Thermal Requirements for Flight of Six Species of Flea Beetle of the Genus *Phyllotreta* (Coleoptera: Chrysomelidae)

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Abstract

KOCOUREK F., LÁSKA P., JAROŠÍK V. (2002): **Thermal requirements for flight of six species of flea beetle of the genus** *Phyllotreta* (Coleoptera: Chrysomelidae). Plant Protect. Sci., **38**: 76–80.

The flight activity of six species of the flea beetles of the genus *Phyllotreta* was monitored by means of yellow water traps in three years. The percentage composition of the total catch of adults made up of the species was 29.5% (*P. vittula*), 28.8% (*P. atra*), 17.5% (*P. undulata*), 12.8% (*P. nigripes*), 7.1% (*P. vittata*) and 4.3% (*P. nemorum*). The flight activity of each species had two peaks. The spring peak was made up of overwintering adults migrating to host plants, and the summer peak of newly emerged adults. A regression model of flight activity in both generations was established based on the sum of day degrees above the temperature threshold for flight (10.2°C). The onset of flight activity of adults of the overwintering generation in spring started at 30 day degrees, and that of the adults of the summer generation at 280 day degrees. These temperature requirements for flight activity indicate when best to inspect crops for effective pest management.

Keywords: *Phyllotreta vittula*; *P. undulata*; *P. nigripes*; *P. vittata*; *P. nemorum*; cruciferous crops; yellow water traps; day degrees; temperature thresholds; regression models

There has been an increase in damage caused by flea beetles of the genus *Phyllotreta* in many European countries since the 80’s of the last century. This has been recorded for both cruciferous crops (SAYNOR 1985) and cereals (ARUTYUNOVA & ISHKOVA, 1993). *P. vittula* (Redenbacher) disperses from cruciferous plants to cereals and damages spring cereals (KURPPA 1990; MYZNIKOVA *et al*. 1979) and maize (LECLANT 1977). *P. undulata* Kutschera, *P. nigripes* (F.), *P. vittata* (F.), *P. atra* (F.) and *P. nemorum* (L.) are the most important pests of cruciferous crops, both vegetables and rape (KOSTROMITIN 1978; OSIPOV 1985; HUREJ *et al*. 1997). Beside direct damage, some species are vectors of plant viruses. *P. atra*, *P. nigripes* and *P. undulata* are vectors of the *Erysinum* latent virus of cruciferous plants (SHUKLA *et al*. 1975), and *P. vittula* an efficient vector of brome mosaic bromovirus (BMV) of cereals (RYDEN 1990).

Flight activity of insect pests can be monitored by means of yellow water traps. The yellow colour attracts many species (MOERICKE 1951; NOLTE 1955), including cruciferous pests (SCHRÖDTER & SCHEIDING 1953; NOLTE & FRITZSCHE 1954; FINCH & SKINNER 1974; BRACKEN 1988) and flea beetles (HUREJ *et al*. 1997; FOSTER 1984; LÁSKA *et al*. 1986; LÁSKA & KOCOUREK 1991).

In this study, we used yellow water traps to catch six species of flea beetle of the genus *Phyllotreta*: *P. atra*, *P. undulata*, *P. nigripes*, *P. vittata*, *P. nemorum*, and *P. vittula*. These species have one generation per year. They overwinter as diapausing adults, and in spring migrate to host plants. Adults of the new generation appear in summer (NAIBO 1976; HUREJ *et al*. 1997; FOSTER 1984). The objective of this study was to describe the pattern of flight activity of the beetles as indicated by yellow water trap catches, and specify the thermal requirements for flight activity.

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MATERIAL AND METHODS

Flea beetles were captured by yellow water-traps at Olomouc, the Czech Republic, from 1981–1983. Traps were placed on bare soil near a cabbage field (in 1981), or on black fallow (0.25 ha) 50 m away from a cabbage field surrounded by small plots of various vegetables or forage crops (in 1982, 1983). The yellow traps (diam. 28 cm) were filled with 0.01% water emulsion of Ambush 25 EC (25% permethrin) plus a detergent Agral (0.01%). Two traps, 10 m apart, were run every year. The traps were emptied every 2–3 days. Trapping was performed during the period of above zero temperatures, between March and November. Standard meteorological data were recorded at a station 3.5 km from the experimental fields.

