

## OBSERVATIONS ON THE BEHAVIOUR AND MORTALITY IN COCCINELLIDAE BEFORE DISPERSAL FROM THE EGG SHELLS.

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WHEN ladybird beetles are numerous on bean plots and have laid many egg batches, cannibalism may be an important cause of mortality of the immature stages; larvae dispersing from the eggs in search of food encounter and eat unhatched eggs and newly-hatched larvae clinging to the egg-shells before they are old enough to disperse (Banks, 1955).

Even when coccinellid populations are low there is a certain degree of mortality during the egg stage, for some eggs are apparently infertile and some unhatched larvae may be destroyed by larvae already hatched from the same batch. Hawkes (1920) observed that some eggs of *Adalia 2-punctata* hatched earlier than others and that approximately a quarter of the larvae were eaten before dispersal. Smee (1922) also noted that newly-emerged larvae attacked unhatched eggs and that some eggs were infertile. Jöhnssen (1930) recorded that, on the average, 40 per cent. of the eggs of 9 batches of *Coccinella 7-punctata* and only 6 per cent. of eggs of 9 batches of *A. 2-punctata* did not hatch, but he did not express the mortality as infertile eggs and those in which larvae had developed. He noted that larvae after hatching frequently ate the empty egg-shells, infertile eggs and larvae which for some reason did not emerge.

The mortality in the egg stage in Coccinellidae is discussed here with reference to three common species of bean plots, *Coccinella 7-punctata* L., *Adalia 2-punctata* (L.), and *Propylea 14-punctata* (L.).

### HATCHING.

In all three species hatching takes place approximately seven days after oviposition. The eggs remain yellow until a few hours before eclosion, when they darken and the eyes of the larva show through the chorion. Infertile eggs do not darken and cannot be distinguished, unless damaged, until the hatching of fertile eggs is well-advanced. The larva emerges through an apical split in the chorion and the pronotal egg bursters assist in hatching (van Emden, 1949). The head, thorax and legs are gradually drawn free of the embryonic cuticle and chorion by slow backward and forward movements, and the larva rests on top of the egg-shell with part of the abdomen remaining inside. In this position it remains for an hour or so while the cuticle darkens and hardens.

After a while, the insect makes small movements, sometimes withdrawing the abdomen entirely from the chorion; it may crawl over its fellows and unhatched eggs; more usually it crawls out of the shell, retaining a hold at the top with the tip of the abdomen (the evaginated rectum acts as a sucking disc which is used in locomotion (Gage, 1920)) and brings its head to the base of the shell. Small movements of the head and the presence of small holes in the base of the thin-walled chorion suggest that the larva sucks out any fluid remaining

within the shell. Empty egg-shells may be completely eaten before larvae disperse.

Larvae remain on or near the empty egg-shells for 12-24 hours or more after eclosion ("just-hatched" stage) (Plate 1B) and it is during this time that the destruction of infertile eggs and larvae slow in hatching occurs.

#### SIZE OF EGG BATCHES AND RATES OF MORTALITY.

The number of eggs per batch in *P. 14-punctata* is usually 6 or 7, although as many as 11 have been seen. In *A. 2-punctata* the number is variable, the average being between 12 and 17; a maximum of 36 eggs in a batch has been recorded in this species. In *C. 7-punctata* the number of eggs is also very variable and, although there are usually 20 to 30 eggs, large batches of 40 to 50 eggs are not uncommon, and in one batch 65 eggs were recorded. Smee (1922) gives averages similar to these.

When there are few eggs in a batch the larvae usually emerge together and any attack on one larva by another is usually repulsed. But in larger batches hatching may be spread over a longer time and thus some larvae hatch earlier than others and will attack unhatched eggs and even larvae partly emerged. Thus, the hatching of a batch of 53 eggs of *C. 7-punctata* on 6th June was spread over seven hours. During the first three hours only 6 larvae emerged, but 11 more hatched during the next 25 minutes and were followed by 9, 10, and 9 larvae in successive intervals of 30 minutes; the hatching of 45 eggs lasted four and a half hours (fig. 1). There was a general but not very marked tendency for eggs which had been laid first to hatch early and, in this example, the four infertile eggs and one unhatched larva were destroyed by cannibals.

