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SHORT COMMUNICATION

Discovery of the genus *Airaphilus* (Coleoptera: Silvanidae) in Japan, with a description of a potentially endangered new species

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Abstract. The genus *Airaphilus* Redtenbacher, 1858 (Coleoptera: Silvanidae: Silvaninae) is recorded from Japan for the first time. The record is based on the discovery of a new apterous species, *Airaphilus abei* sp. nov., described and illustrated herein. The new species is similar to *Airaphilus filiformis* (Rosenhauer, 1856), however it can be distinguished by long antennae reaching about body midlength; anterior margin of pronotum about as wide as head; elytra without a humeral tooth, rounded to base and more to apices; and long metaventrite. Only five specimens have been found and these were collected in 1992 at Kokeyachi bog in the far north of Honshu. This bog and the adjacent wetlands have begun to dry out and are undergoing a transition to grassland. These factors, together with the apparently very limited distribution and the possibly restricted mobility due to lack of hind wings, suggest that at least in this locality the new species may be endangered.

Key words. Coleoptera, Silvanidae, *Airaphilus*, new species, aptery, Byobuyama Wetland Cluster, Kokeyachi bog, Japan, Palaearctic Region

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Introduction

The genus *Airaphilus* Redtenbacher, 1858 (Coleoptera: Silvanidae: Silvaninae) currently contains about 36 described species (Wurst & Lange 1996, Thomas & Leschen 2010). In a molecular phylogenetic study (McElrath et al. 2015), *Airaphilus* was shown to be the earlier-branching clade of the subfamily Silvaninae. In addition, it has strongly developed mandibular mycangia, unlike the reduced ones of the other silvanine genera (McElrath et al. 2015). *Airaphilus* species are widely distributed in the Palaearctic Region, especially in Europe, and also occur in Africa and Southeast Asia. Although, more species have been described in this genus than in any other belonging to the Silvaninae, no modern comprehensive taxonomic study has been carried out. Older descriptions are sometimes quite inadequate and there are doubts about the status of certain species (Ratti 2007, Ratti & Nardi 2011, Fancello 2017, Fancello et al. 2017). Consequently, identification can be difficult and there is a need for a modern revision of the genus. The biology of *Airaphilus* species is also poorly known, although there is information on habitats. For example: haystacks, in roots of dune grass, damp meadows, base of dying plants in a coastal sand dune, humus and leaf litter, under bark of dead trees (Sengupta & Pal 1996, Halstead & Mifsud 2003, Ratti 2007, Halstead 2011, Ratti & Nardi 2011, Friedman 2015, Fancello 2017, Fancello et al. 2017). Ratti (2007) reported that *Airaphilus elongatus* (Gyllenhal, 1813) is often collected on plants from marshy places, especially from flowers of *Carex elata* All. on wetlands or at lakeside.

A new species, *Airaphilus abei* sp. nov., collected from Kokeyachi bog, is described in this paper and represents the first record for the genus in Japan. Like several known species, this new species is apterous. Apart from total wing loss, some other *Airaphilus* species are known to be brachypterous. Wing reduction or loss tends to be found in Mediterranean species except those having extensive

distributions like *A. elongatus*, which occurs in Europe and Central Asia. *Airaphilus elongatus* exhibits dimorphism of wing development, both macropterous (normal) and brachypterous forms occurring together and it is not related to sex or season (Ratti 1976).

Kokeyachi bog is located in the far north of Honshu (Tsugaru City, Aomori Prefecture) and is part of the Byobuyama Wetland Cluster where various aquatic insects and plants are found. It has been selected as one of the important wetlands in Japan by the Ministry of the Environment (Ministry of the Environment 2016). The Kokeyachi bog used to be amply filled with water and contains wetland dwelling plants like *Sphagnum* sp. and *Vaccinium oxycoccos* L. (To-o Nippo Press 2017). However, the bog has been drying out and undergoing a transition to grassland of Japanese pampas grass (*Miscanthus sinensis* Andersson) due to reduction of amount of snowfall, higher temperatures in summer and construction of agricultural drainage channels (To-o Nippo Press 2017). The other wetlands belonging to the Byobuyama Wetland Cluster have also been faced with similar changes to those of the Kokeyachi bog. Restoration of these wetlands is required to conserve the wetland dwelling plants and animals.

