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Notes on some Archaeognatha (Insecta, Apterygota) from extreme localities and a complementary description of *Petridiobius (P.) arcticus* (Paclt, 1970)

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(With 15 figures)

Abstract

Some data on four species of Archaeognatha (Insecta, Apterygota) inhabiting localities with extreme biotic conditions and a complementary description of *Petridiobius* (*P.*) *arcticus* (Paclt, 1970) are provided.

K e y w o r d s: Insecta, Apterygota, Archaeognatha, extreme biotic conditions, complementary description, *Petridiobius arcticus*.

Introduction

The impulse for this article came from the second author who asked for the identification of a machilid species living on rocks near Girwood (Alaska). The machilid could be determined as *Petridiobius* (*Pacltibiobius*) *arcticus* (Paclt, 1970). This spurred a project to describe the life-cycle and the specific features of some other Archaeognatha which are living under extreme conditions and to provide a complementary description of *P. arcticus*.

A summarizing and complete account of the biogeography of the Archaeognatha does not exist. The recent Archaeognatha (= Machiloidea) can be subdivided into 3 groups: (1) Machilidae (ca. 47 genera); (2) Meinertellidae (ca. 19 genera); (3) Machiloidea *incertae sedis* (3 genera).

Sturm & Machida (2001: 55-62) gave an overview of the northern and southern limit of distribution of Machilidae and Meinertellidae but did not include the climatical and terrestrial conditions of the different localities. We therefore attempt to describe here some extreme conditions where different species of Archaeognatha can subsist.

Remarks on biology of four species of Machiloidea living under extreme but very different conditions

1. Adaptability of *Promesomachilis hispanica* (Silvestri, 1923) under extreme variations of temperature and precipitation

The first example relates to the adaptability of a group of *P. hispanica* (Machilidae) living on the extreme South of the Iberian Peninsula (Hornachuelos), situated on an desert-like landscape underlained by limestone. The investigations were carried out by Gaju-Ricard (1989). The young animals appeared about November and under temperatures between 5-15 °C during the rainy season. The mating proceeds in April/May, with the deposition of eggs in May/June. During June and August the temperatures climb up to 28 °C and the amount of rainfall returns to a minimum. *P. hispanica* is able to endure these great variations of temperature and precipitation with a high degree of resistance in these hostile surroundings.

2. *Machilinus meyi* (Sturm, 2001), a new *Machilinus* sp. from the high mountain regions of Chile

The genus *Machilinus* (Meinertellidae) with more than thirty described species and four subgenera is distributed worldwide (North America, southern Mexico, South America and the Mediterranean area). *M. meyi* was found at a height of ca. 4000 m, one of the highest localities known for Meinertellidae. From a geological aspect, the American Andes are young mountains reaching an altitude of 3000 m only after the Pliocene. This shows a relatively high rate of adaptation under extreme conditions by some *Machilinus* species. Some Machilidae (*e.g., Allopsontus swani* Wygodzinsky, 1974) were found at heights of 5100 to 5700 m in the Himalaya (Nepal: Arun Valley).

3. Flood-resistance of eggs and life-cycle adaptation in the central Amazonian inundation forests

Neomachillellus scandens (Adis & Sturm, 1987) (Machiloidea, Meinertellidae) is a litter inhabitant of inundation forests in the Rio Negro valley, which are annually flooded for 5-6 months. At the beginning of the non-inundation period juveniles hatch from previously submerged eggs on the forest floor and reach maturity after 3-4 months. Adults propagate in the leaf litter where females deposit their eggs which are subjected to the next flooding. Both sexes subsequently migrate into the trunk/canopy area and perish. In nearby primary and secondary dryland forests, *N. scandens* has no defined reproduction period and juvenile stages are found throughout the year.

4. Halophilous Machilidae

Some genera of Machilidae are halophilous or partly halophilous and nearly all of them belong to the subfamilies Petrobiinae and Petrobiellinae. Within the Machilinae, the subfamily richest in genera and species, only *Lepismachilis sturmi* (Janetschek, 1955) is known to be halophilous (occurrence: Korsika, beach with big stones, ca. 1-2 m above sea-level). The Meinertellidae did apparently not evolve any halophilous taxa.

