

Weevils (Coleoptera, Curculionoidea) Associated with Ferns in Japan

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Abstract Weevils associated with ferns (pteridophytes) in Japan are studied taxonomically and enumerated with plant association records for the first time. Three families, four genera and seven species are recognized including a new species, *Caenosilapillus morimotoi* KOJIMA et FURUHASHI, sp. nov. Ten genera and eleven species in six families of ferns are utilized by weevils as adult food plants.

Ferns (pteridophytes) are primitive plants that were already well represented during the Carboniferous Period, approximately 350 million years ago (mya) (TAAFFE, 2002). The first weevils are thought to have appeared in the late Jurassic Period and to have undergone rapid diversification as the angiosperms began to diversify during the Cretaceous Period, approximately 100 mya (OBERPRIELER *et al.*, 2007). The association between weevils and ferns is known only in the more derived weevil groups, such as Erihniidae and Curculionidae. Consequently, it has been proposed that the association between weevils and ferns may have arisen secondarily, after having been associated primarily with angiosperms (OBERPRIELER *et al.*, 2007).

In Japan, approximately 700 taxa of ferns have been recorded to date, making this one of the most biodiverse groups for which information has been collected (EBIHARA, 2010). Nonetheless, relatively little is currently known about the weevil fauna associated with ferns in Japan.

In this paper, we will enumerate the Japanese weevil taxa associated with ferns for the first time. Although several curculionid species in the subfamily Cossoninae are known to associate with ferns (KUSCHEL *et al.*, 2000), these taxa have been excluded from this treatment and are currently under study. This manuscript is dedicated to the late Dr. Katsura MORIMOTO, who was a global authority on weevil systematics.

Material and Methods

Standard technique for the examination of dry, pinned specimens were used. Classification system of weevils is followed ALONSO-ZARAZAGA and LYAL (1999).

Specimens studied were based on the collections of the following institutions: ELKU (Entomological Laboratory, Kyushu University, Fukuoka); KUM (Kyushu University Museum, Fukuoka); NIAES (Institute for Agro-Environmental Sciences, NARO, Tsukuba); TUA (Tokyo University of Agriculture, Atsugi).

Enumeration with Description of a New Species

Family Dryophthoridae

Subfamily Cryptodermatinae

Cryptoderma RITSEMA, 1885

Oxyrhynchus SCHOENHERR, 1823: c.1137 (type species: *Calandra discors* FABRICIUS, 1801; Orthoceri, Oxyrhynchides).

Cryptoderma RITSEMA, 1885: 54 (revision; Curculionidae, Cryptoderminae); ALONSO-ZARAZAGA & LYAL, 1999: 63 (cataloged; Dryophthoridae, Cryptodermatinae).

See ALONSO-ZARAZAGA & LYAL (1999) for other synonymy.

Remarks. This Oriental apterous genus currently constitutes its own subfamily. While little is known about the biology of the genus, previous records from Japan suggest a strong association between this genus and ferns (KOJIMA & MIYAMOTO, 2020, in press).

1. *Cryptoderma fortunei* (WATERHOUSE, 1853)

Oxyrhynchus Fortunei WATERHOUSE, 1853: 172 (type locality: “China Boreali”).

Cryptoderma fortunei: BOVIE, 1908: 2, fig.2; MORIMOTO, 1978: 114; 1984: 346, pl. 68, fig. 12; OHNO, 1992: 55 (bibliography); LYAL, 2011: 185 (cataloged); ALONSO-ZARAZAGA *et al.*, 2017: 238 (cataloged).