Material and methods

External characters were observed and dissections made using a stereomicroscope (Olympus SZX10). Dissections were carried out according to the methods of Yoshida & Hirowatari (2014). After observation, the dissected genitalia were mounted in Euparal on a cover glass for each specimen, each glass was glued to a piece of cardboard and pinned with the specimen.

Photographs were taken using a digital camera (Canon EOS 7D) with a macro lens (Canon MP-E 65 mm), and composite images were produced using automontage software (Combine ZM). For examination with a scanning electron microscope (SEM), one specimen was dehydrated with absolute ethanol and sputter-coated with gold-palladium with a JEOL Ion Sputter JFC-1100. SEM photographs were taken using JSM-5600LV.

Examined specimens have been deposited in the Ehime University Museum, Matsuyama, Japan (EUMJ) and the Systematic Entomology, Hokkaido University, Sapporo (SEHU).

Technical terms follow Halstead (1980) and Yoshida & Hirowatari (2016). Abbreviations used for measurements are as follows:

BL	Body length, HL + PL + EL.
EL	Elytra length, along the suture plus length of scutellar shield.
EW	Elytra width, greatest combined width.
HL	Head length (dorsal), measured along imaginary median line from anterior margin of clypeus to posterior margins behind temples.
HW	Head width, greatest across eyes.
IE	Head width, between eyes.
PL	Pronotum length, measured along the median line.
PW	Pronotum width, greatest excluding fine lateral teeth.

Taxonomy

Airaphilus abei sp. nov.

[Japanese name: Hyoutan-hoso-hiratamushi]
(Figs 1–3)

Type material. Holotype: ♂, Kokeyachi bog, Tsugaru City, Aomori Prefecture, Japan, 5. V. 1992, Azuma Abe leg. (EUMJ). Paratypes: 1♀ and 2 unsexed specimens, same data as (EUMJ); 1 unsexed specimen, ABE76-373 [the label data is missing], Azuma Abe leg. (SEHU).

Description. Habitus (Fig. 1). BL: 2.77–3.36 mm (n = 4). Surface dark brown except for reddish brown antennae, legs, elytra and distal abdominal ventrites; setae golden.

Head (Figs 1, 2A). Subquadrate, slightly shorter than wide, HL 0.43–0.49 mm, HW 0.50–0.56 mm, HW/HL 1.10–1.22; IE/HL 0.72–0.80 (n = 4); genal region (front of eyes) a little enlarged laterally, frontal region with paired yellowish setae; temples very short. Eyes moderate in size, strongly protruding, longer than length of antennomere I. Punctation sparse and shallow, consisting of punctures of various sizes, interspaces between punctures with reticulate microsculpture. Pubescence thick and short, ventrally composed of thinner setae, directed toward posterior. Labrum completely covered by clypeus. Antennae (Fig. 2A) very long (about half as long as body), with trimerous club; antennomere XI asymmetric, outer side somewhat concave; all antennomeres densely covered with thin, short and semi-elect pubescence plus some thin, longer erect setae; antennal total length and antennomere approximate length ratios from base to apex, both for the holotype, 1.35 mm; 1.6 : 1.2 : 1.3 : 1.1 : 1.1 : 1.1 : 1.1 : 1.0 : 1.2 : 1.1 : 1.8.

Pronotum (Fig. 1) longitudinally oval, gradually narrowed towards anterior and posterior margins, widest slightly anterior to middle; anterior margin width almost equal to (not exceeding) head width across eyes, PL 0.67–0.81 mm, PW 0.58–0.72 mm, PL/PW 1.12–1.16 (n = 4); lateral margins with about 12 small teeth at regular intervals, each bearing a short thick seta; anterior margin a little wider than neck of head; surface of pronotum with punctation sparse and shallow, including longitudinal, oval punctures, interspaces with reticulate microsculpture, pubescence moderately dense and short, directed from sides posteriorly and towards midline; anterior margin with setae mainly directed anteriorly and towards middle on each side.

Scutellar shield wide, about twice as wide as long, width slightly less than eye length.

Elytra (Fig. 1A) elongate, oval, EL 1.66–2.05 mm, EW 0.73–1.00 mm (greatest width posterior to middle), EW/BL 0.26–0.30, EW/EL 0.44–0.49 (n=4), with widely rounded apices. Strial punctures small and very shallow, bearing short thick setae on anterior margins. Lateral margins with many minute denticles at bases of setae, without obvious humeral tooth.

