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Life cycle of a European seed beetle species, Bruchidius pauper (Boheman, 1829) (Coleoptera, Chrysomelidae: Bruchinae)

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Abstract – Regarding their life cycles, all European seed beetle species were considered univoltine, overwintering as adults. Rearing *Bruchidius pauper* from the legumes of *Coronilla coronata* in a field insectary during 2008–2009 showed an exceptional life cycle: the larvae reached full growth in late autumn and entered winter diapause; they pupated only in mid-May to mid-June of the next year, and the adults emerged in mid-June to mid-July. Egg-laying began after the legumes reached full length, and it lasted about one month. The females might assess the presence of seeds as they avoided flat, seedless legume segments. In the less infested legume samples the eggs were evenly distributed, this might indicate some epideictic mechanism. Larval behaviour is described in detail. *B. pauper* did not occur in samples of *Securigera varia* and *Anthyllis vulneraria* which have been mentioned by earlier authors as hosts.

Key words – *Coronilla coronata*, *C. vaginalis*, *Securigera varia*, *Anthyllis vulneraria*, *Bruchidius pusillus*, egg-laying behaviour, resource assessment, epideictic mechanism, larval behaviour, diapause.

INTRODUCTION

Lukjanovitsh & Ter-Minasian (1957) distinguished the following two groups of temperate zone bruchid species as regards life cycle and egg-laying behaviour.

Group 1: The females lay eggs on green legumes; the larvae develop in the growing seeds reaching the adult stage before autumn. The adults emerge from the seeds mostly in the same year; they remain in reproductive diapause until spring. Thus, only one generation develops per year.

Group 2: The females lay eggs on or into ripening or already ripe legumes or on dry seeds and the larvae develop in dry seeds. There is no adult diapause, therefore only environmental factors determine the number of generations per year. Under favourable temperature conditions these species may multiply continuously, for example in stored legumes. (Species of subtropical or tropical origin.)

Below we report that the life cycle of *B. pauper* differs from that of all temperate seed beetle species known so far, because not the adult but the full-grown larva overwinters. This species thus belongs to neither of LUKJANOVITSH & TER-MINASIAN's (1957) groups.

MATERIAL AND METHODS

In the course of a research programme carried out in the Plant Protection Institute since 1984 on the seed predators of Fabaceae species occurring in Hungary (JERMY & SZENTESI 2003), we have collected ripe or almost ripe legumes of 142 leguminous plant species (approximately 90% of the country's Fabaceae species) in paper bags from which they were transferred in the laboratory to glass jars covered with linen. The jars were kept at room temperature; they were checked for emerging insects once or twice monthly until autumn, when they were transferred to the field insectary for overwintering. In 2008 and 2009 from April on the samples of *Coronilla coronata* L. were re-checked at least twice monthly and at 1 to 3 days intervals in the period of adult emergence.

Legumes of *C. coronata* were checked for presence, number, and place of the eggs on the legume segments. Out of the samples a few legumes carrying eggs were regularly dissected under a microscope and the ontogenetic stadium was recorded.

The taxonomic works cited in the list of references were used for identification.

RESULTS

Host plants

We have reared 539 adults from eight of ten samples of *C. coronata* collected at Nagykovácsi (47°35'N and 18°52'E) (NW of Budapest), at the Kis-Sváb-hegy Nature Reserve (47°30'N and 19°00'E) (Budapest, District XII), and at Pesthidegkút (47°33'N and

18°57'E) (Budapest, District II) in five different years. We could collect only one small sample of *C. vaginalis*, which is a known host of *B. pauper,* however, no adults emerged from it and no bruchid eggs were found on the legumes. This species did not occur in the samples of any other leguminous species.

Life cycle

Adults – According to our laboratory observations and rearing in a field insectary no adults emerged during the year of egg-laying. In 2008–2009 the adults emerged from mid-June to mid-July of the next year.

Oviposition – Egg-laying began when the legumes were still light green though already well formed and the legume walls were hard. As adults hatched during one month, most eggs were laid on already fully developed yellowish legumes. In 154 out of our 216 samples, i.e., in 71.3% of cases the eggs were found on the distal third of the legume segments. In most samples the eggs were quite evenly distributed among the legumes as two or more eggs were found only rarely on the same legume. Eggs occurred exclusively on convex segments while no eggs were laid onto flat ones. The sample from Kis-Sváb-hegy was an exception as it was heavily infested (~80% of legumes bore eggs), and up to 5 eggs per legume segment were found. In two instances two eggs even touched each other.