Each season, the pattern of flight activity of each species was described using the numbers of adults caught in the traps over 2–3 day intervals. The overwintering and summer generations of adults were separated based on the onset of occurrence of immature beetles of the summer generation. To determine the thermal requirements for flight cumulative flight activity was plotted against the sum of day degrees experienced each day above the temperature threshold for flight (10.2°C). The temperature threshold was the lowest maximum daily temperature for flight (LÁSKA & KOCOUREK 1991). The day degrees were calculated, starting each season on January 1st, as Σ [(daily maximum – daily minimum)/2] – (temperature threshold for flight).

RESULTS

The proportions of the total capture of adults that consisted of each species were 29.5% (*P. vittula*), 28.8% (*P. atra*), 17.5% (*P. undulata*), 12.8% (*P. nigripes*), 7.1% (*P. vittata*) and 4.3% (*P. nemorum*). The numbers of overwintering and summer generation adults of the cruciferous pests *P. atra*, *P. undulata*, *P. nigripes*, *P. vittata* and *P. nemorum* were similar. The captures of *P. vittula*, which disperse from cruciferous plants to cereals, were 6–14 times larger in the summer than in the spring (Table 1).

Table 1. Total numbers of adults of the overwintering and summer generations of flea beetles of the genus *Phyllotreta* caught by yellow water traps

Species	1981		1982		1983	
	generation					
	overwintering	summer	overwintering	summer	overwintering	summer
P. vittula	36	170	74	1042	183	854
P. atra	195	278	181	197	808	648
P. undulata	158	302	168	176	333	265
P. nigripes	176	88	134	85	366	172
P. vittata	41	100	47	186	80	113
P. nemorum	13	44	79	77	119	20

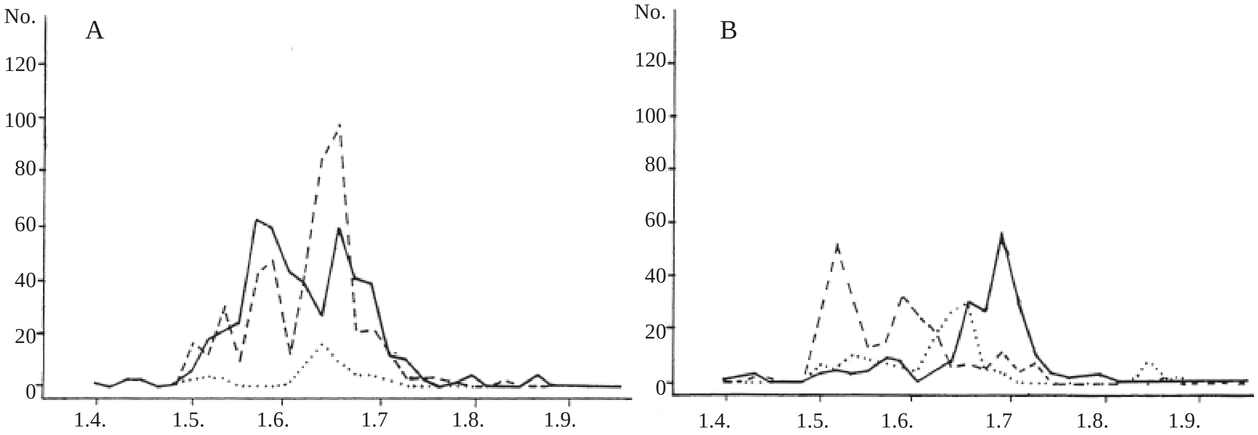

Fig. 1. The flight activity of flea beetles based on the captures over 2–3 days by two yellow water traps in 1981

A: —— *Phyllotreta atra*, --- *P. undulata*, ········ *P. nemorum*; B: —— *P. vittula*, --- *P. nigripes*, ········ *P. vittata*

The flight activity of each species each year had two peaks (Figs 1–3). The spring peak corresponded to the migration of the overwintering adults to host plants, and the second to the dispersal of newly emerged adults of the summer generation. In 1981, both peaks partially overlapped due to a delayed flight of the overwintering generation (Fig. 1), caused by low temperatures in May. The timing of the first peak differed each year. The peak occurred in the first decade of May in 1981 (Fig. 1), the second decade of May in 1982 (Fig. 2), and the second decade of April in 1983 (Fig. 3). The summer peak occurred in early July, invariably each year.

