

**FIRST RECORD OF PROTURA (HEXAPODA) IN ISRAEL
WITH NOTES ON THEIR DISTRIBUTION AND ECOLOGY**

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ABSTRACT

Protura (Hexapoda) is recorded for the first time from Israel with three western Palaearctic species: *Acerella muscorum* (Ionescu), *Berberentulus berberus* (Conde) and *Acerentomon meridionale* Nosek. The density of the proturan population in pine forest soil on Mt. Carmel is estimated to be approximately 4,000 specimens per m² in the winter and about 350 specimens per m² in the summer.

KEY WORDS: Protura, *Acerella*, *Acerentomon*, *Berberentulus*, Israel, soil microarthropods.

INTRODUCTION

Telsontails (Protura) are delicate, unpigmented, minute hexapods, usually less than 2 mm long, living in moist and concealed habitats, in soil and decomposing organic material. Silvestry (1907) was the first to discover and recognize Protura (Tuxen, 1964). In his monograph, Berlese (1909) classified Protura as a subclass (Myrientomata) of Insecta. Later authors, such as Sharov (1966), Yin (1984), Kristensen (1991), Kukalova-Peck (1991), and Houston (1994), classified Protura in a separate class of Hexapoda. The class and order Protura are now placed as the sister group to the Collembola, in the Ellipura (= Parainsecta), which is recognized as the sister group to the Insecta (Houston, 1994).

Protura consists of about 600 species, divided into some 68 genera (Nosek, 1973; A. Szeptycki, unpublished data). The higher classification of the order Protura is not fully understood. Usually the order is divided into two superfamilies: Eosentomoidea, with two families (Houston, 1994), and Acerentomoidea, with two families (Houston, 1994), or eight families (Yin, 1984). The classification of Yin (1984) is adopted in this paper.

Proturans lack eyes and antennae, have entognathous mouthparts and a 12-segmented abdomen, with distinct pairs of abdominal appendages on the three anteriormost segments (Tuxen, 1964). The fore legs are enlarged, covered with numerous setae and sensillae, and project forward (Figs. 1-2), functioning as sensory organs. Only the mid and hind legs serve for locomotion. The detailed morphological structures of the fore legs (Figs. 3—4), which are taxonomically important, were studied by Conde (1948, 1949) and Tuxen (1964).

The development of proturans is anamorphic, i.e. immature forms resemble adults and additional segments are added to the body in the course of the second and third molts. The

various instars differ mostly in their dimensions, chaetotaxy and the degree of development of the genital organs.

Only a few Protura specimens were collected in Israel prior to this study (J. Wahrman and M.P. Pener, The Hebrew University, Jerusalem; D. Gerling, Tel Aviv University, personal communication), but they are still unidentified below the order level and have not yet been reported in the scientific literature.

The purpose of this paper is to report on Protura from Israel for the first time and present some aspects of their ecology in a pine forest on Mt. Carmel.

MATERIALS AND METHODS

The area sampled is a natural pine forest (*Pinus halepensis* Mill.) located on the slopes of Nahal Galim (32°44' N, 35°00' E), Mt. Carmel, Israel, with an approximate altitude of 400 m above sea level.

The study site was visited during a period of 17 months, between April 1991 and August 1992. In each visit we took 12 random samples of pine forest soil. Each sample was taken with a 5-cm corer, 15 cm deep, and placed in a Berlese funnel. Soil microfauna samples were collected in tubes filled with ethyl alcohol (95%), which were later transferred to 70% ethyl alcohol for preservation. Some specimens were mounted on microscopic slides. Most of the specimens are deposited at the entomological collection of the University of Haifa, Oranim. A few specimens are deposited at the National Entomological Collection, Tel Aviv University.

RESULTS

Taxonomy

We collected 375 proturan specimens in the pine forest on Mount Carmel during 1991–1992. These specimens were identified (by AS) as belonging to the following three species (with their approximate relative abundance in parentheses): *Acerella muscorum* (Ionescu) (Acerellidae) (77%), *Berberentulus berberus* (Condé) (Berberentulidae) (16%), and *Acerentomon meridionale* Nosek (Acerentomidae) (2%), plus some unidentified specimens (5%). All three species belong to the superfamily Acerentomoidea, which is characterized by the absence of tracheae and thoracic spiracles.

