material and methods

The distribution of *E. aurinia* in the Czech Republic is restricted to western Bohemia, where it forms relatively small local populations ("colonies") restricted to wet meadows and non-intensive pastures. Closely adjoining colonies are interconnected by adult dispersal and exhibit a metapopulation dynamics (Hula *et al.* 2004). Adult butterflies are on wings from late May until late June. Females lay batches of eggs on leaves of *Succisa pratensis*, and larvae feed on that plant communally in loose silk-woven nests until hibernation. Prior to hibernation, they form more compact hibernation nests. Post hibernation larvae live solitarily.

We have studied the species from 2002 onwards, applying annual counts of larval webs at all known sites, combined with mark-recapture counts of adults within a system of seven interconnected colonies (Hula *et al.* 2004). Annual numbers of occupied colonies ranged from 21 to 28 (mean = 23.3), their sizes ranged from single nest to about one hundred nests (with annual medians between ten and twenty nests). Annual numbers of adults and larval webs exhibited a close correlation.

The observations of predation of larvae originated during counts of larval webs, conducted each year during the first week of September. Visiting all colonies takes about a week. The time spent at one colony site varies from twenty person-minutes to about five person-hours, depending on colony size. The attacks on adults were observed during the mark-recapture studies, which consisted of daily marking of butterflies by one to three persons, covering the entire adult flight period (details in Hula *et al.* 2004).

The autumn counts of larval webs were conducted to monitor population changes and we did not record the exact numbers of bugs. It would require a different method of searches than just zigzagging the localities. Therefore, we only recorded if we had observed predation per site, and so we do not know the exact numbers of the predation occasions by the bugs.

3. Results

3.1. Predation on larvae

Predation by the bug was observed every year, but recorded in detail only in 2003 and 2004. Attacks by the bug were observed at six out of 28 occupied colonies in 2003 (21%), and at eleven out of 21 colonies in 2004 (52%). The colonies were typically medium- to large-sized (> 20 larval webs), but in one case in 2004, we observed predation within an isolated and extremely small colony (19 km from the closest site, six larval webs).

The bugs attacked both exposed caterpillars and, particularly in cooler days (< 15° C, overcast sky), inactive caterpillars hidden in silken webs. When feeding on exposed caterpillars, the bug typically approached the larval mass, stalked a larva with proboscis, walked a few centimetres away and sucked with its proboscis protruding onwards (Fig. 1). The larvae tried to escape by wiggling their bodies, but out of some fifty observations, the efforts never succeeded. After consuming the prey, the bug typically returned to the larval group and singled out another caterpillar. In

Fig. 1. Adult *Picromerus bidens* preying on larva of *Euphydryas aurinia*. Note the silken meshing of larval web in the right. Environs of Karlovy Vary, western Bohemia, 2 September 2003. © V. Hula.

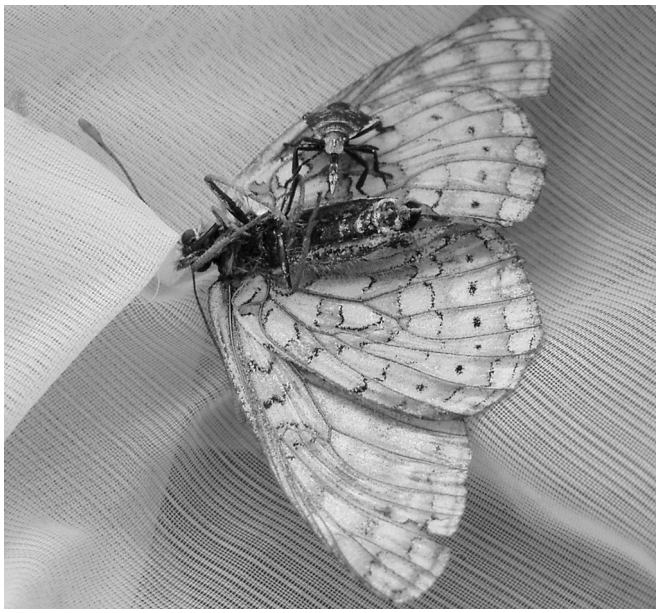

Fig. 2. Nymph of *Picromerus bidens* feeding on adult *Euphydryas aurinia*. The butterfly, still alive, was hanging from a spider web. Bochov near Karlovy Vary, western Bohemia, 18 June 2003. © V. Hula.

one case, we observed five such returns. When attacking larvae hidden in the web, the bug first explored web surface, trying to locate an opening. In three cases, it punctured the encasing silk and poked its proboscis within the web for a few seconds, until it pierced a larva. One larval group was usually attacked by a single bug, but in one case, three bugs exploited one web.

