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What are *Halomachilis akkesiensis* and *Halomachilis kojimai* described from Hokkaido, Japan? (Insecta: Archaeognatha: Machilidae)

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The late Dr. Hajime Uchida described jumping bristletails from the rocky coast in Akkeshi Town, Hokkaido, Japan, twice. The first was *Halomachilis akkesiensis* Uchida, 1949 in *Zoological Magazine* (Uchida 1949) with a publication date of June 20, 1949. The original description (Uchida 1949), which did not have an attached figure, was written in Japanese, the English translation of which is:

"…several specimens of *Halomachilis*, known as a halophilic genus were collected from the rocky coasts in Akkeshi, Hokkaido; the tip of the mandible is smooth but has one or two small teeth on the inner side, representing the intermediate form between the *Machilis* type (with four-teethed tip) and the *Halomachilis* type (with smooth tip), which may be suggestive of the phylogenetic background of this species; extremely long antennae that are almost 1.5 times longer than the body length, and each of their annuli only possesses a circular short setation; lateral ocelli are characteristic in shape." (p. 110).

Later, Uchida (1955, 1960) erroneously cited the year for *H. akkesiensis* as 1950, which was followed by Tadauchi (1989) and Machida (2020).

Archaeognathans from the same locality were again described as *Halomachilis kojimai* (Japanese name: kojima-ishinomi) in *Iconographia Insectorum Japonicorum*, published on November 10, 1950, in the Japanese language with a few illustrations by Uchida (1950). Although Uchida did not explicitly declare these specimens to be a new species, the description is available and potentially valid, since the name was formed before 1999 [cf. International Commission on Zoological Nomenclature (2000), Art. 16.1]. The description of *H. kojimai* in Japanese can be translated to English as:

"…several specimens of a halophilic genus *Halomachilis*, which had been referred to as *Petrobius*, were observed on the rocks on the coast in Akkeshi, Hokkaido; only females are present; individuals are small sized, with a body length of 9–10 mm; antennae and caudal filaments are extremely elongated, both measuring more than 1.5 times the body length, and cerci measure about one-third of the caudal filament; antennae only have a circular short setation, which gives them a hard impression, they are uniform in color without dark and light alternation; the body is dorsally covered with dark gray scales, the ventral side is dark yellowish, maxillary palpi are dark, legs and coxal and abdominal styli are pale, tarsi are blackish; compound eyes of both sides had a slight contact with each other, leaving a wide triangular area anteriorly in between; lateral ocelli are strongly constricted in the middle; the tip of the mandibles is smooth, but one or two small teeth are present on the inner side; abdominal segments I, VI, and VII have one pair of ventral sacs, II–V have two pairs; ovipositor is short, slightly surpassing the end of the coxite IX, its annulation is inconspicuous, both anterior and posterior gonapophyses possess one or two long apical setae." (p. 4)

No information could be found on the type specimens of either description, but it is likely that these specimens were kept in Dr. Uchida's private collection, since there exists no record regarding the deposition of the specimens matching these descriptions in Hirosaki University, where Dr. Uchida was affiliated. However, according to the late Dr. Shigeo Chiba and Dr. Takeyuki Nakamura of Hirosaki University, there exists a high probability that these specimens were lost in a major offshore earthquake affecting the Miyagi Prefecture in 1978. Dr. Uchida's residence was in Sendai City (the capital of Miyagi Prefecture) at that time and collapsed. Therefore, it is not possible to study type material. However, the species

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described in 1949 and 1950 by Dr. Uchida are undoubtedly conspecific, considering their nearly identical descriptions and collection localities. Therefore, we conclude that *Halomachilis akkesiensis* and *H. kojimai* are synonyms; and according to the principle of priority *H. akkesiensis* and *H. kojimai* are, respectively, the senior and junior synonyms.

