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APTEROUS AND BRACHYPTEROUS COCCINELLIDS AT THE END OF THE FOOD CHAIN, *CIONURA ERECTA* (ASCLEPIADACEAE) - *APHIS NERII*

BY

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Aphis nerii on its host plant *Cionura erecta* (Asclepiadaceae) can serve as prey for coccinellids (*Adonia variegata*). When *A. nerii* is the sole food of larval coccinellids, all larvae give rise to brachypterous or apterous adults. If such deformed insects are then fed on aphids from a different species of host plant, the progeny are normal.

A large population of coccinellids with the wings and elytra atrophied was seen feeding on *Aphis nerii* Fons. infesting *Cionura erecta* (L), in Greece (Horefton, Pilion). Breeding was undertaken to determine whether the observed anomalies are due to the quality of the food, and whether other characteristics are also affected.

RESULTS

Observations on naturally occurring populations

Two species showing wing and elytral atrophies were observed: *Adonia variegata* (Goeze) and *Semiadalia undecimnotata* (Schneider). In *A. variegata*, all intermediates occurred between fully apterous individuals and normal ones (Fig. 1). Usually, the atrophies on the left and right sides were nearly symmetrical, but strong asymmetries were sometimes encountered and wings and elytra were not always atrophied to the same extent. Likewise, the few observed specimens of *S. undecimnotata* showed a high variability in their wing development.

These aberrant ladybirds of both species were quite active and some specimens of *A. variegata* were observed *in copula*.

In the neighbourhood of Horefton in August, *A. variegata* (adults and larvae) feed mainly on *A. nerii* and *Aphis craccivora* Koch. The former *Aphis* is most abundant on *C. erecta*, and to a lesser extent on another asclepiad, *Cynanchum acutum* L. *A. craccivora* infests *Robinia pseudacacia* L.

Adults and pupae of *A. variegata* were collected on the three host plants, and the pupae were allowed to develop into adults. The proportion of normal and abnormal coccinellids was determined for each plant (Table I).

Nearly all aberrant ladybirds were encountered on *C. erecta*, and only pupae collected on this plant emerged as wing-atrophied adults. Aberrant specimens were discovered on all bushes of *C. erecta* found heavily infested with *A. nerii*. Some plants grow in the village, others at several km outside it, along the coast, far from any human habitation or activity.

The only four abnormal *A. variegata* collected on *R. pseudacacia* could have easily migrated from a bush of *C. erecta* about 8 m distant and housing a very dense population of these ladybirds. Indeed, brachypterous coccinellids were sometimes observed running on the ground several meters away from any *C. erecta*.

Although only few pupae and adults were collected on *C. acutum*, it is highly significant that all were normal although feeding also on *A. nerii*.

Our observation on *S. undecimnotata* is less extensive: only five normal and seven wing-atrophied adults were obtained from pupae collected on *C. erecta*. No specimens were observed on the other plants.

TABLE I

Distribution of wing-atrophied A. variegata *in relation to the aphid and host-plant species*

		Aphis nerii-Cionura erecta	*Aphis nerii-Cynanchum acutum*	*Aphis craccivora-Robinia pseudacacia*
adults collected	normal	273	28	745
	wing-atrophied	344	0	4
		$P^{(1)}<0.001$		
pupae	total collected	80	6	56
	emerged to normal adults	9	4	53
	emerged to wing-atrophied adults	17	0	0
		$P^{(2)}= 0.026$		

(1) χ^2 test.
(2) Fisher exact probability test.

Experiments on development and reproduction

The wing-atrophied *A. variegata* lay viable eggs. Larvae from either aberrant or normal females were fed from hatching with either *A. nerii* collected on *C. erecta* as the only food, or with *A. craccivora* collected on *R. pseudacacia* (Table II). All the individuals fed with *A. nerii* developed into adults with wings and elytra totally or strongly atrophied, those fed with *A. craccivora* developed quite normally. These

atrophies are thus food-dependent and completely reversible at the next generation. No significant difference was observed between the viability of the larvae obtained from normal or abnormal parents and bred on the same food, but the mortality was higher and the development slower on the *A. nerii* diet.

