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TROPHIC REGULATION OF POSTDIAPAUSE OVARIOLE MATURATION IN *COCCINELLA SEPTEMPUNCTATA* [*COL.: COCCINELLIDAE*]

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In 1977 the vernal maturation of *Coccinella septempunctata* L. females was investigated in relation to the variation in aphid population density on alfalfa and cereals in central Bohemia. The ovarioles do not ripen unless the aphid population density reaches a certain threshold. This leads to considerable variability in the time of vernal reproductive activity (up to 1.5 months in the same geographic locality) among subpopulations living on crops with different aphid densities. This mechanism enables the reproduction of the aphidophagous insect to synchronize with the population development of the aphid.

The factors regulating the postdiapause vernal reproductive maturation in insects were recently critically evaluated by TAUBER & TAUBER (1976). The known cases spread into 3 classes depending on the role that diapause, quiescence, and postdiapause temperature summation each play in determining the onset of vernal reproductive activity. In a sympatric population of a species all of these mechanisms assure that reproductive maturation is more or less synchronized with the return of favourable conditions. In an aphidophagous insect, *Coccinella septempunctata* L., however, great differences (up to 1.5 months) in time for ovariole maturation occurred between local subpopulations. These differences arose even in closely positioned places unseparated by physical barriers. The source of this variation and the nature of modifying factor were investigated.

MATERIAL AND METHODS

In 1977 *C. septempunctata* females were sampled by sweeping 3 nearby fields at Praha-Ruzyně: an alfalfa field "A" with a high initial (in late April) density of pea aphid (*Acyrthosiphon pisum* HARRIS, an alfalfa field "B" with a low initial density of *A. pisum*, and a field of barley "C" with a low initial density of grain aphid (*Sitobion avenae* F.); and also a large alfalfa field with several local infestations of *A. pisum* in Potěhy near Čáslav (eastern Bohemia). Supplementary samples were also taken on several other fields (alfalfa, clover, cereals) at these 2 localities.

The aphids swept were counted either directly (when the sweeping net contained less than 200 aphids) or, in the case of larger samples, their number was estimated. The error between estimation and direct counting did not exceed 10-15 % and was unimportant considering that the aphid catches varied by 5 orders. All counts were transformed to the number of aphids per 100 sweeps.

The state of ovarioles of *C. septempunctata* was investigated from samples of 30-70 females. Ripe ovarioles (mature eggs with chorion present) are visible in intact females through the tergal part of abdomen when the elytra are raised. The unripe, maturing or questionable specimens were dissected.

RESULTS AND DISCUSSION

Large variation in the time of the onset of ovariole maturation occurred in the 3 fields at Praha-Ruzyně (fig. 1). The differences were in keeping with the size of the aphid populations. In alfalfa field "A" the maturation began in the 2nd half of April and was practically completed by mid-May after which a small proportion of unripe females in the population was maintained presumably by immigration. Eggs were first noted on May 3. Here the aphid increased from 512 per 100 sweeps on April 27 to 8320 per 100 sweeps on May 15. In alfalfa field "B", only 1.5 km away and not separated from field "A" by forest, hedgerows or similar barriers, the *C. septempunctata* females remained immature until late May and matured in the 1st 10 days of June. Here aphid numbers were 6 to 138 per 100 sweeps up to about early June when 600 aphids per 100 sweeps were recorded. On the barley field "C" lying between the 2 alfalfa fields, the maturation of *C. septempunctata* ovarioles began about 10 days later still, and here also it corresponded with a certain increase of aphid population. The numbers of aphids caught at that time by sweeping, however, were substantially lower than on alfalfa (40 to 85 per 100 sweeps) and the increase was less marked.