A regression model of the flight activity above the temperature threshold for flight is shown in Fig. 4. The overwintering generation started flying in spring when the sum of day degrees reached 30 degrees. The flight reached a maximum at 70 day degrees, and declined when the sum of day degrees attained 140 degrees. In 1981, the maximum spring flight occurred at a higher sum of day degrees than in 1982 and 1983, and the intensity of flight did not subsequently decline (Fig. 4a). In summer, flea beetles started flying at 280 day degrees. In 1981 and 1982, the summer flight reached a maximum at 450 day degrees, and sharply declined at 600 degrees. However, in summer 1983 the maximum and decline in flight activity occurred at higher day degrees (Fig. 4b). This indicates that the development of the summer generation of flea beetles was delayed in 1983.

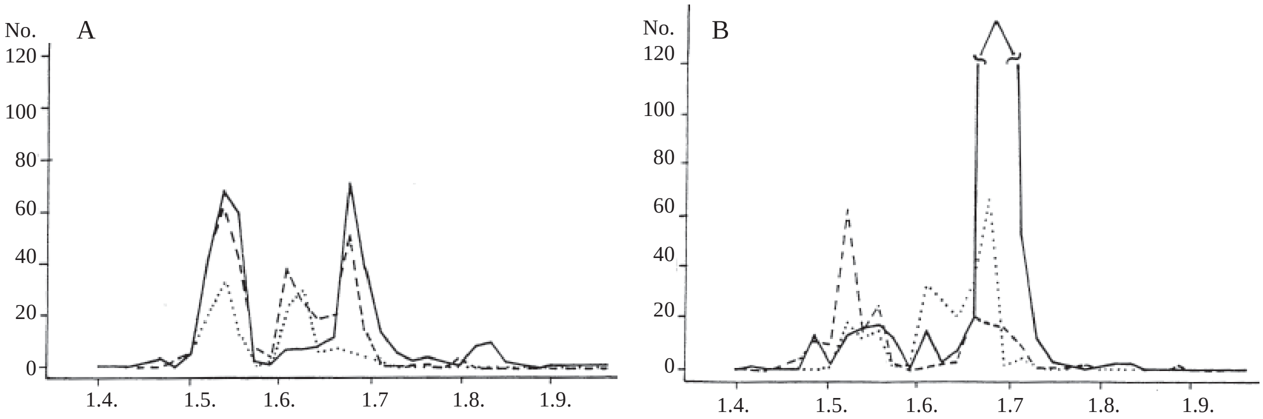

Fig. 2. The flight activity of flea beetles based on the captures over 2–3 days by two yellow water traps in 1982

A: —— *Phyllotreta atra*, --- *P. undulata*, ········ *P. nemorum*; B: —— *P. vittula*, --- *P. nigripes*, ········ *P. vittata*

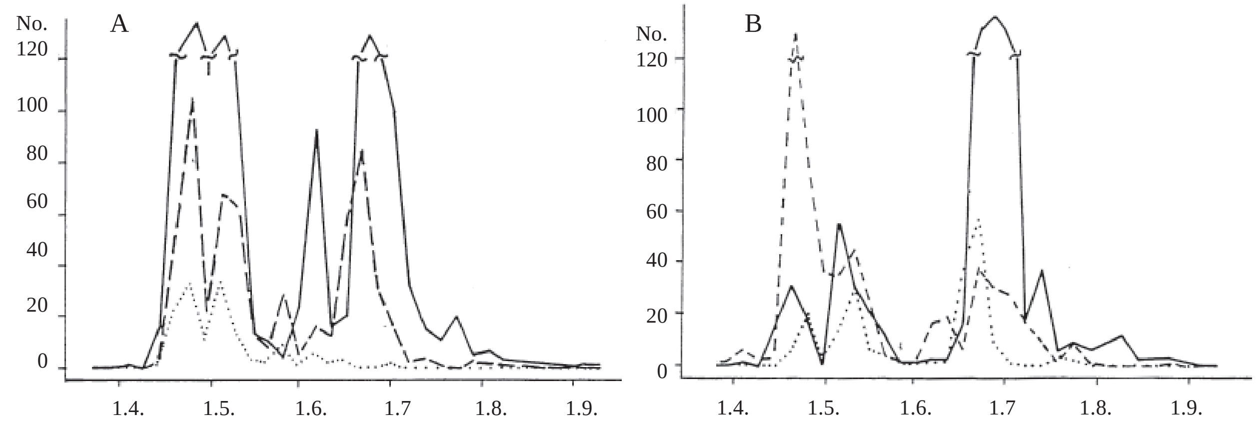

Fig. 3. The flight activity of flea beetles based on the captures over 2–3 days by two yellow water traps in 1983

