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Flight activity of *Coccinella septempunctata* (Coleoptera: Coccinellidae) at different strata of a forest in relation to migration to hibernation sites

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Coccinellidae, *Coccinella septempunctata*, flight activity, long distance flight behavior, hibernation migration, meteorological conditions

Abstract. The flight activity of *C. septempunctata* was examined in a mixed oak forest, North Hungary, in 1987–1988. Malaise traps were established at the shrub level (0–2 m), the canopy level (12.5–14.5 m) and above the forest (25–27 m). A fourth trap was placed in an open grassland 200 m from the forest edge at the ground level. Exact meteorological data were registered during the season.

The highest flight activity was observed in late July – early August in both years. This period fits to the migration period of *C. septempunctata* to hibernation sites. In this period a "long distance flight behaviour" was observed in the high strata of the forest. The meteorological conditions highly influenced the flight activity of beetles, especially in the canopy level. In 1987, long distance flight behaviour was almost completely absent due to the low temperature and high wind speed.

INTRODUCTION

The aggregation and migratory behaviour of coccinellids is well-known and often discussed in the literature. Hagen (1962, 1966) distinguished two types of aggregation and also two types of migration in coccinellids. Hypsotactic species migrate long distance, and use optical cues for orientation. Climatotactic species usually do not change their habitat for hibernation, and the orientation is by a complex of responses to external stimuli. Hodek (1967) distinguished a third, intermediate type as well and classified *C. septempunctata* as a member of this group. This species has a very plastic life cycle (Hodek, 1973; Honěk, 1989) and is variable in aggregation and migration behaviour (Savoiskaya, 1960; Benham & Muggleton, 1978). The hibernation areas far from the breeding sites are occupied mostly by the well developed individuals, that can perform a long flight behaviour. Physically less capable individuals occupy mostly the "lowland" hibernacula close to breeding sites (Honěk, 1983, 1989).

The flight activity and behaviour of *C. septempunctata* and other coccinellids have been studied often in the laboratory (Iperti, 1978; Rankin & Rankin, 1980; Zaslavsky & Semyanov, 1983, 1986; Okuda & Hodek, 1989; Honěk, 1990). There are few and sporadic field observations on the flight behaviour of the coccinellids (Iperti & Buscarlet, 1972; Iperti & Rolley, 1973; Mikkola, 1978; Honěk, 1985). In this two year field study, the seasonal changes of the flight activity of *C. septempunctata* were examined at different strata of an oak forest and, specifically, whether the flight behaviour differs in spring and late summer and at different weather conditions.

MATERIAL AND METHODS

The study site was a mixed oak forest (Querceto-petreae cerris) in Northern Hungary near Eger. Three Malaise traps were established at different heights inside the forest on a metal tower: at the shrub level (0–2 m), within the canopy level (12.5–14.5 m) and above the canopy (25–27 m). A fourth trap was placed in an open grassland 200 m from the forest edge at the ground level. The traps were 2 m high, and the whole surface of the trap wings were 10 m^2. For the detailed description of the traps and the forest see Markó et al. (1992). The traps were emptied every day between April and October in 1987 and 1988. Daily mean temperature, wind speed, air pressure, relative air humidity, sunny hours per day were recorded each day of season.

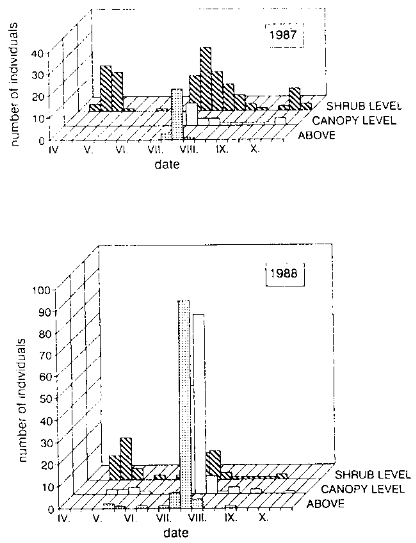

Fig. 1. Seasonal dynamics of *C. septempunctata* at the different strata in 1987 and 1988.

RESULTS

In total 813 and 553 individuals of *C. septempunctata* were collected by the four traps in 1987 and 1988, respectively. Two peaks can be found on the seasonal dynamic curves, one in the beginning of May, and a second one at the end of July (Fig. 1). There was a third, smaller peak in the first days of October but only in 1987.

Sixty three and 74% of the individuals were caught during the period of the late summer migration in 1987 and 1988, respectively. This migration occurred at the same time in the two years (July 12–August 2 in 1987 and July 13–August 3 in 1988).

The flight activity and the distribution of individuals between the different strata was affected by the weather conditions. The correlation analysis between flight activity and the weather conditions showed different r values, but the highest correlations were found with the air temperature and the wind speed. Fig. 2 describes the combined effect of the daily mean temperature and wind speed (measured at 13.00) on the flight activity. From this figure a threshold for any flight seems to be at 15°C and wind speed much higher than 20 m/s. For the high flight activity the threshold seems to be about 22°C and 10 m/s.