This observation offers two conclusions: (1) That *C. septempunctata* females attained reproductive maturation only after a threshold density of aphid numbers had been reached, though such a threshold density seems not to be the same on all crops. Expressed as numbers per 100 sweeps this threshold density on alfalfa lies between 100 to 300 aphids, and on barley about 40 aphids. This difference is due partly to sampling error and also to the spatial structure of the crop, the aphid species eaten, and the time taken to eat, and/or other modifying factors. This dependance on aphid abundance for vernal ovariole ripening regardless of calendar date was also confirmed by observation in several other fields planted with various crops. (2) The local active and inactive *C. septempunctata* subpopulations are sharply delimited. The borderlines between them usually coincide with the edges of infested and uninfested crops. Thus on May 17 at Praha-Ruzyně there were 5 % of active females (1 individual out of 19) in 10 metre wide belt of uninfested barley bordering highly infested alfalfa (with 92 % of ripe females). Several similar situations were observed.

Even within one field, however, considerable differences may be found in the degree and amount of ovariole maturation. This situation was investigated in detail on a large alfalfa field near Potehy. On May 18 at different places in the field the percentage of ripe females varied between 18.2 to 66.7 % corresponding with the density of the aphid population. These differences arose in early May and disappeared only after some weeks when the aphids had become evenly abundant over all field (fig. 2).

In such foci of aphid populations (at least, if these are sparsely distributed) a large concentration of *C. septempunctata* population also occurs. Thus in 1977 in early May there was about 100 times greater density of *C. septempunctata* in the foci of dense *A. pisum* populations than on neighbouring crops; and even at the time of 1st alfalfa cutting (May 15 to June 15) the population density on alfalfa was more than 10 times greater than on cereals (HONEK, in press). From this fact (if the ovariole maturation is taken as indicative) one may conclude that when dispersing *C. septempunctata* come into contact with aphid populations of high density, they settle and remain there. It could imply that they are able to perceive and evaluate the population density of aphids.

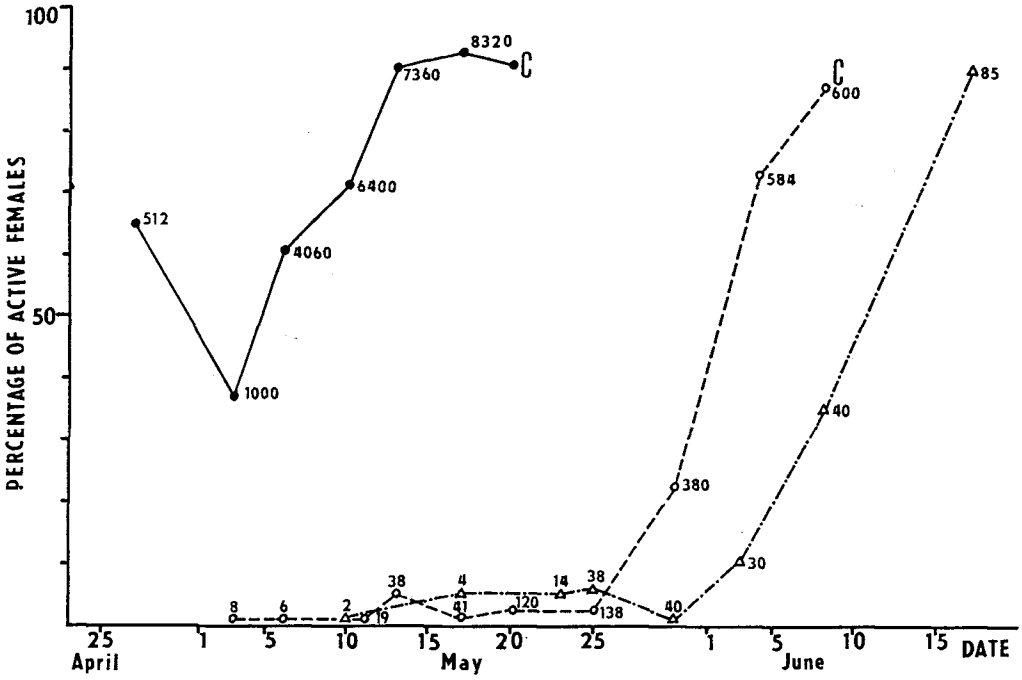

FIG. 1. The maturation of *C. septempunctata* ovarioles on 3 fields with different aphid density: •——• alfalfa "A" (high density of *Acyrthosiphon pisum*); o—o alfalfa "B" (low density of *A. pisum*); Δ-.-.-Δ barley "C" (low density of *Sitobion avenae*). The figures indicate the numbers of aphids per 100 sweeps at the places and time of collection of *C. septempunctata* samples. c = cutting.