A: —— *Phyllotreta atra*, --- *P. undulata*, ········ *P. nemorum*; B: —— *P. vittula*, --- *P. nigripes*, ········ *P. vittata*

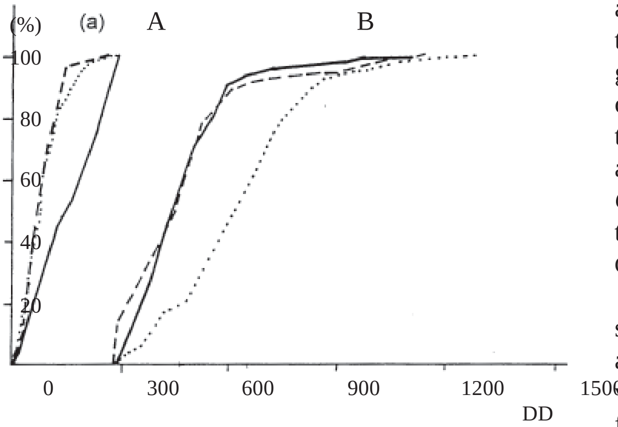

Fig. 4. The relationship between the cumulated flight activity (%) and the sum of day degrees (DD) above the threshold for flight (10.2°C) for overwintering (A) and summer (B) generations of flea beetles

—— 1981, --- 1982, ········ 1983

DISCUSSION

Monitoring of the flight activity of six species of flea beetle of the genus *Phyllotreta* by means of yellow water traps revealed two periods of intensive flight activity. The first consisted of young adults in early July. The second occurred after winter diapause, and consisted of overwintering beetles searching for host plants. The yellow water traps did not record the autumn flight, when the adults search for overwintering sites, possibly because attraction to yellow at that time of the year does not make biological sense.

Similar results to those reported here were previously reached for *P. vittula* (Hurej *et al.* 1997; Naibo 1974) and *P. undulata* (Foster 1984). As in our study, adult flea beetles occurred on plants during two periods of the year: overwintering adults from May to early June, and summer generation adults in July. On the other hand, Vig (1998) found adults of the summer generation of *P. vittula* from August until October. This was because the overwintering adults oviposited late into the year, which resulted in larvae pupating and emerging as adults as late as October. Our results indicate that the development of the summer generation of flea beetles was delayed in 1983. This delay may have resulted from a prolonged oviposition of the overwintering beetles as suggested by Vig (1998).

Interestingly, the migration in spring did not start immediately the temperature threshold for flight was attained. Each season, a few overwintering beetles were caught in the traps before the last decade of March. They were caught on sunny days, when the temperature was above the lower threshold for flight (10.2°C). However, the mass migration did not start until the sum of day degrees reached 30 degrees. This pattern differs from that of other cruciferous pests. A mass migration of overwintering adults of the pollen beetle, *Meligethes aeneus* (F.), and the weevils, *Ceutorrhynchus napi* (Gyllenhal) and *C. quadridens* (Panzer), start immediately the temperature exceeds their threshold for flight (Láska & Kocourek 1990).

The migration of the overwintering generation in spring started when the sum of day degrees reached 30 degrees and that of the summer generation 280 degrees. These values make it possible to reliably estimate the onset of flight activity. Similar estimates were published by Sobakar & Timokhina (1991) for *P. vittula*. Though the subsequent incidence of flight activity varies with weather, the thermal requirements for the onset of flight activity can be used to indicate when the monitoring of adult flea beetles in crops should start. That is, this system indicates the appropriate times to inspect the crops.

Foster (1984) suggested that a predictive model for *P. undulata*, based on the captures of adults in yellow water traps in late summer, could be used in Scotland to predict the size of the potentially damaging population the following summer. Such predictions seem impossible in other species and countries (Sevagina 1991). Our results suggest that a knowledge of the phenology of the beetles, based on yellow water trap catches, is likely to give a good indication of when best to inspection crops for effective pest management; however, this monitoring does not seem to be suitable for forecasting population sizes in the future.

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