Larval behaviour – Our repeated observations during ontogenesis showed the following course of larval behaviour. The larva emerged from the egg penetrates under the eggshell into the legume through the already more or less hardened (half ripe) legume wall. It bores into the more or less fully developed seed. Then it gradually increases the penetration hole on the seed and it begins to push yellowish faeces through the hole into the legume cavity. As the larva develops the penetration hole increases, new holes appear in its neighbourhood, and more faeces are pushed out so that finally about 1/3 to 1/2 of the seed coat disappears and the full grown larva occupies the space between the partly remaining seed coat and the cavity of the legume segment forming a pupation chamber. There are many faeces in the legume cavity around the pupation chamber. As a final step the full grown larva lines the pupation chamber with a translucent film.

The dissection of damaged legumes has shown that each larva consumes only one seed within one legume segment during development. It does not penetrate into the neighbouring segment.

Overwintering – Fully developed larvae or praepupae overwintered. It seems that a cold shock is needed to finish larval development since no larvae were found alive in samples that were stored the over the winter in heated rooms, in spite of prevention of inevitable desiccation. The samples stored under close to field conditions were exposed in winter to low temperatures of −10 to −12°C during several days.

Pupation and adult emergence – Pupation took place from mid-May to mid-June. The pupa lied in the pupation chamber with its head close to one end of the legume segment. The adult hatched through a round hole made on the side of the legume segment close to its end. The adults emerged in both years from mid-June to mid-July showing a peak around the beginning of July, so the last adults emerged when the legumes of *C. coronata* were already almost ripe.

DISCUSSION

Up to now the following plant species have been mentioned in the literature as hosts of *B. pauper* (only plant species with Hungarian occurrence are considered here): *C. coronata* L. (DELOBEL & DELOBEL 2006, GYÖRGY & MERKL 2005, JERMY & SZENTESI 2003), *C. vaginalis* LAM. (STREJČEK 1990), *Securigera varia* (L.) LASSEN (= *Coronilla varia* L.) and *Anthyllis vulneraria* L. (BOROWIEC 1988, HOFFMANN 1945, KASZAB 1970, LUKJANOVITSH & TER-MINASSIAN 1957, ZACHER 1952). However, no *B. pauper* adults emerged from 29 samples of *A. vulneraria* and from 99 samples of *S. varia* indicating that the corresponding literature data might be erroneous. At the Nagykovácsi site *S. varia* occurs at a distance of a few meters, i.e., within the beetle's cruising distance from a large stand of *C. coronata*, which has been heavily infested. Thus, the earlier data on *S. varia* might have resulted from misidentification of the plant species. Also STREJČEK (1990) remarks that *S. varia* is mistakenly mentioned as a host. Interestingly, *B. pauper* seems to "recognize" the phyletic difference between *S. varia* and *C. coronata*, which represent two different genera (WHITE 2009).

The life cycle of *B. pauper* differs from that of all temperate zone bruchid species known so far, as not the adult but the full grown larva overwinters. Thus, it represents a separate type differing from the life cycle types proposed by LUKJANOVITSH & TER-MINASSIAN (1957). The peak emergence of the adults, around the beginning of July, is well synchronized with the appearance of host plant's fully formed though not yet ripe legumes.

The clear preference of egg-laying females for convex legumes while they avoid undeveloped, flat ones, as well as the generally even distribution of eggs among the legumes, indicate both the females' ability of resource assessment and the presence of some epideictic mechanism. However, if the

female population is very dense, as in the case of the Kis-Sváb-hegy sample, these mechanisms may not function.

The larva of *Bruchidius pusillus* (GERMAR, 1824), a closely related species developing in the legumes of *Securigera varia,* may penetrate occasionally into the neighbouring legume segment, so it reaches full growth in the second segment (Á. SZENTESI unpubl. observation). As the structures of the legumes of both *C. coronata* and *S. varia* are actually identical, it cannot be excluded that the larva of *B. pauper* may show a similar behaviour.

Further experiments may reveal the optimal temperature regimes for the overwintering of the larvae, as it seems so far that without the effect of low winter temperature the larvae do not finish development rather they die.

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