Wing-atrophied *A. variegata* collected in nature were fed with *A. nerii* infesting *C. erecta*. The adults were assembled in groups of four or five and fecundity and mortality over a 14-day period were compared with those of similar groups of

TABLE II

Development of A. variegata *on* Cionura-*infesting* Aphis nerii *or* Robinia-*infesting* Aphis craccivora

Parents of larvae	Number of larvae	Food	Adults normal	Adults wing-atrophied	Duration of development (days) mean ± S.D. [1]	
normal	30	*A. nerii*	0	19	17.8 ± 1.0	P < 0.001
	30	*A. craccivora*	28	0	14.4 ± 0.7	
wing-atrophied	30	*A. nerii*	0	17	16.2 ± 1.1	P < 0.001
	23	*A. craccivora*	22	0	13.8 ± 0.8	

[1]) Student's t-test. The durations of the development of the larvae issued from either normal or wing-atrophied parents cannot bedirectly compared, as these were done at slightly different times.

TABLE III

Fecundity of normal and wing-atrophied Adonia variegata. *Six replicates, each of four or five insects, were set up for each treatment. Only the totals for all treatments are shown*

	Composition at start	Composition after 14 days	Number of eggs laid	Number of eggs/ live female/day
Normal adults fed with *Robinia*-infesting *A. craccivora*	15♀, 14♂	13♀, 11♂	3747	18.2
Wing-atrophied adults fed with *Cionura*-infesting *A. nerii*	17♀, 13♂	1♀, 9♂	1011	7.7

normal adults, collected on *R. pseudacacia* and fed with *A. craccivora* (Table III). The sex of each individual was determined at the end of the experiment. The mortality of the aberrant females was higher, and the daily egg production was

lower from the beginning of the experiment. Since the age of the adults collected in nature was unknown, it is possible that the wing-atrophied females were older than the normal ones, though this seems unlikely. The species is multivoltine and both populations included all stages of development. No differences could be detected, however, in the state of the ovaries at emergence (number of ovarioles and maturation of the oocytes.).

Lacewing and syrphid larvae were also found preying upon *A. nerii* infesting *C. erecta*. Some were collected and fed with this aphid until the adult stage. Twenty-five syrphid larvae (two different species) yielded four adults and eighteen parasitoid Hymenoptera, fourteen lacewing larvae produced seven adults. No wing deformity was observed.

DISCUSSION

Cionura-infesting *A. nerii* is obviously a much less favourable food for *A. variegata* than *Robinia*-infesting *A. craccivora*. With the former, larval mortality is higher, post-embryonic development longer, and probably female fecundity lower and mortality higher. Moreover, the wings and the elytra fail to develop normally.

The wing deformities of the ladybirds collected in nature showed a much greater variability than those found by rearing experiments, which always produced strong wing reduction. This suggests that larvae found on *C. erecta* do not necessarily complete their development while feeding only on *A. nerii*; either they migrate from one plant to another, or they find alternative food on the same host plant. I have observed larvae of *S. undecimnotata* sucking some blood from pupae of *A. variegata* on densely populated *C. erecta*. This could also partially explain the high proportion of pupae of *A. variegata* which failed to hatch (Table I).

At least the deficiency in the development of the wings and the elytra seems to be an indirect effect of the host plant. Indeed, such atrophies were not detected in *A. variegata* developing on *Cynanchum acutum*-infesting *A. nerii* (Table I). In France (Alpes Maritimes and Basses-Alpes), *A. variegata* grow normally on *A. nerii* colonizing *Nerium oleander* L., and even show some preference for this aphid (Iperti, 1965). *Coccinella undecimpunctata* in Egypt (Ibrahim, 1955) and both *C. undecimpunctata* and *C. septempunctata* in Israel (Rothschild *et al.*, 1970; 1973) develop normally when preying upon *A. nerii* feeding on *N. oleander*.

