

Ladybirds mothers eating their eggs: is it cannibalism?

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Abstract

In laboratory experiments the behaviour of starved females of four species of Coccinellidae [*Harmonia axyridis* (Pallas), *Adalia bipunctata* (L.), *Propylea quatuordecimpunctata* (L.) and *Hippodamia (Adonia) variegata* (Goeze)] was examined. A typical behaviour was recorded, but only in *H. axyridis* and *A. bipunctata*. The female laid one single egg and ate it immediately afterwards. When this egg was artificially removed, the mother showed rapid foraging movements looking for the subtracted egg. All the removed eggs were unviable. These eggs may be considered rather trophic eggs for the female's own nutritional benefit than a maternal care to mitigate offspring starvation.

Key words: *Harmonia axyridis*, *Adalia bipunctata*, *Propylea quatuordecimpunctata*, *Hippodamia variegata*, trophic eggs, cannibalism, Coccinellidae.

Supplemental material at www.bulletinofinsectology.org.

Introduction

Cannibalism is a frequent behaviour in animals and plays an important role in population dynamics (Fox, 1975; Polis, 1981). The ecology and evolution of intraspecific predation in insects is well documented among diverse taxa (Elgar and Crespi, 1992). The most frequent cases of cannibalism are adults, older larval or nymphal stages eating juvenile stages or eggs. Exceptions can be found in holometabolous insects where not sufficiently protected pupae can be cannibalised. Moreover, in laboratory experiments, larvae of the wax moth *Galleria mellonella* (L.) parasitised by the tachinid *Pseudogonia rufifrons* (Wiedemann) cannibalised pupae more than did larvae that were not parasitised (Dindo, 1988). Cannibalism in adults is particularly rare (contrary to the popular perception that in Mantoidea sexual cannibalism is very common) (Elgar, 1992). An ecological factor that generally favours cannibalism, particularly in entomophagous insects, is a low availability of food which may depend to varying degrees upon population density (Elgar and Crespi, 1992). In some insects another typical cannibalistic behaviour consists in the deposition of unviable eggs just for nutritional purposes. In subsocial and eusocial insects these eggs are called trophic eggs. Crespi (1992) defined trophic eggs as "ovarian-derived structures or fluid, homologous to fertile eggs that cannot develop into viable offspring and are normally eaten".

In *Myrmica rubra* (L.), Brian and Rigby (1978) described the existence of two types of eggs: 'D'-shaped eggs, which are fertile eggs that are deposited by the queen and workers and originate males and females, and 'O'-shaped eggs, laid only by workers, which may be offered as food to first instar larvae and the queen. This behaviour was observed also in other eusocial insects. Usually, the queen of the stingless bee eats trophic eggs produced by the workers (Sakagami *et al.*, 1965, 1973). Trophic eggs are produced in non social insects, too. West and Alexander (1963) observed that females of

Anurogryllus muticus (De Geer) lay small eggs as food for first instar nymphs. This behaviour can also be observed in insect species, which deposit eggs in masses. In fact, in several cases not all the eggs in a cluster are fertile. The fertility of the eggs was not always investigated, but anyway kin and non-kin cannibalism is frequent because eggs may be used as first food source for newly-hatched individuals both in phytophagous and entomophagous insects (Stevens, 1992; Barros-Bellanda and Zucoloto, 2005). In early experiments on ladybirds the unviable eggs were not considered (Agarwala, 1991). Later sibling egg cannibalism was demonstrated as a quite common strategy to mitigate offspring starvation risk, but not always the production of trophic eggs was considered (Hodek and Honek, 1996; Dixon, 2000; Osawa, 2002; Michaud and Grant, 2004; Perry and Roitberg, 2005 a; 2005 b; 2006). In this note we report laboratory observations on the egg-laying behaviour of starved females of four aphidophagous ladybird species.

Materials and methods

The insects and rearing methods adopted were those described in Burgio *et al.* (2002; 2005) and Santi *et al.* (2003). The aphidophagous ladybirds tested were the exotic multicoloured Asian or harlequin ladybird *Harmonia axyridis* (Pallas) (figure 1), and the three native species: *Adalia bipunctata* (L.) (two spot ladybird) (figure 2), *Propylea quatuordecimpunctata* (L.) (fourteen spot ladybird) and *Hippodamia (Adonia) variegata* (Goeze) (Adonis' ladybird). Females of different ages were collected from rearing cages. Only those that had already oviposited viable eggs in clusters were selected, isolated in vials and left without preys for 24 hours. These females were then transferred into a Petri dish arena (12 cm diameter with a filter paper disc) together with *Myzus persicae* (Sulzer) at two densities (5 and 40 aphids) and without preys. Fifty females per prey density (0, 5, and 40 aphids respectively) were tested (for a



Figure 1. *H. axyridis*.