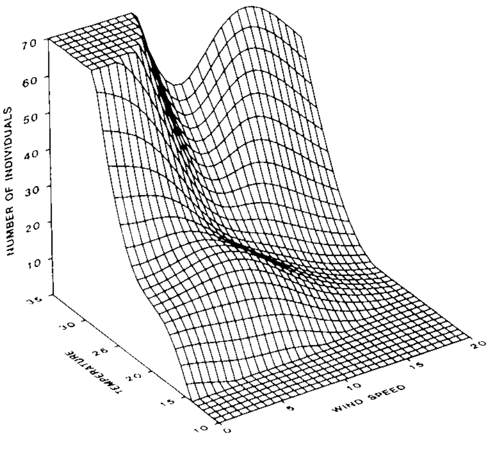

Fig. 2. The effect of the daily mean temperature and the wind speed on the flight activity of *C. septempunctata* (1987, open grassland).

In the late summer migration period of 1988 there was a change in the distribution of individuals between the different strata. The flight activity was

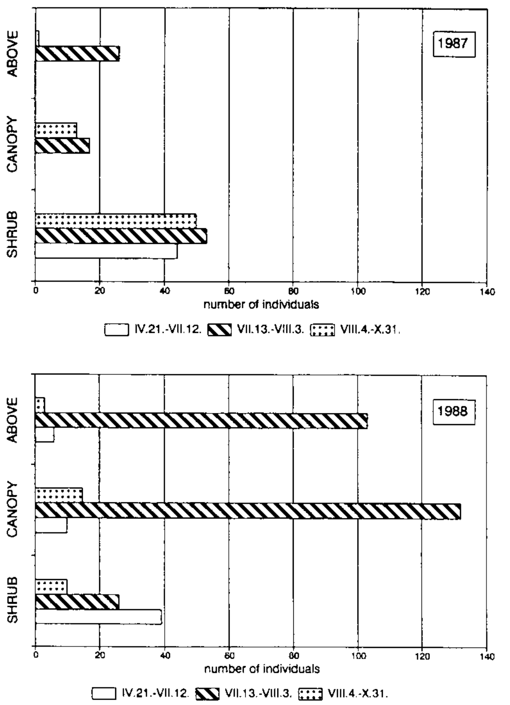

Fig 3. Distribution of coccinellids among the levels in different periods of the season.

high in the canopy and above the forest while it was low at the ground level (Fig. 3), in contrast to the other parts of the season when the number of individuals increased from the high to the low strata. In 1987, when the weather conditions were not suitable for long distance flight, this change could not be observed. The number of individuals caught at the shrub level was more than twice higher in 1987 than in 1988.

DISCUSSION

The peaks of the seasonal dynamic curves in May and July can be explained by the migration from and to the hibernacula, respectively. Iablokoff-Khnzorian (1982) stated that the migration to the hibernation sites of *C. septempunctata* begins in August. However, Savoiskaya (1966) in Kazakhstan, and Honěk (1989) in Bohemia reported the beginning of this period in the second half of July. Our observations fit to these with a migration period between mid July and early August. About two thirds of the individuals were caught in this relatively short period, which means that the flight activity is much higher in this time than in the other parts of the season (Honěk, 1990).

C. septempunctata is variable in aggregation and migration behaviour as well. In the migration period in 1988 the higher number of individuals was caught in traps above and at the canopy level, and this number decreased to the ground level. This suggests a "long distance flight" behaviour (Hodek, 1973; Hodek et al., 1993) during this period. *C. septempunctata* prefers higher areas as hibernation sites (Hodek et al., 1977). The well developed, large individuals appear as freshly moulted adults from 12 July in the lowland breeding sites, and from about 28 July, smaller individuals are caught (Honěk, 1983). The flight activity of young adults begins to increase 3 to 5 days after the adult ecdysis, and reaches its maximum on the 10th day (Zaslavsky & Semyanov, 1986). Honěk (1990) found that the take-off activity increased to a maximum 40–60 h after adult moulting. Our observations on the migration period (between July 13 and August 3 with a peak about July 24–27) fit well the data mentioned above, and suggest that the early-moulted, well-developed adults can perform long distance flight behaviour, and can occupy the preferred hibernation sites in the higher areas (the collection site is just on the edge of the Bükk mountains). The smaller and physically less capable individuals mostly occupy the "lowland" hibernacula later in the season (Honěk, 1989).

The flight activity of coccinellids, especially the long distance flight, is highly influenced by the weather conditions. *Semiadalia undecimnotata* requires special weather conditions for long distance migration. At temperature below 22°C only 21% of individuals had a "migration flight", while a 6 m/s wind speed can decrease flight behaviour to 5% (Iperti, 1978). The intensity of wing spreading reaction of *C. septempunctata* in ether narcosis, which is assumed to refer to the migratory state of the beetles, depends strongly on temperature. Below 20°C the intensity was lower and the duration shorter than at higher temperature (Zaslavsky & Semyanov, 1983). The flight of *C. septempunctata* in field experiments was observed at temperature above 21°C and this can be considered a threshold for flight (Honěk, 1985). In our study, temperature and wind speed were the most important factors affecting the flight activity. The daily mean temperature below 22°C, and/or the high wind speed (higher than 10 m/s) strongly decreased the flight activity, especially in the higher strata. In the migration period of 1987, there was no long distance flight and only few individuals were caught in the high strata traps. During 1987, more than two thirds of the days during the migration period were not suitable for long distance flight, and very probably this was the reason of the lack of high strata migration. However, the number of individuals in the shrub level was more than twice as high as in 1988. In conclusion, in the year when the weather conditions were not suitable, the migration probably was performed in smaller steps, closer to the ground. However, the long distance (summer) migratory flight in suitable weather conditions differs from the dispersion (spring) flight in the height and probably in distance of the flight. This supports Hagen's (1962) concept of categorisation of the flights.

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