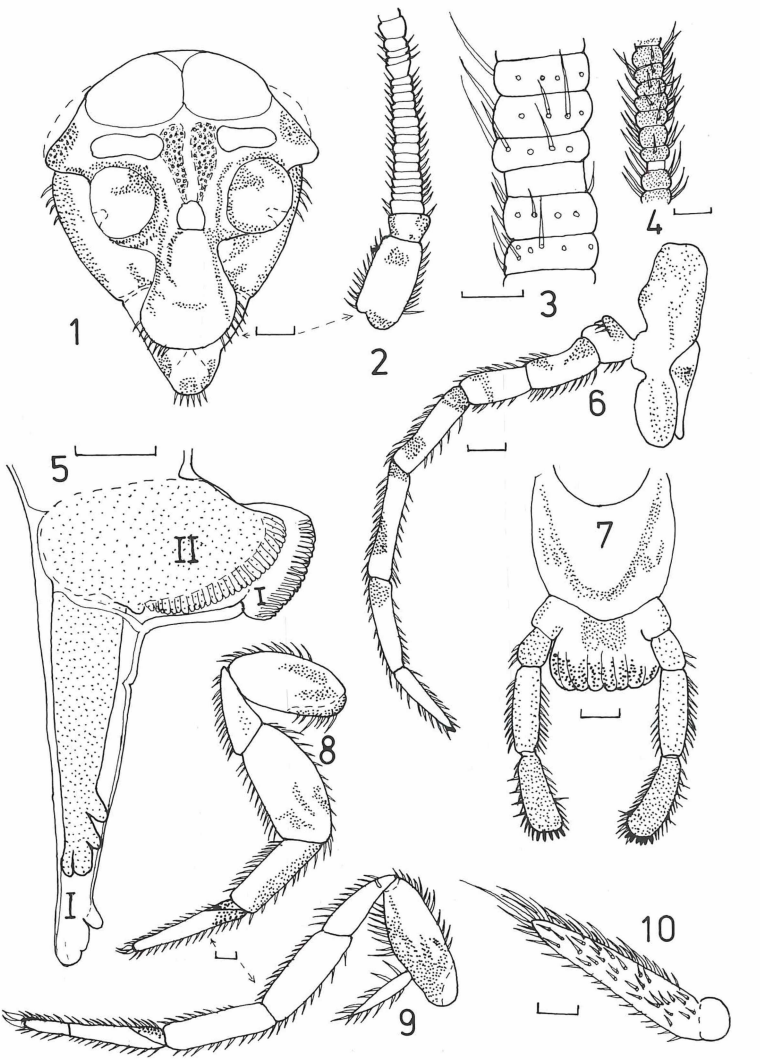
One of the northernmost halophilous taxa is *P. arcticus* (Paclt), which inhabits rocky coastal sites throughout Southern Alaska, at least from the Sand Point to Sitka (Folsom 1902). The following biological information resulted from field and laboratory observations of a population near Girwood, Alaska where mean monthly temperatures remain below freezing from November to March. Field observations were made from August till November 2003 and in February 2004. More than twenty individuals of *P. arcticus* were found throughout this time in fissures of sparsely vegetated rock faces, from 1-3 m above the high tide mark. In August and September, a few individuals were out in the open by day foraging or basking in the sun. Many more became active in the open after dusk. No individuals less than 7 mm long or eggs of the species were found. *P. arcticus* may exhibit a one year life cycle with eggs deposited in the spring, immatures growing into adults over the summer, and adults overwintering.

It appears that *P. arcticus* subsists almost entirely on lichens. When provided with a variety of lichens and mosses from their natural habitat, a laboratory colony feed only on *Umbilicaria* spp. foliose lichens. The animals also readily consumed lichens gathered from forests around Soldotna (Alaska) including *Stereocaulon*, *Peltigera*, and *Lobaria*, preferring *Stereocaulon* above all other foods.

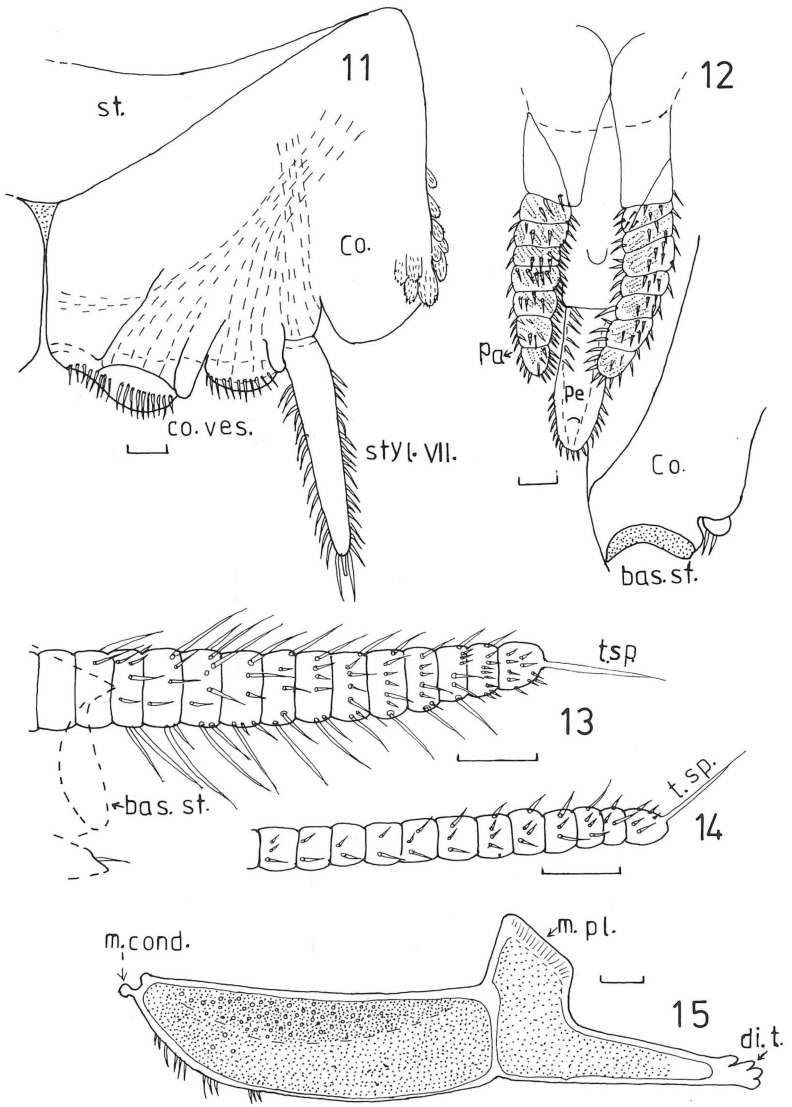
A complementary description of *Petridiobius* (*P.*) *arcticus* (Paclt, 1970) (Archaeognatha, Machilidae, Petrobiinae)