Specimens examined. Japan: Honshu. [Aichi-ken] 3 males, Inuyama-shi, Aichi, 13.IX.1981, T. NOHIRA (KUM). [Fukui-ken] 1 male, Nakaikemi, Fukui, 25.VII.1995, O. KISHIMOTO (KUM). Shikoku. [Tokushima-ken] 1 male, Mt. Daisen-zan, Miyoshi-gun, 31.VII.1950, M. CHÛJÔ (KUM). Kyushu. [Fukuoka-ken] 1 female, Wakitabarû, Kurate, 30.VII.1948, M. YANO, on sap of *Ulmus* sp. (KUM); 1 female, Tashiro, Yame-gun, 16.VI.1953, Y. MIYATAKE (KUM); 1 ex., Mt. Fukuchi, Kokura City, 9.VI.1948, T. MATSUDA (KUM); 1 male, Mt. Inunaki, 23.VI.1970, S. OGATA (KUM); 1 male & 1 female, Mt. Abura, 29.VII.1970, S. OGATA (KUM); 1 female, Mt. Miikeyama, Ômuta-shi, 19.V.1973, H. KINOSHITA (KUM). [Nagasaki-ken] 1 male, Mt. Konpira, Nagasaki City, 26.VII.1953, S. IKUSHIMA; 1 female, same locality, 30.VII.1954, S. IKUSHIMA; 1 male, same locality, 55.-., Yamaishi (KUM); 1 male, Mt. Iwaya, Nagasaki City, 31.VIII.1955, Y. NONAKA; 1 male, same locality, 17.VII.1965, Y. NONAKA (KUM); 1 male, Takashima, Nagasaki, Nishisonogi, 22.VII.1954 (KUM); 2 males & 2 females, Mt. Yahirodake, Sasebo-shi, 26.VI.1977, J. OKUMA (TUA); 1 female, Mekuragaharu, Shikamachi-chô, 19.VI.1983, J. OKUMA (TUA). [Tsushima Is.] 1 female, Hikage, Izuhara-chô, 2.VII.1983, J. OKUMA (TUA); 1 female, Waita, 17.VI.1991, Y. OKUSHIMA (TUA). [Ôita-ken] 1 male, Sobosan (Bungo), 29.VI.1932, HORI, FUJINO & CHO; 1 male, same locality, 5.VII.1932, HORI, FUJINO & CHO; 1 female, same locality, 14.VII.1932, HORI, FUJINO & CHO (KUM). [Kumamoto-ken] 1 male, Iwano, Higo, 5.V.1950 (KUM); 2 females, Tensui-cho, 31.VII.1988, K. KIDO (KUM); 1 male & 3 females, Yamatsukuri, Soyô-machi, 10.VII.1994, I. OHTSUKA (KUM); 42 exs., 12.VII.1994, I. OHTSUKA, from gutter (KUM). [Kagoshima-ken] 1 male, Cape Sata, Ôsumi Penn., 2–5.V.1958, K. MORIMOTO (KUM). Korea: Chejudo Is. 1 male & 1 female, Yongshil, Mt. Hallasan, 24.VII.1990, Y.-C. YEOL (KUM); 1 male & 1 female, Ora-dong, Cheju City, 26.VII.1990, K. YOSHIKAWA, by banana trap (KUM).

Distribution. Japan: Honshu, Ie-shima Isls., Oki Isls., Shikoku, Kyushu, Hirado-jima Is., Tsushima Is., Gotô Isls.; Korea, China.

Biology. Adults of this weevil were collected on *Pteridium aquilinum* (Warabi in Japanese; Dennstaedtiaceae), *Thelypteris torresiana* var. *clavata* (Himewarabi in Japanese; Thelypteridaceae) and *Diplopterygium glaucum* (Urajiro in Japanese; Gleicheniaceae) (OHNO, 1992). Adults were also

occasionally found feeding on the sap of trees and in fruit traps baited with banana and pineapple.

Remarks. This species is distinguished from the next species by having narrow oblique elytral bands, maximally as broad as the distance between the punctures of the striae, and each band not reaching the suture.

2. *Cryptoderma kuniyoshii* MORIMOTO, 1978

(Fig. 27)

Cryptoderma kuniyoshii MORIMOTO, 1978: 106 (type locality: “Hateruma-mori, Iriomote Is.”); 1984: 346 (diagnosis & distribution); TANIKADO, 1985: 6 (Okinawa-jima Is.); HORI, 1986: 234 (on *Thelypteris acuminata*); HAYAKAWA, 1988: 6 (Ishigaki-jima Is.); YOSHITAKE, 1997: 13 (Miyako-jima Is.); LYAL, 2011: 185 (cataloged); ALONSO-ZARAZAGA *et al.*, 2017: 238 (cataloged).