Hind wing absent.

Legs (Fig. 2B) long, with reticulate to rugose microsculpture, covered with many short setae, thinner than those of pronotum; femora thick, profemora moderately expanded; tibiae gradually widening distally, apically with some short conical spine-like setae; tarsi (Fig. 2C) long, tarsomeres I–III large and lobed; claws simple.

Fig. 1. *Airaphilus abei* sp. nov., habitus of holotype (male). A – dorsal view; B – ventral view. Scale: 1.0 mm.

Ventral surface (Fig. 1B). Metaventrite long, about 3/4× as long as abdominal ventrite I, with punctation sparser than on pronotum; mesoventrite with larger and deeper punctation than other ventrites; setae thinner than those of pronotum, each located by a puncture and directed anteriorly on prosternum, and posteriorly on meso- and metaventrites; ventrites mostly covered with coarse transverse microsculpture; intercoxal process of procoxae widening toward base; mesocoxal process narrowed posteriorly, somewhat widened near apex. Abdomen more than 1.5× as long as wide; intercoxal process narrowed towards base and rounded; femoral line absent; setae short and thin.

Male genitalia (Figs 2B–H). Tergite VIII transversely oblong, about twice as long as wide, with many short setae along posterior margin; sternite VIII with paired small oblong plates connected by a membrane, ventrally with several very short setae, with two setae of medium length on each posterior portion; sternite IX Y-shaped, widening around middle; branches with moderately sclerotized plates, densely pubescent with short setae on each inner area (Fig. 2B). Median lobe (Figs 2C, D) with rounded apex, longer than wide, with sparse and weak punctation on apical 1/4; median strut Y-shaped with short branches, long and somewhat broad, less than 3× as long as median lobe; ostium opening ventrally around apex (Fig. 2C). Parameres (Fig. 2E) elongate, enlarged at basal 1/3, gradually narrowed toward apex, connected to each other at inner margin of basal 1/3, except on area around basal inner margin covered with many short setae, with some median length to long setae around apices. Phallobase (Fig. 2E) moderately long; tegminal strut short Y-shaped, branches widely divergent with a membrane between them; basal piece transversely oblong, with long branches extending from anterior angles and connected to tegminal strut, a membrane present between branches, posterior margin concave at junction of parameres. Internal sac (Fig. 2D) very long, apex with a long and thin strut (ejaculatory duct) and a U-shaped small plate, with long and more or less angulated armature in apical half, U-shaped thin strut around basal half.

Differential diagnosis. *Airaphilus abei* sp. nov. is similar to *A. filiformis* (Rosenhauer, 1856), another apterous species, but it can be distinguished by having the following characters: 1) Antennae about half as long as