We succeeded in collecting many archaeognathan individuals from the rocky coast of Akkeshi Town, Hokkaido, which are exactly identifiable to *H. akkesiensis* (Figs. 1A–D). In the newly collected *H. akkesiensis* specimens, we found several significant diagnostic features that had not previously been mentioned in the description of the species; most significantly, the antennae, maxillary and labial palpi, thoracic legs, and thoracic and abdominal styli are completely devoid of scales. The total absence of scales on the appendages is only known in *Petrobiellus* Silvestri, 1943 representing the subfamily Petrobiellinae Kaplin, 1985 in Machilidae (Kaplin 1985; Sturm & Machida 2001).

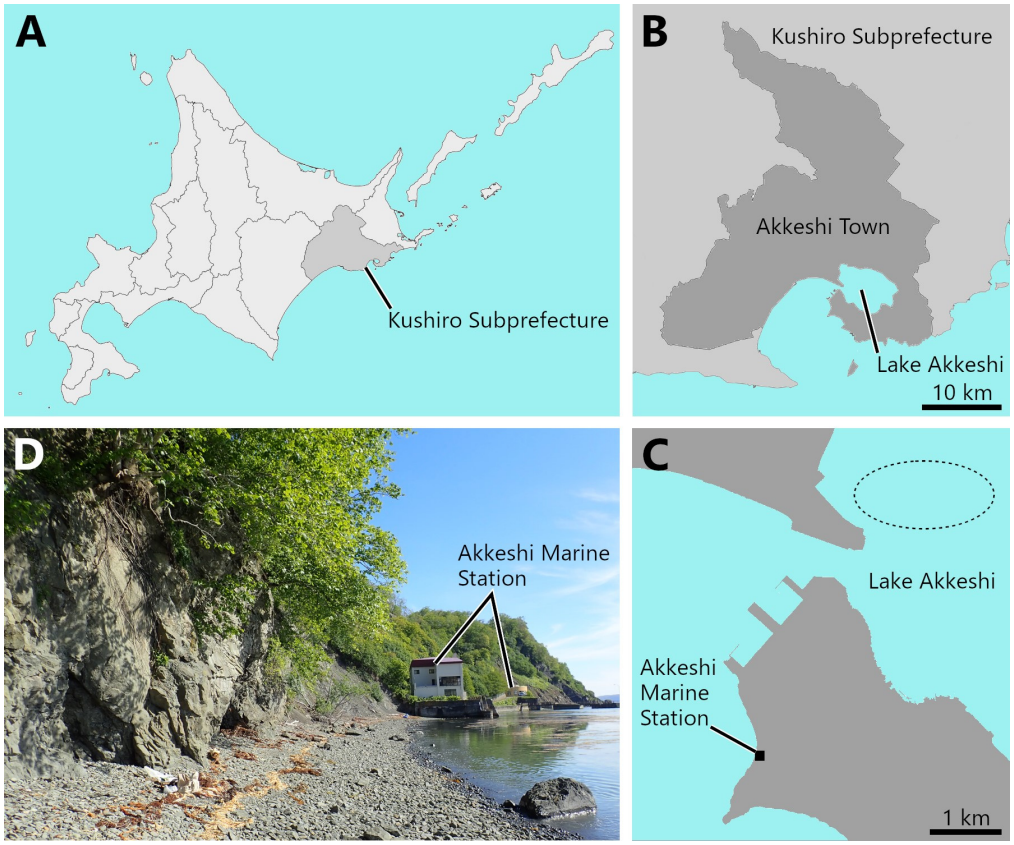

FIGURE 1. Collection locality of *Petrobiellus akkesiensis* **comb. nov.** (A–C) Maps of the collection sites. (B) and (C) were constructed using the GSI Map Vector (https://maps.gsi.go.jp/vector/). Dotted line in (C) indicates submerged island, see text. (D) Collection sites around the Akkeshi Marine Station, Akkeshi Town, Hokkaido, Japan.

The genus *Halomachilis* was established by Verhoeff (1910) for *H. adriatica,* collected from Abbazia, Italy. However, according to Carpenter (1913) and Reilly (1915), *Halomachilis* is a synonym of *Petrobius* Leach, 1809. *Petrobius* is known only in Europe and the eastern part of North America (originally found in Europe, and later artificially introduced to eastern North America) (Wygodzinsky & Schmidt 1980; Sturm & Machida 2001). Given the distribution and recognition of new characters, the affiliation of the Asian *H. akkesiensis* to either *Petrobius* or *Halomachilis* would be questionable. We hereby propose the new combination, *Petrobiellus akkesiensis* (Uchida, 1949) **comb. nov.** Given below are brief notes on this species.

