Notes on egg-batch size in Adalia bipunctata (Coleoptera, Coccinellidae)

Jørgen Baungaard and Matti Hämäläinen

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Original data on egg-batch size in *Adalia bipunctata* (L.) are compared with information in the literature. Since the mean and the frequency distribution of the egg-batch sizes are fairly constant, it is suggested that some optimal batch size may exist, and its possible origin is discussed in relation to reproductive strategies.

J. Baungaard, Institute of Zoology and Zoophysiology, Zoological Laboratory, University of Aarhus, DK-8000 Aarhus C, Denmark.

M. Hämäläinen, University of Helsinki, Institute of Agricultural and Forest Zoology, SF-00710 Helsinki 71, Finland.

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The eggs of *Adalia bipunctata* (L.) are deposited on the underside of leaves in clusters of varying size (Banks 1955). The aim of the present study is to present some theoretical considerations on egg-batch size in *A. bipunctata* based on original observations and data in the literature.

Materials

Ten egg batches and 47 imagines (14 ♂♂, 33 ♀♀) were collected from a heavily aphid-infested cherry plum tree in a city garden in Denmark, and taken to the laboratory. The adults were supplied with aphid-infested (undetermined species) cherry plum leaves, and another 10 egg batches were obtained during the next three days, after which oviposition ceased.

To get more comprehensive information on the batch size, unpublished observations of the second author were incorporated in the present data. These results were obtained by feeding overwintered, field-collected *A. bipunctata* adults in the laboratory with *Acyrthosiphon pisum* (Harris) or *Myzus persicae* (Sulz.), using the methods described in Hämäläinen et al. (1975). This material consisted of 1904 egg batches laid by 36 females during an average oviposition period of 33 days (range 3—74).

Results and discussion

The mean size of the egg clusters (Table 1) corresponds well with earlier records (see references in Table 1 and Iperti 1978a), which indicates that the mean batch size varies little compared with the considerable range of the egg numbers.

In both the Danish (Fig. 1) and Finnish (Figs. 2 and 3) materials batch sizes near the mean are more frequent than very low or high values and the distribution is contagious (χ^2 test, $p < 0.05$).

Egg-batch size may be assumed to be a function of physiological and other biological factors.

Since the total ovariole number in *A. bipunctata* is 48 (Robertson 1961), the maximum batch sizes of 43, 45, 47 and 47 obtained by Ellingsen (1969) and in the present study seem to be near the physiological maximum, representing one mature egg per ovariole. The "super batches", 85 and 65 eggs (Table 1), most probably result from a second oviposition close to an earlier laid batch.

The results indicate that medium to small batch sizes are most frequent. This, and the fact that the possibility of producing relatively large batches is seldom utilized by *A. bipunctata* suggest the presence of some optimum batch size(s), around which the actual batch sizes normally fluctuate in response to environmental factors.

A. bipunctata may be termed an opportu-

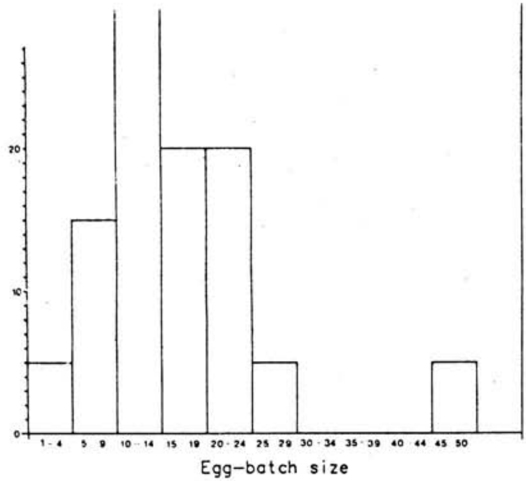

Fig. 1. Frequency distribution of egg-batch sizes of *Adalia bipunctata* ovipositing on cherry plum leaves. x = 16.4, n = 20.

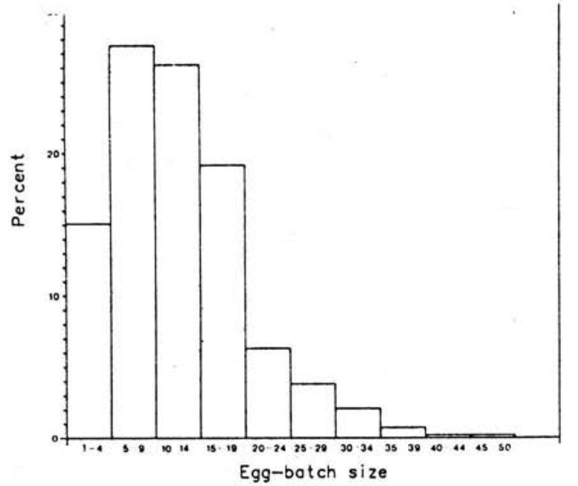

Fig. 2. Frequency distribution of egg-batch sizes of *Adalia bipunctata* fed on *Acyrthosiphon pisum*. x = 12.0, n = 819.

nistic species. Depending on an ephemeral aphid prey, it is often faced with suddenly and unpredictably deteriorating food conditions, and therefore has to maximize the exploitation of its resources whenever the opportunity arises.