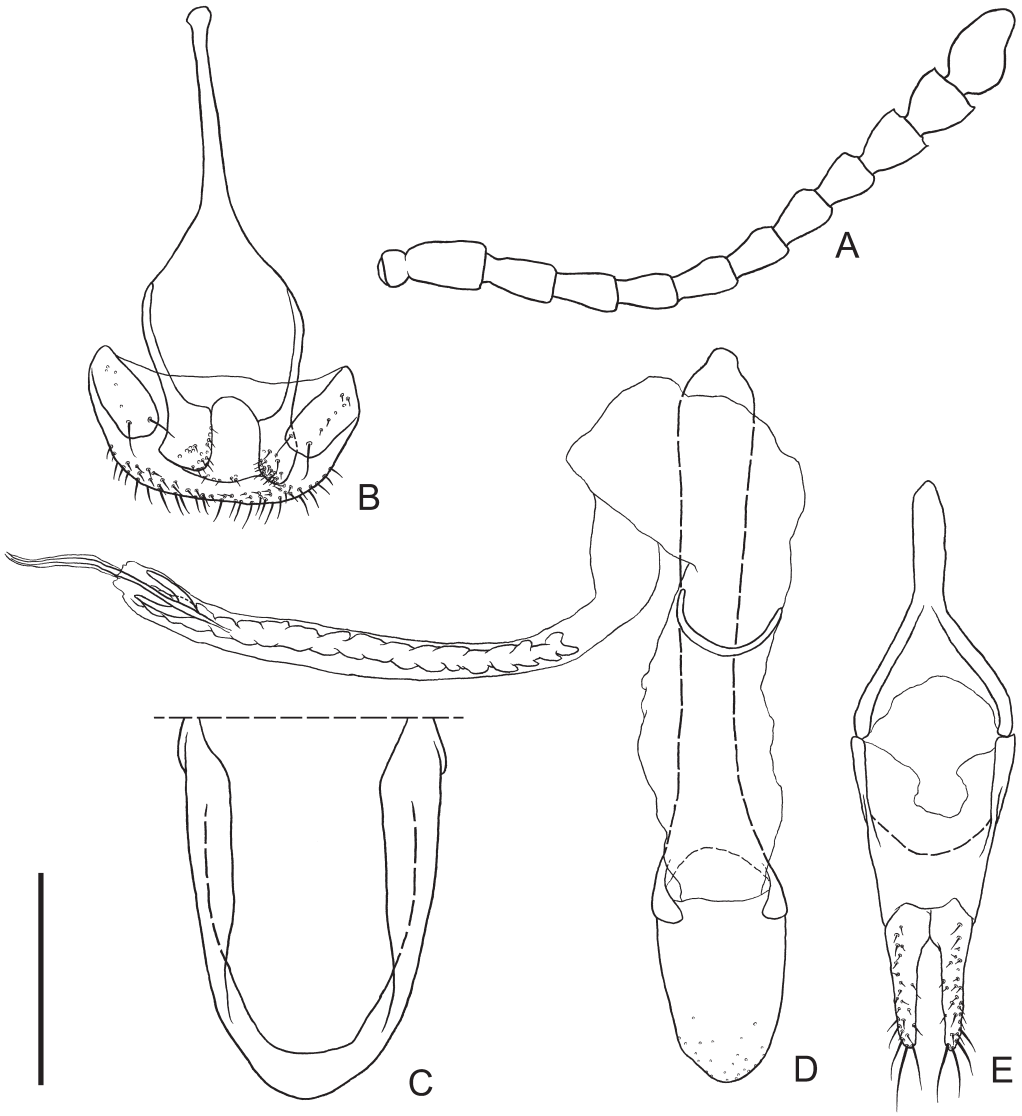

Fig. 2. *Airaphilus abei* sp. nov., holotype (male), antenna and genitalia. A – right antenna; B – abdominal sternites VIII and IX, ventral view; C – apex of median lobe, dorsal view; D – median lobe, ventral view, including internal sac; E – phallobase, ventral view, including parameres. Scale: 0.4 mm for A; 0.2 mm for B, D, E; 0.1 mm for C.