Specimens examined. Japan: Ōsumi Isls. [Satsuma-Kuroshima Is.] 1 male & 4 females, Ōsato, 7–9.VIII.1990, K. YOSHIKAWA (KUM); 4 males & 7 females, same locality, 3–5.VII.2016, H. KOJIMA (TUA); 1 female, same locality, 11.IX.2016, H. KOJIMA (TUA); 1 female, Kaminakazato, 10.IX.2016, H. KOJIMA (TUA); 4 males & 2 females, Sondō Ōsato-Katadomari, 5.VII.2016, H. KOJIMA (TUA); 3 males, same locality, 11.IX.2016, H. KOJIMA (TUA); 1 male & 6 females, same locality, 10.V.2017, H. KOJIMA (TUA); 1 male & 1 female, Mt. Kamugoyama, 14.IX.2016, H. KOJIMA (TUA); 1 male, same locality, 15.IX.2016, H. KOJIMA (TUA); 1 female, Nakazato-rindō (Kaminakazato-Katadomari), 15.IX.2016, H. KOJIMA (TUA); 2 males & 3 females, Mt. Yaguradake, 4–5.VII.2016, H. KOJIMA (TUA). Ryukyus. [Okinawa-jima Is.] 1 male, Izumi, 30.IV.1984, M. TANIKADO (KUM); 1 ex., Namizato, Motobu-chō, 12.VI.2018, H. YOSHITAKE (NIAES); 1 ex., Kanekadan, Uruma-shi, 29.VI.2019, H. YOSHITAKE (NIAES); 8 exs., Yamada, Onna-son, 3–4.VII.2019, H. YOSHITAKE (NIAES). [Ishigaki-jima Is.] 4 males & 1 female, Kabira, 17.VI.1996, T. FUKAISHI, by pineapple trap (KUM); 1 male, Mt. Yarabudake, 17–20.IV.1998, S. OHMOMO (KUM); 1 female, Mt. Omoto, 8.V.1990, T. HANATANI (TUA). [Iriomote-jima Is.] Holotype, male, Hateruma-mori, 5.X.1963, S. KUNIYOSHI (ELUK); 1 male & 1 female (paratypes), same data as the holotype (KUM); 1 female, Shirahama-rindō, 31.V.1977, J. OKUMA (TUA); 2 exs., Ōtomi-yūhodō, 2.IV.2019, H. YOSHITAKE (NIAES).

Distribution. Japan: Ōsumi Isls. (Satsuma-Kuroshima Is.), Ryukyus (isls. of Okinawa-jima, Miyako-jima, Ishigaki-jima and Iriomote-jima).

Biology. Adults of this weevil were collected on *Diplopterygium glaucum*, *Microlepis strigosa* (Ishikaguma in Japanese; Dennstaedtiaceae), *Odontosoria chinensis* (Horashinobu in Japanese; Lindsaeeaceae) and *Woodwardia prolifera* (Hachijyōkaguma in Japanese; Blechnaceae) on Satsuma-Kuroshima Island during the day time (KOJIMA & MIYAMOTO, in press), and *Thelypteris acuminata* (Hoshida in Japanese; Thelypteridaceae) on the islands of Okinawa-jima and Iriomote-jima, where they were usually found on the plant at night.

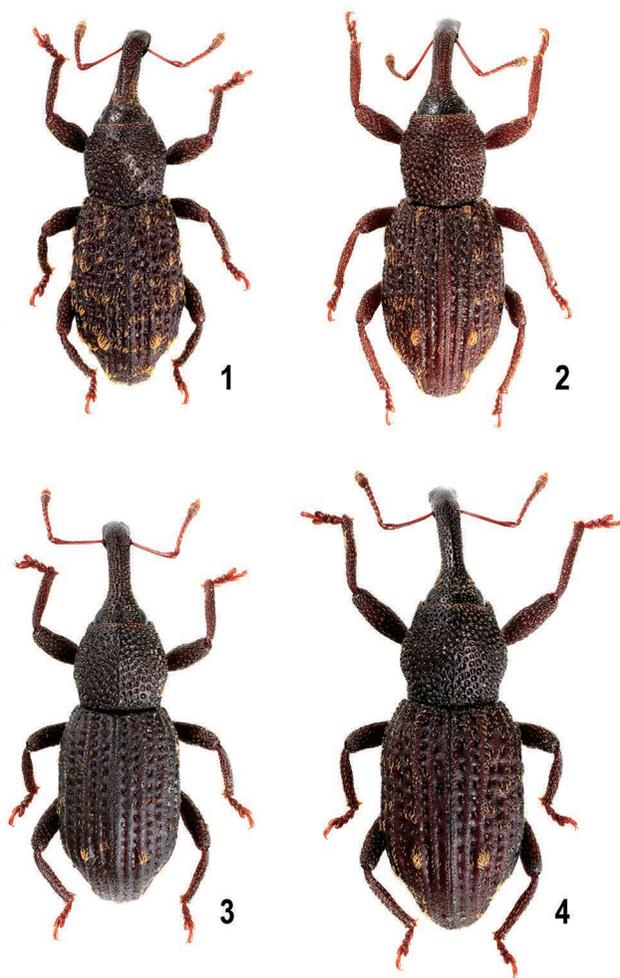
Remarks. Body varies from 8.3 to 16.7 mm in length. This species is distinguished from *C. fortunei* by broad oblique elytral band, much wider than the distance between the punctures of the striae, and each band reaches the suture.