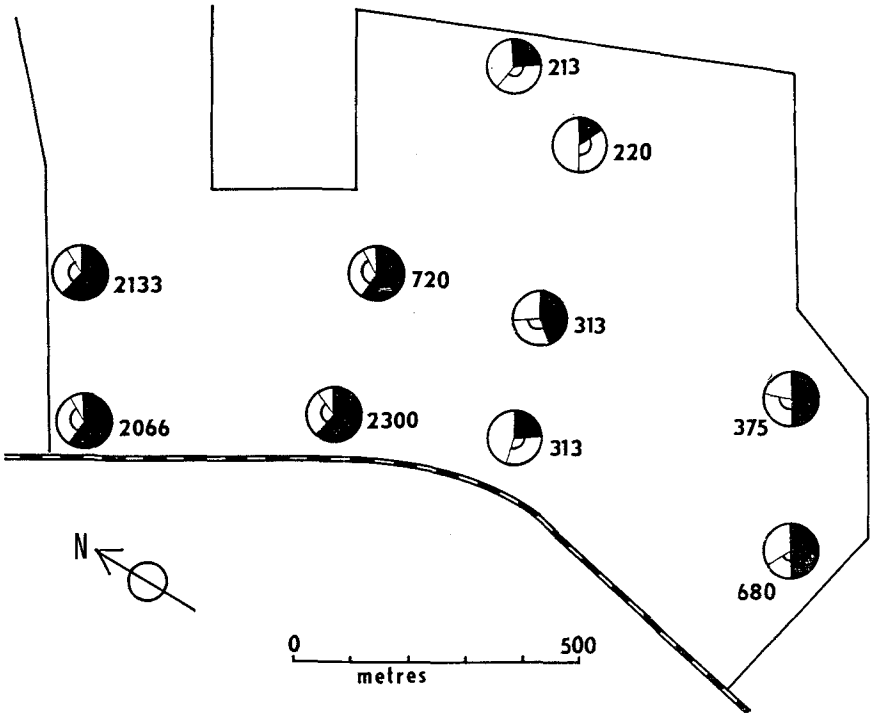

FIG. 2. The proportion of mature (black), intermediate maturing (white with central stripe), and unripe (white) *C. septempunctata* females at 10 places in an alfalfa field with diversified aphid population density (Potěhy; May 18, 1977). The figures indicate numbers of *Acyrthosiphon pisum* per 100 sweeps.

It was demonstrated (1) that vernal maturation in *C. septempunctata* females depends on the amount of food available and (2) that there is a great variation in its timing among local populations. This aspect of postdiapause development in *C. septempunctata* has not hitherto been studied (HODEK, 1973; HODEK *et al.*, 1977). The trophic regulation of postdiapause reproductive activity is presumably of adaptive significance for exclusively entomophagous predators. It enables their reproductive activity to synchronize with host population density. For phytophagous insects or entomophagous species able to substitute their animal food for a vegetable one it is probably of less importance, since such a food is usually available in sufficient quantity. In this case their maturation may be more dependent on physical environmental characteristics, e.g. temperature and photoperiod. The bland statement that unfed females of an anautogenous insect do not lay eggs is perhaps trivial, but its consequences for population biology appear to be far from trivial.

RÉSUMÉ

Régulation trophique de la maturation printanière des ovarioles chez *Coccinella septempunctata* [*Col.: Coccinellidae*]

En 1977, la maturation printanière des femelles de *C. septempunctata* a été étudiée par rapport à la variation de la densité de population des pucerons sur la luzerne et sur les céréales, en Bohême centrale. Les ovarioles ne mûrissent pas tant que la densité de la population de pucerons n'atteint pas une certaine valeur. Ce fait occasionne des différences considérables (jusque 1 mois 1/2), dans le début de la reproduction au printemps entre différentes sous-populations vivant sur différentes cultures dans le même site géographique. Ce mécanisme permet la synchronisation de la reproduction de l'insecte aphidiphage avec le développement de la population du puceron.

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