3.2. Predation of adults

Observed twice, in both cases on handicapped butterflies. In 2003, a nymph of the bug stalked a butterfly that loosely hanged from a low-situated spider's web, still trying to escape. We captured the bug while it fed on the butterfly and photographed it while feeding (Fig. 2). In 2004, we encountered a nymph sucking on a male butterfly that was worn so heavily that it was unable to fly.

4. Discussion

Picromerus bidens is a generalised predator of a wide range of insects, including hymenopteran, coleopteran and lepidopteran larvae (Larivière & Larochelle 1989, Volkov & Tkacheva 1997). For such a generalist, larvae of *E. aurinia* represent an important food source in early autumn, when only a few larvae of other species occur in high densities. The bug attacks the larvae quite efficiently and visits a single larval group repeatedly. Hence, it might act as a substantial mortality factor. Although it is unlikely to be a threat to the survival of large colonies, it might deplete small populations, such as the one consisting of six larval webs. We observed attacked adult butterflies only when damaged or already entrapped.

Predation by Heteroptera has been observed in other Melitaeini as well. Van Nauhuys and Hanski (2004) list predation on neonate *Euphydryas gilletti* (Barnes, 1897) by unspecified Miridae, and predation on *Melitaea cinxia* (Linnaeus, 1758) by Pentatomidae. Vrabec and Jindra (1998) reported substantial larval mortality of *Euphydryas maturna* (Linnaeus, 1758) caused by *Picromerus bidens.*

The majority of checkerspot species develop on plants containing iridoid glycosides or (as in the case of *E. aurinia* that feeds on *Succisa pratensis*) secoiridoids, which they sequester for their defence (Wahlberg 2001, Suomi *et al.* 2003). Although the distastefullness of *E. aurinia* was not yet conclusively assayed, supportive indices include relatively slow flight, faking death when handled, aposematically coloured last-instar larvae and pupae, and larval gregarious-

ness. *P. bidens* seems to be able to overcome lepidopteran chemical defences (Sirepinska 1998, Vrabec & Jindra 1998, Naumann *et al.* 1999, Stefanescu & Ribes 2000, Dantart 2003). It would be fascinating to study whether this bug and other predatory pentatomids (cf. Hamilton & Heath 1976) actually prefer chemically protected Lepidoptera and employ their protective compounds for their own defence, similarly to some phytophagous Heteroptera that sequester plant toxins (Aldrich *et al.* 1997, Tullberg *et al.* 2000).

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References

Aldrich, J. R., Leal, W. S., Nishida, R., Khrimian, A. P., Lee, C. J. & Sakuratani, Y. 1997: Semiochemistry of aposematic seed bugs. — Entomol. Exper. Appl. 84: 127–135.

Anthes, N., Fartmann, T., Hermann, G. & Giselher, K. 2003: Combining larval habitat quality and metapopulation structure – the key for successful management of pre-alpine *Euphydryas aurinia* colonies. — J. Insect Conserv. 7: 175–185.

Dantart, J. 2003: Erugues d'*Inachis io* (Lepidoptera: Nymphalidae, Nymphalinae) depredades per *Picromerus bidens* (Heteroptera: Pentatomidae, Asopinae). — Butll. Soc. Cat. Lep. 90: 21–23

Ehrlich, P. R., & Hanski, I. 2004: On the wings of checkerspots: A model system for population biology. — Oxford University Press, Oxford. 371 pp.

Hamilton, I. & Heath, J. 1976: Predation of *Pentatoma rufipes* (L.) (Hemiptera: Pentatomidae) upon *Zygaena filipendulae* (L.) (Lepidoptera: Zygaenidae). — The Irish Naturalist 18: 337.