Infertile eggs are always attacked, sometimes by more than one larva, and the contents sucked out; their remains can be recognised by their shrivelled appearance and by traces of yellow yolk. Eggs which would have hatched but for an attack are also collapsed, but the dark remains of larvae within the shells distinguish them from infertile eggs.

In *P. 14-punctata*, where the egg batches contain few eggs, nearly all larvae hatch together and the proportion of fertile eggs destroyed by cannibals is low (about 6 per cent.); in *A. 2-punctata* and *C. 7-punctata* where batches are larger this proportion is considerably higher (10-12 per cent.) (Table I).

TABLE I.—Mortality of *Coccinellidae* in the egg stage.

	<i>C. 7-punctata.</i>	<i>A. 2-punctata.</i>	<i>P. 14-punctata.</i>
Number of batches . . . . .	16	11	10
Number of eggs . . . . .	499	186	57
Mean eggs per batch . . . . .	32	17	6
Proportion of infertile eggs (%) . . . . .	13.2	4.8	5.3
Proportion of fertile eggs eaten by larvae already hatched (%) . . . . .	9.5	12.4	5.6
Proportion of total eggs from which no larvae were obtained (%) . . . . .	21.4	16.6	10.6

Infertile eggs are uncommon in *P. 14-punctata* and *A. 2-punctata*, but in *C. 7-punctata* they occur regularly and are invariably eaten by the larvae before they disperse.

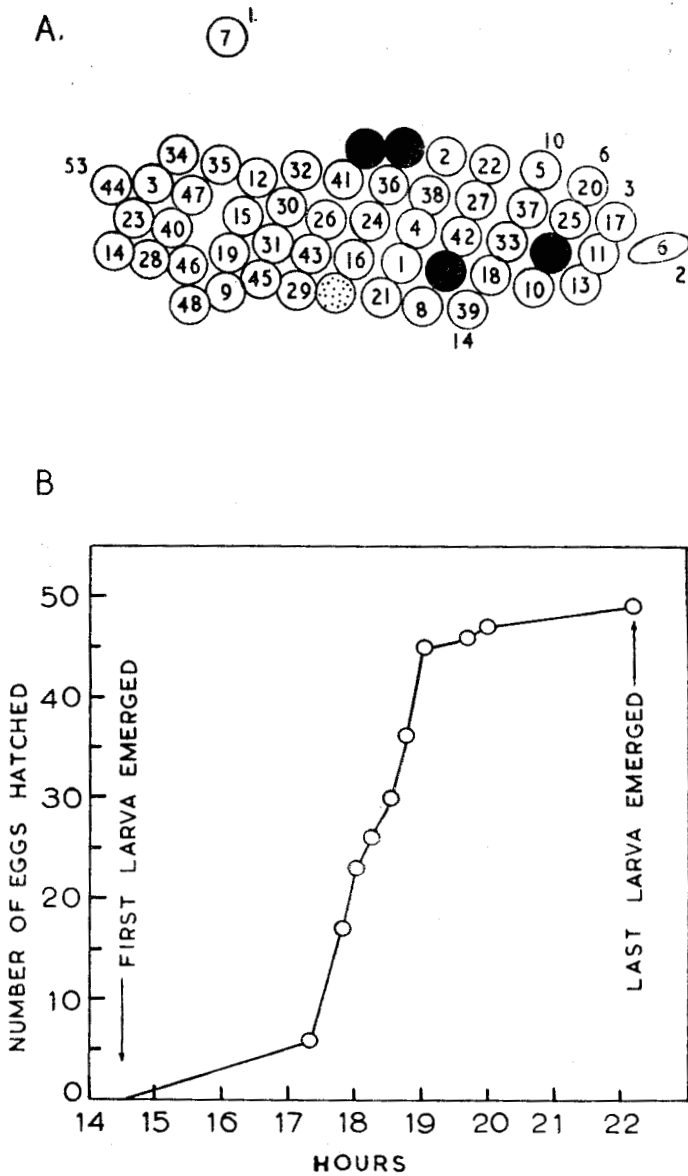


FIG. 1.—Hatching of a batch of 53 eggs of *Coccinella 7-punctata*. A. Plan of the batch; the numbers within the eggs show the order of hatching, those outside, the order in which they were laid. The infertile eggs (in black) and one fertile egg (stippled) were eaten by larvae. B. The numbers of eggs hatched over a period of 8 hours.