(See short videos about “trophic egg laying” in supplemental materials at www.bulletinofinsectology.org)



Figure 2. *A. bipunctata*.

total of 150 females per species). Female behaviour was video-recorded or directly observed for one hour at room conditions (25-27 °C, 60-70 RH, light 500-600 lux).

The single egg laid by “trophic egg laying” females in absence of preys was removed using a fine paintbrush wetted with water. The eggs were then kept in an incubator at 25 °C (70 RH) to await their fate. A total of 25 and 18 trophic eggs of *H. axyridis* and *A. bipunctata* respectively were examined.

Results and discussion

The starved females of the two species *H. axyridis* and *A. bipunctata* showed a typical behaviour when isolated without preys: the females laid one single egg, turned off at a straight angle, and immediately ate the egg, “trophic egg laying” behaviour (see short videos in supplemental materials at www.bulletinofinsectology.org). Thirty-eight out of 150 starved *H. axyridis* females and 25 out of 150 starved *A. bipunctata* females, showed “trophic egg laying” behaviour. This behaviour was observed twice in the same female only in a few cases (not reported in the table), and only when the first egg laid had been artificially removed. The mother showed rapid foraging movements looking for the subtracted egg. (see short videos in supplemental materials at www.bulletinofinsectology.org). Later, the females started to lay a regular egg cluster and to forage and prey

when preys were in the arena. In presence of aphids the “trophic egg laying” behaviour was observed only once in *A. bipunctata* and 4 times in *H. axyridis* (table 1). In fact, the starved ladybird females of all four species, as soon as they were transferred into the arena with the preys, showed extensive and intensive foraging and eating behaviours.

All the single eggs laid by the females and artificially removed before eating were found unviable. No apparent difference in shape and/or colour was observed between the unviable trophic eggs and the eggs in the cluster subsequently laid by the same female. Egg hatching occurred regularly in these egg masses, and the percentage of newly hatched larvae in our conditions was about 60-70%, comparable to that observed in previous studies on ladybird egg fertility (Hodek and Honek, 1996). The “trophic egg laying” behaviour recorded in *H. axyridis* and *A. bipunctata* was similar between these two species, but was never observed in *P. quatuordecimpunctata* and *H. variegata* (table 1). We therefore assume that this typical single “trophic egg laying” and eating behaviour evolved in some Coccinellidae species as a useful mechanism to overcome stress conditions such as lack of preys.

Discussions concerning intraspecific predation and oophagy are still open in many animal taxa (Elgar and Crespi, 1992). In amphibians showing oophagy this behaviour is not considered cannibalism if the consumption of unfertilised eggs is involved (called trophic or nutritive eggs by Crump, 1992). As reported in the introduction kin cannibalism is well documented and in Coccinellidae sibling egg cannibalism is present in newly hatched ladybird larvae. Michaud and Grant (2004) demonstrated that in different ladybird species eggs laid in clusters versus eggs laid singly may be in relation with cannibalism. Single eggs are less likely to be cannibalised by newly hatched larvae than eggs in clusters. Perry and Roitberg (2005b) demonstrated that *H. axyridis* mothers may mitigate offspring starvation risk by laying trophic eggs in the cluster. These eggs were named trophic because they were apparently infertile. The laying of infertile eggs was higher in low versus abundant food treatments, and its relation to prey abundance was evinced. Also in our observations

Table 1. Number of observed events of “trophic egg laying” by the four ladybird species. 50 females for species for each aphid density.

Coccinellidae species	No. Aphids			Trophic eggs artificially removed at 0 aphid density
	0	5	40	
<i>H. axyridis</i>	34	4	0	25
<i>A. bipunctata</i>	25	0	1	18
<i>P. quatuordecimpunctata</i>	0	0	0	-
<i>H. variegata</i>	0	0	0	-

H. axyridis and *A. bipunctata* females may have perceived the lack of food and ‘voluntarily’ produced one single trophic egg with adaptive benefit. Anyway, this egg apparently was laid for the female’s own nourishment, and not for the offspring, and can therefore not be considered a parental care. Further studies are needed to investigate why this typical mother behaviour was not detected in *P. quatuordecimpunctata* and *H. variegata*.

To our knowledge, this typical “trophic egg laying” behaviour of the mother has not been reported in literature, probably due to the difficulty to analyse this rapid event. In laboratory conditions this behaviour can be easily observed due to the absence of plants, honey dew, pollen and other interactions present in natural habitats, while observing the same behaviour in the field could be very complicated due to the fact that the event takes less than one second. As indicated by Thomas and Manica (2003), very few cases of associations between parents and offspring are reported in literature (they found filial cannibalism in an assassin bug both in field and laboratory studies). Our preliminary investigations indicate that the mother behaviour observed in the two ladybird species, *H. axyridis* and *A. bipunctata*, should not be considered filial cannibalism, but is more likely a “trophic egg laying” behaviour for the female’s own nutritional benefit.

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