Hula V., Konvicka M., Pavlicko A. & Fric Z. 2004: Marsh Fritillary (*Euphydryas aurinia*) in the Czech Republic: Monitoring, metapopulation structure, and conservation of the endangered butterfly. — Entomol. Fennica 15: 231–241.

Konvicka, M., Hula, V. & Fric, Z. 2003: Habitat of pre-hibernating larvae of the endangered butterfly *Euphydryas aurinia* (Lepidoptera : Nymphalidae): What can be learned from vegetation composition and architecture? — Eur. J. Entomol. 100: 313–322.

Larivière, M. C. & Larochelle, A. 1989: *Picromerus bidens* (Heteroptera: Pentatomidae) in North America, with a world review of its distribution and bionomics. — Entomol. News 100: 133–146.

Naumann, C. M., Tarmann, G. M. & Tremewan, W. G. 1999: The Western Palaearctic Zygaenidae (Lepidoptera). — Apollo Books, Stenstrup. 304 pp.

Sirepinska, A. 1998: Towards an Integrated Management of *Dendrolimus pini* L. — In: McManus, M. L. & Liebhold, A. M. (eds.), Population Dynamics, Impacts, and Integrated Management of Forest Defoliating Insects. Proceedings of Conference held in Banska Stiavnica, Slovakia, in August 18–23, 1996. Online at http://www.iufro.org/iufro/iufronet/d7/wu70307/banska/

Stefanescu, C. & Ribes, J. 2000: Una larva d'*Iphiclides podalirius* (Lepidoptera: Papilionidae) depredada per *Picromerus bidens* (Heteroptera: Pentatomidae, Asopinae). — Butll. Soc. Cat. Lep. 86: 33–35.

Suomi, J., Siren, H., Jussila, M., Wiedmer, S. K. & Riekkola, M. L. 2003: Determination of iridoid glycosides in larvae and adults of butterfly *Melitaea cinxia* by partial filling micellar electrokinetic capillary chromatography-electrospray ionisation mass spectrometry. — Anal. Bioanal. Chem. 376: 884–889.

Tullberg, B. S., Gamberale-Stille, G. & Solbreck, C. 2000: Effects of food plant and group size on predator defence: differences between two co-occurring aposematic Lygaeinae bugs. — Ecol. Entomol. 25: 220–225

Van Nauhuys, S. & Hanski, I. 2004: Natural enemies of Checkerspots. — In: Ehrlich, P. R. & Hanski, I. (eds.), On the wings of checkerspots: A model system in population ecology: 161–180. Oxford University Press, Oxford. 371 pp.

Volkov, O. G. & Tkacheva, L. B. 1997: A natural enemy of the Colorado potato beetle –*Picromerus bidens*. — Zashchita Karantin Rastenii 3: 30 [In Russian.]

Vrabec, V. & Jindra, Z. 1998: The caterpillars of the rare butterfly *Euphydryas maturna* (Lepidoptera: Nymphalidae) as food for the predatory bug *Picromerus bidens* (Heteroptera: Pentatomidae). — Entomol. Probl. 29: 87–90.

Wahlberg, N. 2001. The phylogenetics and biochemistry of host-plant specialization in Melitaeinae butterflies (Lepidoptera: Nymphalidae). — Evolution 55: 522–537.

Wahlberg, N., Klemetti, T. & Hanski, I. 2002: Dynamic populations in a dynamic landscape: the metapopulation structure of the Marsh fritillary butterfly. — Ecography 25: 224–232.

Wang, R. J., Wang, Y. F., Chen, J. J., Lei, G. C. & Xu. R. M. 2004: Contrasting movement patterns in two species of chequerspot butterflies, *Euphydryas aurinia* and *Melitaea phoebe*, in the same patch network. — Ecol. Entomol. 29: 367–374.

Warren, M. S. 1994: The UK status and suspected metapopulation structure of a threatened European butterfly, the Marsh Fritillary *Eurodryas aurinia*. — Biol. Conserv. 67: 239–249.

Wilkinson, G. 1907: Habits and habitat of *Melitaea aurinia*. — Entomol. Rec. J. Var. 19: 273–275.