Larvae which have eaten a coccinellid egg are easily recognised by the distended abdomen, and the separation of the thoracic and abdominal segments shows the yellow contents of the gut through the integument (Plate 1A).

Five newly-hatched larvae of *A. 2-punctata* were fed on one egg each of their own species; on the average they lived almost twice as long as unfed larvae (fig. 2). Other larvae of the same age, provided with two and three eggs but no other food, lived still longer and reached the second instar within four days after hatching, the usual time for this species when abundant aphids are provided (4.6 days, Clausen, 1916; 4 days, Smee *loc. cit.*). Water extended the life of unfed larvae by only a few hours.

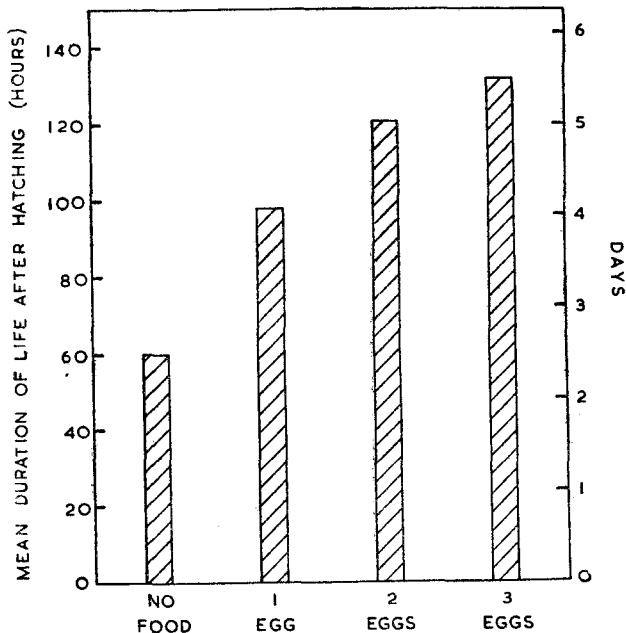


FIG. 2.—The average duration of life of 4 groups of 5 newly-hatched larvae of *Adalia 2-punctata*. One group had no food; the 5 larvae of the other groups were fed on 1, 2 and 3 eggs of this species.

If this early cannibalism before dispersal occurs in the field, and there is no reason to suppose that it does not, then larvae which hatch early and are able to eat an egg probably benefit in that by living longer they are able to make a more prolonged search for aphids. When prey density is low cannibalism would have a survival value for individual larvae. The numbers of larvae which would benefit in this way is, however, unknown, and all that can be said at present is that the numbers would apparently be correlated with the size of the egg batch and, therefore, with the species, that is, lower in *P. 14-punctata* than in *A. 2-punctata* and highest in *C. 7-punctata*.

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## SUMMARY.

In the three common species of Coccinellidae occurring on bean plots, *Coccinella 7-punctata*, *Adalia 2-punctata* and *Propylea 14-punctata*, important causes of mortality in the egg stage were infertility and predation by newly-hatched larvae of the same batch.