It was known already that all aphids are not equally suitable for the development of ladybirds, and that their suitability as food could sometimes depend on their host plant (literature in Hodek, 1973), but the morphogenetic affect described here has not previously been reported to my knowledge. It remains to be verified, whether the postulated influence of the host plant extends over the entire habitat and geographical range of *Cionura erecta:* rocky places, river gravels, and maritime sands, in Yugoslavia, Albania, Greece, Crete, Bulgaria and Turkey (Tutin *et al.*, 1972).

The nature of the plant and aphid toxins affecting the ladybirds remains unknown. *A. nerii* feeding on *N. oleander* and *Asclepias curassavica* contain

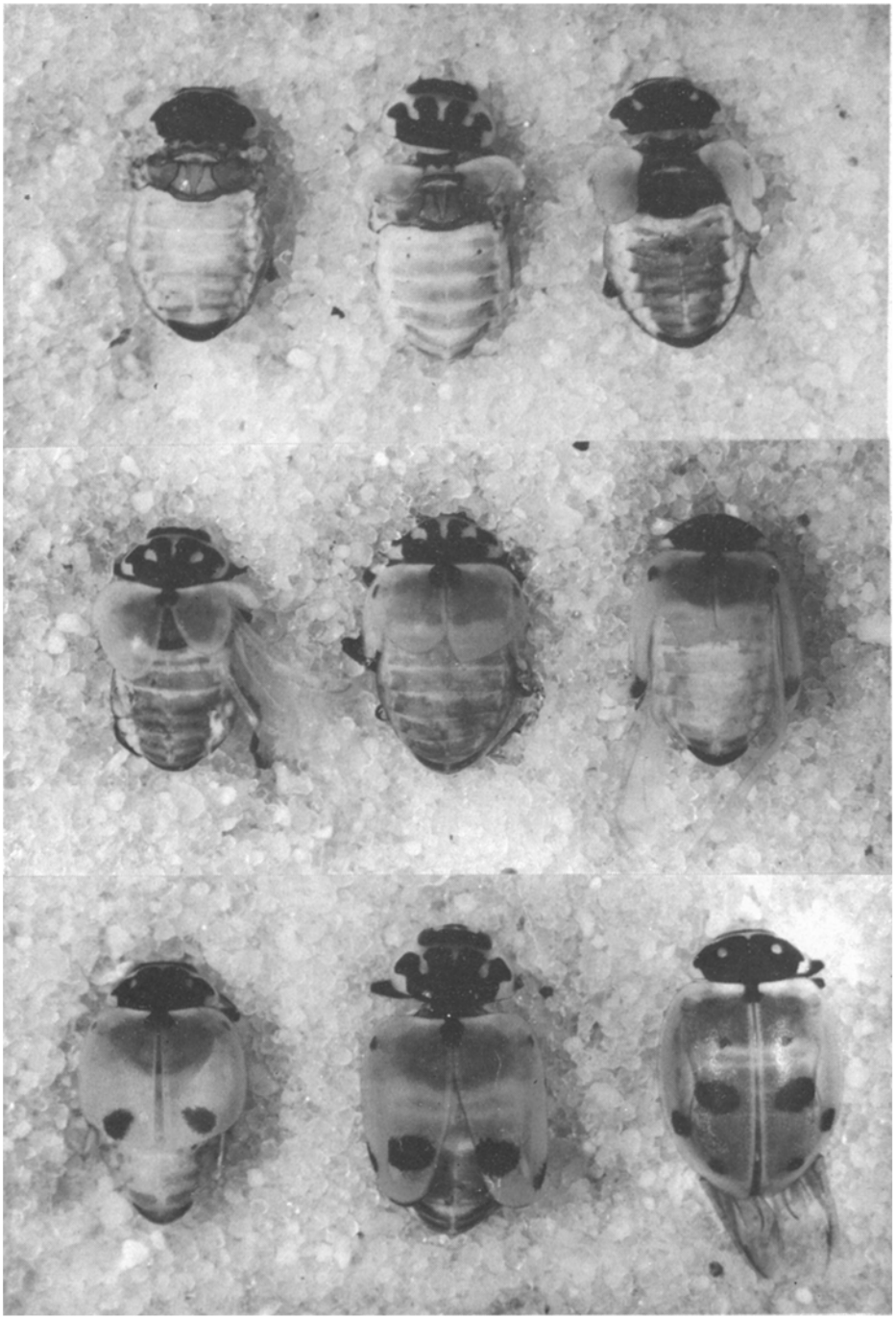

Fig. 1. Wing-atrophied *Adonia variegata* collected on *Cionura erecta* infested by *Aphis nerii*

cardenolides sequestered from their host plants (Rothschild *et al.*, 1970). A preliminary analysis failed to demonstrate the occurrence of cardenolides in both *C. erecta* and *A. nerii* collected on it. The wing deficiences suggest a possible juvenile hormone effect, but no juvenile hormone activity has been detected using the *Galleria* test in either the plant or the aphids. The aphid extract appeared toxic for the *Galleria* pupae.

The *Galleria* tests were performed in the laboratory of Prof. J. de Wilde (Wageningen). Dr. D. Daloze (Brussels University) checked for the cardenolides. The aphids were identified by Dr. J. H. Martin (British Museum) and Dr. V. F. Eastop, the asclepiads by Dr. R. Ross (British Museum) and Dr. M. Tanghe (Brussels University), and *Adonia variegata* by Dr. H. Fürsch (Ruderting).

RÉSUMÉ

COCCINELLES APTÈRES SUR CIONURA ERECTA *(ASCLEPIADACEAE) INFESTÉE PAR* APHIS NERII

De nombreuses *Adonia variegata* et quelques *Semiadalia undecimnotata* présentant des atrophies des ailes et des élytres ont été observées en Grèce (Horefton, Pilion). Sur la base des arguments suivants, il est suggéré que ces anomalies sont dues indirectement à la plante-hôte (*Cionura erecta*) sur laquelle se développent les pucerons (*Aphis nerii*) dont se nourrissent les coccinelles:

