SHORT NOTE

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# Confinement stimulates trivial flight in *Coccinella septempunctata* (Coleoptera: Coccinellidae)

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**Flight activity, *Coccinella septempunctata***

**Abstract.** Coccinellids (ladybird beetles) are usually kept in small containers before or during flight tests. We have recorded in mature reproductive adults of *Coccinella septempunctata* that confinement can increase both the tendency to fly (take-off) and the performance (duration) of trivial flight. This possibility should be taken into consideration in the interpretation of flight tests.

## *Introduction*

Seasonal changes in vagility of coccinellids have a great impact on the use of these species in biological or integrated control. This use, together with demands of basic research, stimulates experimental studies to monitor the flight tendency and duration during particular periods of the year and so determine the effects of age, reproduction, prey availability and physical factors on these two parameters.

When the flight behaviour of coccinellids is monitored the collected animals are kept in a limited space, impeding their inherent tendency to disperse when they forage for prey or leave their dormancy sites. We suspected that confinement may modify flight characteristics. Our preliminary tests indicate such modification which may lead to imprecise interpretation of flight tests.

## *Methods*

Flight activity of overwintered ovipositing adults of *Coccinella septempunctata* foraging for aphids on shrubs (*Philadelphus, Spiraea* series A, B) and herbs (*Tripleurospermum* series C) was tested in late spring. In additional control groups (n = 42 on 9 June, n = 18 on 20 June) flight activity was measured on the day of collection (day 0). In series A and B (n = 12 in each series) the activity of experimental specimens was measured on days 0, 1, 2, 3, and 4. In series C (n = 12), flight activity was measured on days 0 and 3. The series C represented a sort of control for the potential objection that A and B animals might have been stimulated by daily "forced" flight. Between measurements the beetles were kept outdoors, each specimen isolated in a Petri dish (90 mm diameter), provided with water, and half of the beetles in each sample also with aphids (*Aphis philadelphi, Brachycaudus* sp.). Temperature was recorded inside the cage where the Petri dishes were kept.

The flight activity was measured as propensity or tendency to fly (take-off), and duration of the flight. Measurements were performed in a controlled environment chamber at 32–33°C. The surface was illuminated by eight 15 W fluorescent tubes from 50 cm height. The measurements took place between 10 a.m. – 4 p.m., after 1/2 hour acclimation in the chamber.

Take-off was measured as the time elapsed from releasing the ladybird onto a small Petri dish (50 mm dia) to its attempt to fly (ranging from 1 s to 60 s if no flight occurred, see Okuda & Hodek, 1989). The time was then recalculated as number of potential take-offs per minute (60/TO-1). Ten trials for each specimen were averaged.

Flight performance was measured as duration of tethered flight using the technique of Dingle (1966) modified by Rankin & Rankin (1980b); the ladybird was attached by wax on its pronotum to a pin head. Flight was initiated by moving the insect rapidly through the air and maintained by a low air current. This method is different from that of non-stimulated flight used by Solbreck (1974). Durations of ten trials for each specimen were pooled.

Because the values of both parameters were highly variable and the distribution strongly skewed, non-parametric statistics (based on ranks) were used for analysis. However, trends for either means or medians or ranks were similar.

## *Results*

When the feeding and reproducing animals were tested on the day of sampling (day 0) their flight performance was very low in all cases during late May and in June; the average accumulated duration of flight remained as low as 50 s in late May and early June, and slightly higher (70–90 s) on June 20 and 26 (Fig. 1). There was no significant difference between confined starved and fed beetles (Mann-Whitney tests: series A: $U = 491$, $p = 0.54$; B: $U = 459$, $p = 0.89$; C: $U = 101$, $p = 0.09$); therefore both subsamples were pooled. In contrast to the insects just after collection, ladybirds kept for several days in Petri dishes increased their duration of tethered flight, particularly in the instance of sample B (almost 1,000 s). In series A and B, the duration decreased on the fourth day, although it still remained quite high (more than 600 s in B) in comparison to insects on the day of sampling (Fig. 1). In series C (beetles left three days "at rest"), the increase in flight duration was very similar to series A, where flight was tested every day.

The incidence of take-offs increased after confinement, most steeply in A, the second day after confinement from 2 to 16 $min^{-1}$. A similar steep increase was registered in series C: from 4 to 14 $min^{-1}$. When duration was compared between days 0 vs. 3 in each series and take-off between days 0 vs. 1 in A and B and 0 vs. 3 in C by Wilcoxon paired test, four of six comparisons indicated significant increase of flight characteristics (duration: $Z = 1.69, 2.35, 2.40$, $p = 0.091, 0.019, 0.016$ in A, B, C, take-off: $Z = 2.75, 1.11, 2.43$, $p = 0.006, 0.266, 0.015$).

Increases in take-offs were recorded at average daily temperatures higher than 20°C. Increases in flight duration, on the other hand, were greatest at much lower temperatures in early June (daily means around 15°C).

Mean daily temperature during outdoor storage (given in Fig. 1) was different for each series and no clear influence on flight performance was revealed.