KEY TO SPECIES OF PROTURA FROM MT. CARMEL, ISRAEL

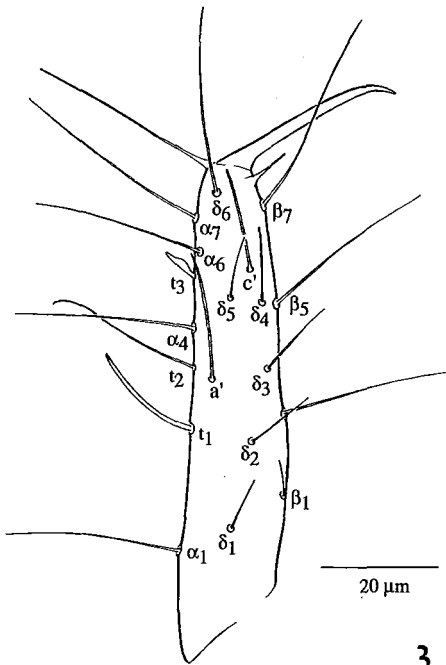
1. Labrum conspicuous, anteriorly prolonged into elongate and pointed rostrum (Fig. 1), ratio of head length to rostrum 5.3–6, body length 1.4 to 1.6 mm
 *Acerentomon meridionale*
- Labrum inconspicuous, rostrum very short (Fig. 2), body less than 1.4 mm long 2
2. Ratio of length of tarsus to pretarsal claw about 2.5 (Fig. 3), comb on tergum 8 with 6–7 teeth; body length 1.1 mm *Acerella muscorum*
- Ratio of length of tarsus to pretarsal claw about 4 (Fig. 4), comb of tergum 8 with 8–10 teeth, body length 0.85 mm *Berberentulus berberus*



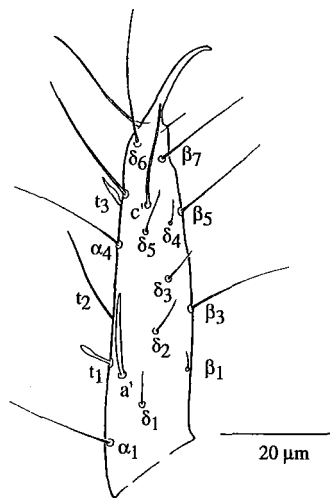
1



2



3



4

Figs. 1–4. 1. *Acerentomon meridionale* Nosek, habitus. 2. *Acerella muscorum* (Ionescu), habitus. 3. *Acerella muscorum* (Ionescu), fore tarsus, interior view (scale = 20 μ m). 4. *Berberentulus berberus* (Condé), fore tarsus, interior view (scale = 20 μ m).

Distribution and Faunistics

All three species of Protura that were found in pine forest soil in Israel have a western Palaearctic distribution (Nosek, 1973). Until now *Acerella muscorum* was known from Central and Western Europe, *Berberentulus berberus* from West Mediterranean countries, and *Acerentomon meridionale* from Southern and Central Europe (Nosek, 1973) and Corsica (Condé, 1980). The new records from Israel expand the distribution of these species eastward to include the East Mediterranean area. Szeptycki (1977) noted that *A. meridionale* resembled the Iranian species *A. dominiaki* Szeptycki and suggested that these two species might be one.

We predict that more taxa may be found in Israel. For example, *Proturentomon pectinatum* (Condé) has been recorded from Algeria (Condé, 1948), Morocco (Condé, 1951) and Lebanon (Condé, 1954).

Ecology

The abundance of microarthropods in pine forest soil on Mt. Carmel is listed in Table 1, which sums up a survey of the upper levels of the soil, down to a depth of 15 cm. Soil microarthropod fauna is dominated by hexapods, mostly Collembola, in the winter and by arachnids in the summer. The total abundance of microarthropod fauna in the winter is about 2.7 times as high as the density in the summer. Lower population density of microfauna in the upper levels of the soil is typical to the dry season in arid and semi-arid habitats, such as in Israel. Proturans comprise 3.6% of the microarthropod fauna in the study area in the winter. In the summer, the dry season in Israel, the number of Protura specimens in the upper level of the soil is dwindling to about one tenth of the number found in the winter, and they comprise only about 0.9% of the summer soil microarthropod fauna. During the dry season most of the proturan population is probably retreating into deeper soil levels that contain higher humidity.

We estimate the number of Protura in the pine forest on Mt. Carmel as 3,910 individuals per m² in February 1992, and as 340 individuals per m² in July 1992. These numbers are comparable to estimated values of proturan density in Italian woodland sites, ranging from 30

TABLE 1

Total number of soil microarthropods, recovered from two anecdotal (but representative) collections (on February 16, 1992 and July 7, 1992) of 12 standard pine forest soil cores, on Mt. Carmel, Israel. Estimated densities (numbers/m²) are also given

| Microarthropods | February | | | July | | |
|-----------------|----------|-------|--------------------|------|-------|--------------------|
| | No. | % | No./m ² | No. | % | No./m ² |
| Hexapoda | | | | | | |
| Protura | 92 | 3.6 | 3,910 | 8 | 0.9 | 340 |
| Collembola | 1,448 | 57.0 | 61,482 | 321 | 34.7 | 13,630 |
| Arachnida | | | | | | |
| Acari | 953 | 38.0 | 40,464 | 583 | 63.4 | 24,754 |
| Myriapoda | | | | | | |
| Pauropoda | 38 | 1.4 | 1,613 | 12 | 1.0 | 424 |
| Total | 2,531 | 100.0 | 107,469 | 924 | 100.0 | 39,148 |

to 3,200 individuals per m². However, the proturan density on Mt. Carmel is much lower than some estimated population densities in North European woodlands: 6,500 in beech wood in Denmark or 28,000 in spruce forests in Norway (Petersen and Luxton, 1982).

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