Taxonomy

Order Archaeognatha

Family Machilidae Grassi, 1888

Subfamily Petrobiellinae Kaplin, 1985

Petrobiellus Silvestri, 1943

***Petrobiellus akkesiensis* (Uchida, 1949) comb. nov.**

[Japanese name: kojima-ishinomi]

(Figs. 2, 3)

Halomachilis akkesiensis Uchida, 1949:110; Uchida 1955:32; Tadauchi 1989:18; Machida 1996:58; Machida 2020:77

Halomachilis kojimai Uchida, 1950:4; Uchida 1965:1; Uchida 1988:529

Petrobius kojimai: Machida 1999:799; Machida 2015:1549.

Petrobiellus kojimai: Machida 2008:6

General features similar to those described by Uchida (1949, 1950). Body length of males 11–12 mm, that of females 12–13 mm. Antennal length approximately 15 mm. Cerci strongly curving outwards (Figs. 2A, B) and approximately 5 mm long; caudal filament approximately 15 mm long. The scale pattern on the dorsal body surface as shown in Figs. 2A, B. Scales absent from the antennae (Fig. 2C), maxillary and labial palpi (Figs. 2D, E), thoracic legs (Figs. 2F–H), and coxal and abdominal styli (Figs. 2G–J). Compound eyes in living specimens army-green in color; dark pigmentation present on the scapus (Fig. 2C), pedicellus (Fig. 2C), maxillary and labial palpi (Figs. 2D, E), and thoracic legs (Figs. 2F–H). Ovipositor extremely long (Figs. 2B, J).

Remarks

The ovipositor is much longer than indicated in Uchida (1950), who had described the ovipositor of the species as short, with its apex slightly surpassing the end of coxite IX. This difference could probably be attributed to the specimens Uchida examined being younger females: the body length in Uchida's description was 9–10 mm, whereas that of females we examined was 12–13 mm.

Petrobiellus is an enigmatic, halophilic genus of Archaeognatha found only in Japan and the Russian Far East. Absence of scales on the appendages is one of the most significant diagnostic features of *Petrobiellus* (Silvestri 1943; Sturm & Machida 2001; Mtow 2021).

The genus contains of four validly described species: *Petrobiellus takunagae* Silvestri, 1943 [from Shirahama, Wakayama, Japan (Silvestri 1943) and from Shimoda, Shizuoka, Japan (Machida 1999, 2020)], *P. curvistylis* Uchida, 1954 [from Hachijo Island, Tokyo, Japan (Uchida 1954)], *P. kusakini* Kaplin, 1980 [from Simushir Island, Chishima Islands, Japan (Kaplin 1980)], and *P. sachalinensis* Kaplin, 2020 [from Sakhalin Island, Russia Kaplin (2020)] (Sturm & Machida 2001; Mtow 2021). Ma *et al*. (2015) detected two "*Petrobiellus*" species from Yunnan Province, China, i.e., *P*. *bannaensis* (Mengla County, Xishuangbanna Dai Autonomous Prefecture) and *P*. *puerensis* (Ning'er Hani and Yi Autonomous County), based only on molecular data. Their descriptions (and proposed names) are apparently unavailable as Kaplin (2020) mentioned, for the following reasons: 1) no morphological descriptions were included; 2) no types were designated; 3) the descriptions were made without designating types, and 4) the concerned species were not declared to be new species [cf. International Commission of Zoological Nomenclature (2000), Arts. 13.1.1., 16.1., 16.4.].