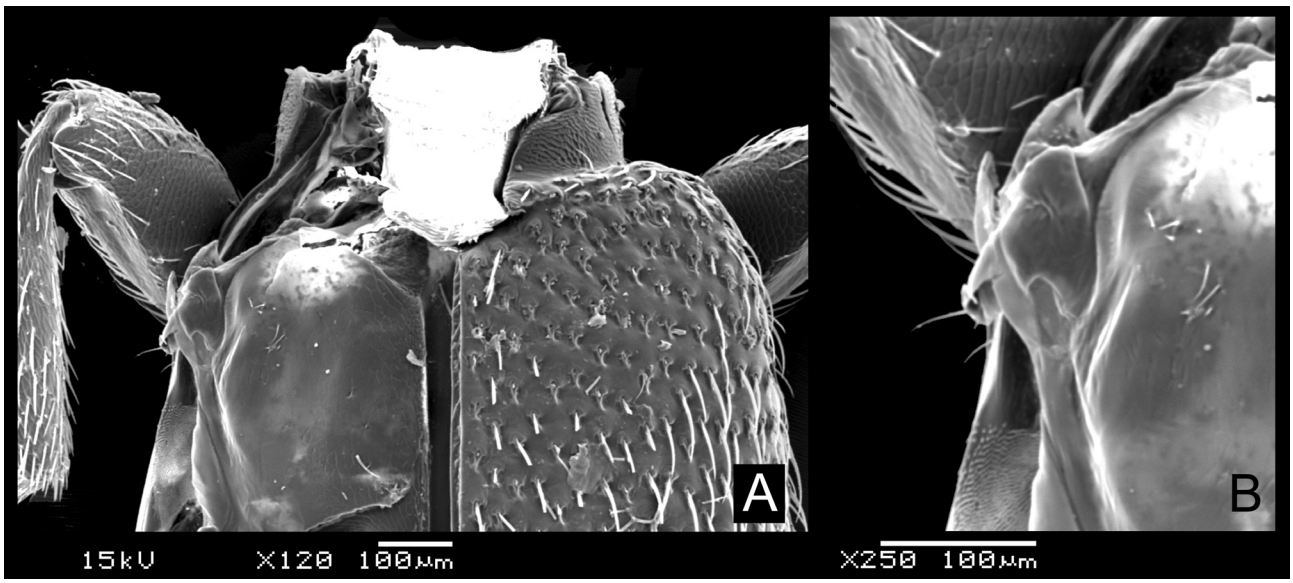

Fig. 3. *Airaphilus abei* sp. nov. A – SEM image of metathorax from which left elytron was removed; B – in detail. Scale: 0.1 mm.

body (similarly long antennae present also in a few other species); in *A. filiformis* obviously less than half as long. 2) Anterior margin of pronotum narrow, about as wide as (not wider than) head across eyes; in *A. filiformis* wider than head across eyes. 3) Elytra without a humeral tooth, somewhat rounded to base and more rounded to apices; in *A. filiformis* elytra each with a poorly developed humeral tooth, distinctly narrowed to base and more narrowed to apices. 4) Metaventrite, about 3/4 as long as abdominal ventrite I; in *A. filiformis* metaventrite shorter, about 1/2 the length of this ventrite. The general appearance of the new species (head, thorax, and elytra) particularly the shape of the pronotum, also the absence of a femoral line on the abdominal ventrite I (in contrast to those species where it is present) plus characters given above, are also useful for distinguishing *A. abei* sp. nov. from other superficially similar ones.

As far as the authors are aware, male genitalia of *Airaphilus* species have been illustrated for only three species; those of *A. serricollis* Reitter, 1878 were illustrated and described by Sengupta & Pal (1996), and those of *A. doramas* Wurst & Lange, 1996 were similarly treated by Wurst & Lange (1996). Genitalia of *A. seabrai* Luna de Carvalho, 1951 were illustrated without description by Luna de Carvalho (1951). Comparison of the genitalia of *A. abei* sp. nov. with these published illustrations showed that the new species differs from them in the form of one or more parts, i.e., parameres, including shape and/or setae on them, median lobe and basal piece. A few additional species, examined by one of the authors (D. Halstead), also revealed some differences in these parts suggesting that male genitalia, particularly the parameres, may provide a guide to species limits and be helpful in identification.

Biological notes. All specimens were collected from the marsh vegetation with ground beetles and/or diving beetles.

Etymology. This new species is dedicated to Dr. Azuma Abe who collected all of the type specimens.

Distribution. Japan (Aomori Prefecture).

Discussion

Although little is known about the biology of *A. abei* sp. nov., the fact that the specimens were collected from the marsh vegetation on the Kokeyachi bog suggests that this is a wetland dwelling species and that it has habits similar to those of *A. elongatus*. Ratti (2007) was of the opinion that *A. elongatus* might have similar habits to those of *Telmatophilus* Heer, 1841 species (Coleoptera: Cryptophagidae) whose adults, according to Otero (2012), mainly feed on pollen of hygrophilous plants (e.g. *Typha* and *Sparganium* spp.). During the present study, gut contents of the new species were examined but no remains of any kind were found.

Assuming that *A. abei* sp. nov. is an entirely apterous species, then its mobility must in general be restricted to movement on the ground and it would be less able to respond rapidly to detrimental changes in habitat. However, as wing development in *A. elongatus* is dimorphic, normal macropterous wings or brachypterous ones being produced, wing dimorphism may also occur in *A. abei* sp. nov. Of course, far more specimens would be needed for examination before any more definite conclusions could be drawn about the apterous condition in this new species.

Based on the facts mentioned above, the authors believe that it is potentially an endangered species. Therefore, further studies on its behavior and distribution are needed. Also, restoration and management of the Kokeyachi bog and the rest of the Byobuyama Wetland Cluster is urgently required to conserve this important area for wetland dwelling animals and plants.

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