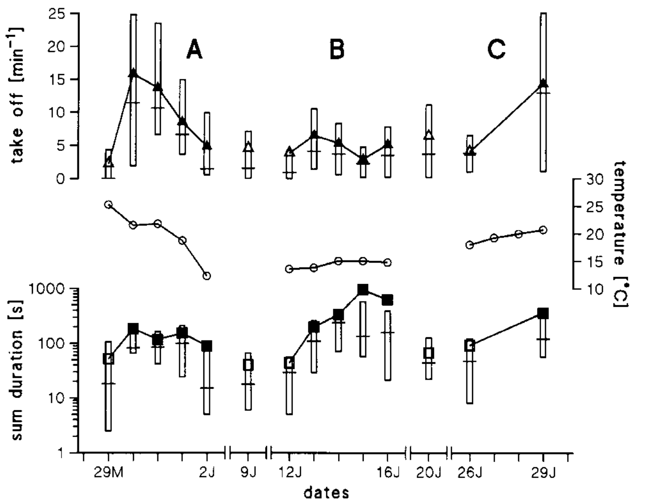


Fig. 1. Flight characteristics in foraging adults of *Coccinella septempunctata* in spring (series A, B, C, and controls). Flight duration (■, below), flight tendency (take-off, ▲, above) and environmental temperature (daily means, O, middle). Open symbols represent means on day of collection, solid symbols are means after confinement in Petri dishes. Bars represent lower and upper quartiles, dashes represent medians.

TABLE 1. Storage of several coccinellid species during flight tests.

| Species | Long storage at low temperature | Short storage at laboratory temperature | Space | Reference |
|---|---|---|---|---|
| *Coleomegilla maculata* | no | 2–25 days<br>15, 19, 23, 27, 31°C,<br>1 h acclim. at 25°C | 60–70 beetles in a plastic box<br>120 × 85 × 60 mm | Solbreck, 1974 |
| *Hippodamia convergens* | 7°C, dark | > 1 day, 24°C<br>often 3 days | "small containers" | Rankin & Rankin, 1980a,b |
| *Hippodamia convergens* | 3°C, 10L : 14D, 4–6 months | 0, 3, 6 days | Petri dishes<br>100 mm diam. | Davis & Kirkland, 1982 |
| *Hippodamia convergens* | 10°C, dark (Dec.–Feb.) | before the 1st flight<br>2 days, 24.5/21°C<br>4 days during the exp. period | not given | Růžička & Hagen, 1985 |
| *Coccinella septempunctata*<br>*Semiadalia undecimnotata* | no | < 1 day | plastic bottles<br>500 ml | Okuda, 1984;<br>Okuda & Hodek, 1989 |
| *Coccinella septempunctata* | no | 5–24 h,<br>> 48 h, 26°C | plastic bottles<br>(volume not given) | Honěk, 1990 |

## *Discussion*

The experiments were undertaken during the period of coccinellid trivial flight. *Coccinella septempunctata* adults left their overwintering sites in late April – early May, about one month before the experiment. The tests were performed on insects foraging for prey, having full guts and, in the case of females, mature ovaries. Evidently they had fed enough before collection so that three days of starvation did not affect their flight ability, as documented by the absence of significant differences between insects fed during confinement and those that were starved.

As absence of prey was not the stimulating factor, the tendency to disperse eggs to a larger area may explain the observed flight behaviour. It is well known that, at adequate temperatures, coccinellids have a tendency to fly away even from favourable habitats with enough prey (e.g. De Bach & Hagen, 1964; Kieckhefer & Olson, 1974; Ives, 1981). The duration of visits of overwintered *Coccinella trifasciata* and *C. californica* to oat and alfalfa fields was measured in Vancouver, Canada; the mean visit lasted only 1–2 days or less and was predominantly affected by temperature (Ives, 1981). Some recent papers report the presence of conspecific eggs or larvae as an inhibitory factor for oviposition (Hemptinne & Dixon, 1991; Růžička, 1994). In our experiments the eggs were removed daily, and some females oviposited repeatedly.

*Coccinella septempunctata* in Central Europe usually feeds on aphids on their primary host-plants, shrubs, in May and early June, but moves later to aphid secondary hosts, herbaceous plants including agricultural crops. Thus a relatively high flight capacity could be retained even after migration from overwintering sites. The higher values of flight duration in series B perhaps reflect this period of movement from primary to secondary host plants, i.e. from shrubs to fields.

In view of the well known vagility of ladybirds our findings on the effect of confinement are not particularly surprising. Nonetheless, this phenomenon apparently has not been taken into consideration in most studies of flight behaviour in Coccinellidae (Table 1). Although in most earlier studies activity was measured within a period of three days or longer, in most cases no changes in flight behaviour with time were reported (Rankin & Rankin, 1980a,b; Davis & Kirkland 1982; Honěk, 1990). For adults of *Hippodamia convergens* collected in their overwintering sites just before spring dispersal, Růžička & Hagen (1985) found a decrease in flight performance during a four-day period. These insects certainly had depleted fuel reserves after about 9–10 months of dormancy (Hagen, 1962; Hodek & Čerkasov, 1963) and were then starved during the experiment. The physiological condition of these coccinellids, differing substantially from our feeding and reproducing adults, explains the opposite tendency in the change of flight duration with time.

In *Coleomegilla maculata*, however, Solbreck (1974) recorded an increase in flight duration with time, although the adults were also collected in overwintering sites, just before spring dispersion, and starved during the experiments. The response was reported as "spring rematuration" of flight behaviour. This interpretation is quite probable for coccinellids sampled several weeks before their dispersal (mid-late April), e.g. in late March. However, the steep increase in flight duration within 4–5 days even in samples collected on April 18 and 26 (when the maturation of flight should have been completed) could have been affected by the confinement of tens of beetles in a limited space, at 23°C (Tab. 1).

By this preliminary note we intend to attract attention to the recorded effect of confinement which might cause flight behaviour observed in the laboratory to be misinterpreted.

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