1. Toutes les larves d'*A. variegata* nourries depuis l'eclosion avec des *A. nerii* récoltés sur *C. erecta* se développent en adultes dont les ailes et les élytres sont soit absents, soit très réduits, aucune de celles nourries avec *Aphis craccivora* récolté sur *Robinia pseudacacia*.

2. La quasi-totalité des coccinelles aberrantes récoltées en nature, l'ont été sur *C. erecta*, mais jamais sur une autre Asclépiadacée, *Cynanchum acutum*, également infestée par *Aphis nerii*.

3. La majorité des pupes de coccinelles récoltées sur *C. erecta* se développent en adultes dont les ailes et les élytres sont atrophiés, aucune de celles récoltées sur *C. acutum*.

4. D'après la littérature, *A. variegata* en France, *Coccinella undecimpunctata* et *C. septempunctata* en Afrique du Nord, se développent normalement sur *A. nerii* colonisant *Nerium oleander*.

Le développement post-embryonnaire d'*A. variegata* est plus long et la mortalité larvaire plus grande lorsque les larves sont nourries depuis la naissance avec *A. nerii* prélevés sur *C. erecta* que lorsque *Aphis craccivora* leur sert de nourriture.

Les *A. variegata* à ailes et élytres réduits s'accouplent et produisent des œufs viables, les larves se développent normalement si une nourriture adéquate (*A. craccivora*) leur est fournie. La longévité et la fécondité des femelles aberrantes nourries avec *A. nerii* récoltés sur *Cionura* paraissent plus faible que celles de femelles normales nourries avec *A. craccivora*.

Les substances toxiques présentes dans le puceron et la plante ne sont pas connues, mais ni des cardénolides ni des substances juvénoïdes ne paraissent devoir être impliquées.

Des larves de syrphides et de chrysopes récoltées sur *C. erecta* et nourries avec des *A. nerii* prélevés sur la même plante se sont développées en adultes normaux.

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