The species is compared here with *Petridiobius* (*Pacltibiobius*) *canadensis* (Sturm, 2001) from Queen Charlotte Islands, British Columbia (Canada).

Body length in *P. arcticus* is about 8.0 - 10.5, in *P. canadensis* 9.5 - 10.5 mm. The form of ocelli is distinctly different. In *P. canadensis* they are clearly pear-shaped with small mediad ends, in *P. arcticus* the ocelli are mediadly thickened. The frontal pigment stripes between lateral ocelli and median ocellus occur in both species, but only in *P. arcticus* it has many small light and rounded spots. Antennae in both species are usually longer than the body. Scapus and pedicellus are scaled with two small dark patches each, flagellum with dark pigment and without scales.



Figs 1-10. *Petridiobius arcticus* (Paclt): **1** - male, 10.5 mm; head, frontal view; **2** - female, 9 mm, basal part of antenna with scapus and pedicellus; **3** - female (= fm), 9 mm; basal part of antenna with jointlet at higher magnification; **4** - male, 10 mm, distal part of antenna with jointlet; chain between jointlets with up to 16 dark joints; **5** - female, 8.5 mm; distal part of mandible shortly before sloughing, old distal teeth (= I) worn; distal parts of the new mandible (= II) dotted; **6** - female, 9 mm, maxilla with maxillar palpus, lateral view; **7** - male, 10 mm, labium with palpi, ventral sight; **8** - male, 10.5 mm, leg. I; **9** - male, 10.5 mm, leg III; **10** - male, 10 mm; stylus of coxite IX (scale bars = 0.5 mm).



Figs 11-15. *Petridiobius arcticus* (Paclt): **11** - male, 10 mm (st. = part of sternite VII; Co. = coxite VII; co.ves. = coxal vesicles; styl. VII = stylus VII; vesicles); **12** - male, 10 mm: ventral view with part of coxite IX (pa = paramere; pe = penis; Co. = distal part of coxite IX; bas. st. = basis stylus IX); **13** - female, 9 mm, end of gonapophysis IX (bas. st. = basis of stylus IX; t.sp. = terminal spine); **14** - female, 9 mm; end of gonapophysis VIII (t. sp. = terminal spine); **15** - male, 10 mm; mandible, frontal view (m. cond. = main condylus; m. pl. = molar plate; di.t. = distal teeth) (scale bars = 0.5 mm).

Distal end of mandible with four teeth [the unidentate distal end figured by Paclt (1970) is an artefact]. Maxillary palps of adult males of *P. canadensis* males with very long setae on the inner side of joints II - V. They are absent in this form in males of *P. arcticus*. The sensory field on male femora I is extremely large in *P. canadensis* but absent in *P. arcticus*. The faceted eyes and the patterns of dark pigment to a great degree are similar in both species.

In spite of many congruencies between the two species there are also clear differences, *e.g.*, different form of lateral ocelli, the bright light spots between the ocelli and on some legs, and the absence of long setae on the maxillary palps of *P. canadensis* males. A sensory field present on the femur I in adult males of *P. canadensis* could not be found in males of *P. arcticus*. The absence of the small number of spiniform setae on the edge of thoracic tergites in these both species (and in *Petrobiellus, Petridiobius* and Petrobiinae in general) (Sturm & Messner 1995) underlines that the subfamily Petrobiinae forms a group of its own.

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