Petrobiellus was originally described by Silvestri (1943), based only on females. Later, Uchida (1954) described *P. curvistylis*, including information on males, and the junior author (RM) succeeded in collecting the males of *P*. *takunagae*, which is the type species of *Petrobiellus* (Sturm & Machida 2001; Machida 2008; Klass & Matushkina 2018): Machida (2020) had suggested *P*. *curvistylis* could possibly be a synonym of *P*. *takunagae*. As for *P*. *akkesiensis*, no male was identified (Uchida 1950, 1965; Machida 2008), but the senior author (SM) recently successfully collected and identified males (Figs. 2A, I). The males of *P*. *akkesiensis* share several remarkably similar features of the genitalia with the males of *P*. *curvistylis* and *P*. *takunagae* (Uchida 1954; Sturm & Machida 2001; Klass & Matushkina 2018): 1) the distal part of the penis is sclerotized and hook-shaped, 2) coxites IX are medially strongly concave, 3) styli IX are robust with the concaved medial side, on which dark strong setae are densely distributed, and 4) the paramerae, which are present only in abdominal segment IX, are slender (Fig. 2I).

Biological notes

Petrobiellus akkesiensis was collected by us on September 1, 1990, and June 6–7, 2022, from the supralittoral cliffs or from under rolling stones along the rocky coasts, around the Akkeshi Marine Station, Field Science Centre for Northern Biosphere, Hokkaido University, Aikappu, Akkeshi Town, Akkeshi County, Kushiro Subprefecture, Hokkaido, Japan (Figs. 1A–D). Uchida (1965) had previously reported that *P*. *akkesiensis* also inhabited the Kaki Islands in Lake Akkeshi, but the Kaki Islands now no longer exist due to subsidence (the approximate area where the islands were is depicted with a dotted line in Fig. 1C).

FIGURE 2. External features of *Petrobiellus akkesiensis* **comb. nov.** (A) Male habitus. (B) Female habitus. (C–H) Female morphology. (C) Right antenna, anterior (medial) view. (D) Left maxilla, lateral view. (E) Labium, posterior view. (F) Left foreleg, posterior (lateral) view. (G) Left middle leg, posterior view. (H) Left hind leg, posterior (medial) view. (I) Male genitalic region, ventral view. (J) Post-abdomen of female, ventrolateral view. Abbreviations: Cx9: coxite IX; Ov: ovipositor; Pa: paramera; Pe: penis; St9: stylus IX. Scale bars: A, B, 5 mm; C–H, J, 1 mm; I, 0.5 mm.

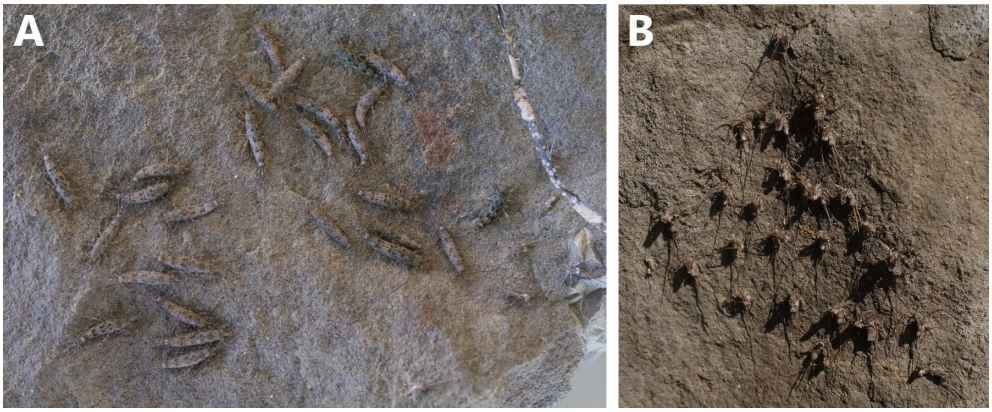

FIGURE 3. Field observations of *Petrobiellus akkesiensis* **comb. nov.** (A) Adults gathered on a rock. (B) Exuviae left in cluster.

Petrobiellus akkesiensis individuals live close to each other in high density (Fig. 3A), similar to halophilic archaeognathan *Petrobius* spp. (Larink 1968). The sex ratio of *P. akkesiensis* seems strongly biased towards females. On June 6, 2022, 75 individuals were collected, among which seven were males and 68 were females; and among 122 exuviae found in a crevice of the cliff eight were males and 114 were females (Fig. 3B).

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