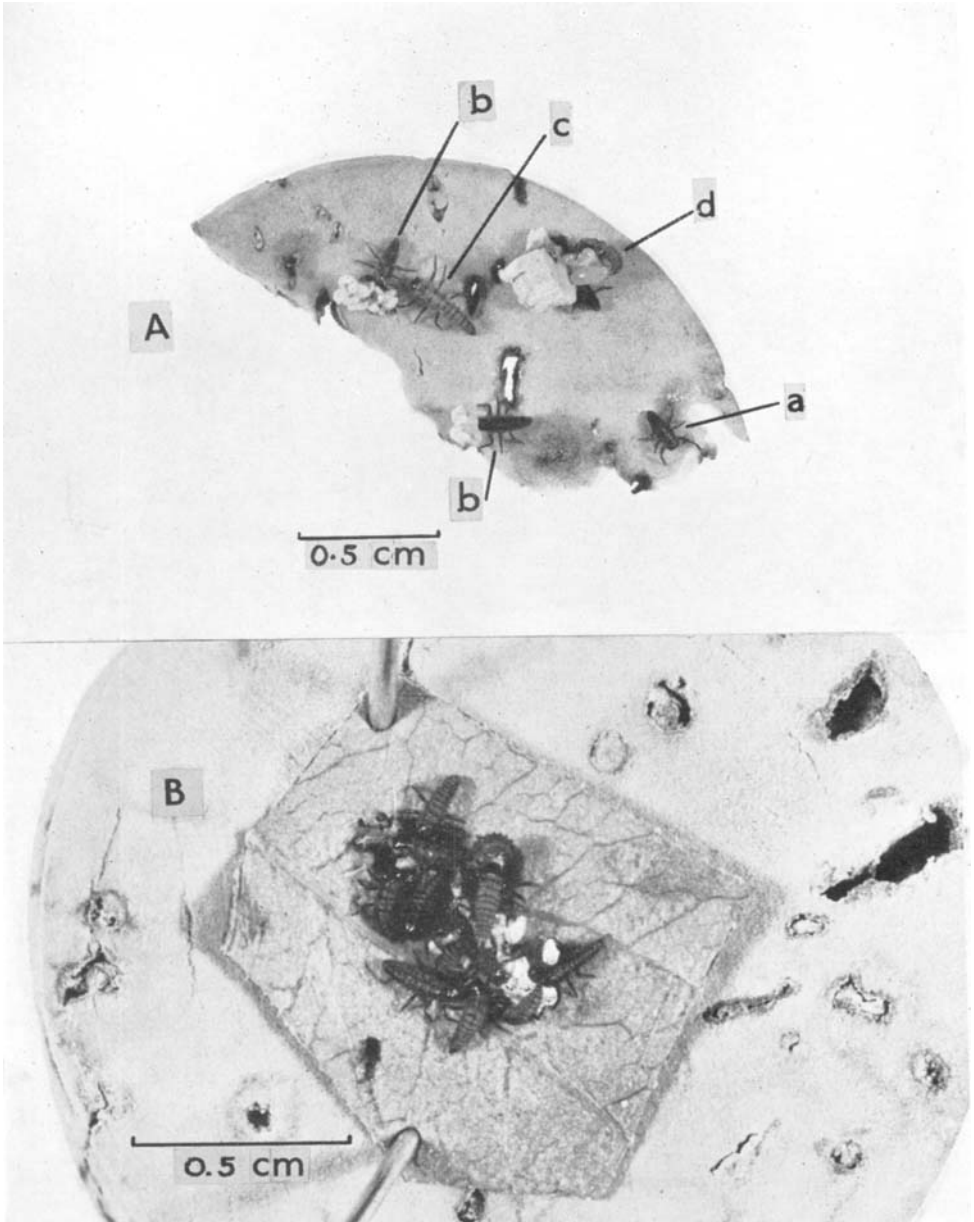
The extent of this predation appears to be associated with the size of the egg batch; in *C. 7-punctata* and *A. 2-punctata*, which have large or medium-sized egg batches, 10–12 per cent. of the fertile eggs were destroyed by larvae already hatched and in *P. 14-punctata*, where egg batches are small and the larvae usually hatch together, approximately 6 per cent. of the fertile eggs were destroyed in this way.

Infertile eggs were not common in *A. 2-punctata* and *P. 14-punctata*, but in *C. 7-punctata* they occurred regularly and were always eaten by the young larvae.

The advantage to larvae which are able to eat an egg before starting a search for prey is emphasised by the results of an experiment which indicated that the provision of one coccinellid egg as food almost doubled the life of a newly-hatched larva, which would thus be able to prolong its search for aphids. Larvae fed on two and three eggs lived even longer and were able to grow into second instars without aphid food.

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A. Newly-hatched larvae of *Propylea 14-punctata* on a piece of cork. (a) unfed larva ; (b) unfed larvae attacking eggs ; (c) fed larva showing distended abdomen ; (d) egg collapsing under attack by larva.

B. "Just-hatched" larvae of *Adalia 2-punctata* on the undersurface of a piece of rose leaf.