An egg maturation cycle that results in the simultaneous maturation of the eggs in every fourth ovariole (ideally, 12 eggs per batch) may be an appropriate strategy. This will give more continuous oviposition; if the eggs in all the ovarioles mature simultaneously before oviposition, suitable sites for oviposition are likely to be left unexploited. Moreover, such a maturation cycle may represent a strategy of "bet-hedging" (cf. STEARNS 1976) — the risk of depositing the eggs in potentially unfavourable conditions is spread out in time and space.

Table 1. Mean (x) and range of egg-batch sizes in *Adalia bipunctata*. Data from the present study and the literature. When possible the 95 % confidence limits are indicated.

	x	n	Range
Present study:			
Obs. on *Prunus*	16.4 ± 4.4	20	3—45
A. pisum food	12.0 ± 0.5	819	1—47
M. persicae food	11.0 ± 0.4	1085	1—47 (85)
Literature data:			
BANKS (1955)	12.5	—	—
BANKS (1956a)	16.9	11	max. 36
BLACKMAN (1967)	11.6	27	—
	11.2	11	—
	14.1	8	—
	13.3	32	—
	10.8	13	—
	11.2	9	—
ELLINGSEN (1969)	15.4	8	2—43
HAWKES (1920)	15.4 ± 5.1	12	3—25
HÄMÄLÄINEN & MARKKULA (1977)	13.9	1892	2—[illegible] (65)

Further, batch size may be influenced by cannibalism, which is frequent in *A. bipunctata* (e.g. HAWKES 1920, DIXON 1959, DIMETRY 1971, 1976a, b). Since survival is improved when the prey is scarce, many authors consider cannibalism adaptive. It may be an important advantage in *A. bipunctata,* which occasionally oviposits on plants not infested by aphids (BANKS 1956b, DIMETRY & MANSOUR 1976), i.e. no direct stimulus by aphids is required to trigger oviposition. The survival-improving effect of cannibalism may select for large egg-batches, and an obvious strategy will be to lay many eggs whenever suitable oviposition sites are encountered. However, large batches may lead to heavy cannibalism and/or high intraspecific larval competition. Consequently,

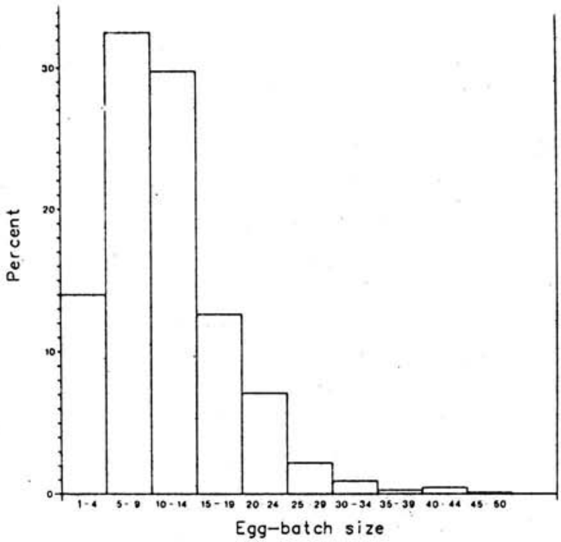

Fig. 3. Frequency distribution of egg-batch sizes of *Adalia bipunctata* fed on *Myzus persicae*. x = 11.0, n = 1085. ("Super batch" of 85 omitted).

On the other hand, small batches neglect the advantage of cannibalism and may result in low survival of progeny if the prey becomes scarce, and low exploitation when food is abundant. Therefore, the optimal batch size may be a compromise between small and large batches, conferring the best overall reproductive success for the species.

More research is needed to confirm that the frequency distribution of the numbers of eggs per batch is fairly constant. A fairly constant frequency distribution might be useful and time-saving in forecasting the success of *A. bipunctata*, a common aphid predator in biological control. Egg counting could be replaced by batch counting, which is easily conducted in the field.

However, this would require knowledge of the actual frequency distribution in a given population of ladybirds, as vitellogenesis and consequently egg production depend on both physical and tropic factors (cf. IPERTI 1978b) so that these may also influence the egg batch size.

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