Family **Erirhinidae**

Subfamily **Erirhininae**

***Caenosilapillus* CHŪJŌ et MORIMOTO, 1962**

Caenosilapillus CHŪJŌ & MORIMOTO, 1959: 147 (type species: *Caenosilapillus babai* CHŪJŌ et MORIMOTO; Curculionidae, No-

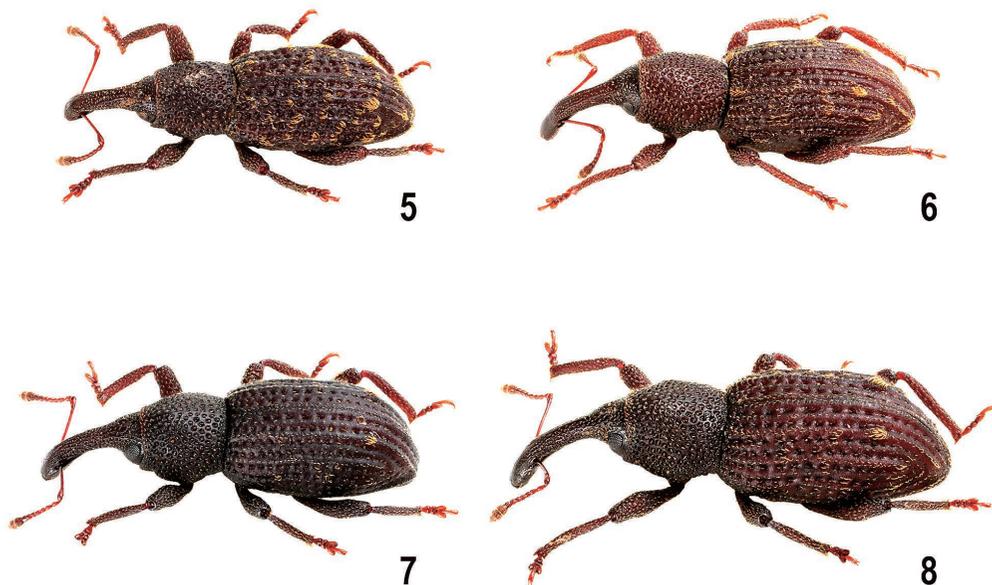


Figs. 1–4. Dorsal habitus images of *Caenosilapillus* spp. — 1 & 2, *C. babai* MORIMOTO; 3 & 4, *C. morimotoi* sp. nov. (1 & 3, male; 2 & 4, female; 1, Gumma-ken; 2, Fukushima-ken; 3 & 4, Yamanashi-ken).

tarinae, Orthoacetini); MORIMOTO, 1962 a: 345 (checklist; Curculionidae, Hyperinae, Notarini); 1962 b: 56 (in key; Hyperinae, Notarini, Orthoacetina); 1989: 505 (checklist; Curculionidae, Eirrhinae); ALONSO-ZARAZAGA & LYAL, 1999: 69 (cataloged; Eirrhinidae, Eirrhininae, Eirrhinini).

Redescription. Medium-sized (4.0–6.0 mm) apterous erirhinid Curculionoidea with exposed surface of body closely punctate and sometimes partly covered with amorphous incrustation or coating, each puncture bearing fine recumbent hairy scale, but often filled with incrustation. Elytra with yellowish brown recumbent lanceolate scales, which are condensed to form spots.

Head broader than long, forehead between eyes broader than base of rostrum, with frontal pit. Eyes not convex from outline of head. Rostrum weakly curved, nearly as long as (male) or longer than (female) pronotum, sides narrowest slightly before base, parallel-sided on median part and broader than median part before antennal insertion. Mandibles each with two large and one external small teeth, of which the last one is obscure in left mandible. Antennae inserted at or before apical



Figs. 5–8. Dorso-lateral habitus images of *Caenosilapillus* spp. — 5 & 6, *C. babai* MORIMOTO; 7 & 8, *C. morimotoi* sp. nov. (5 & 7, male; 6 & 8, female; 5, Gumma-ken; 6, Fukushima-ken; 7 & 8, Yamanashi-ken).

third; scape not reaching base of rostrum and anterior margin of eye; funicle with basal two segments elongate, 3–7th segments quadrate, at least 7th transverse; club visible three-segmented.

Prothorax weakly rounded laterally, subapical constriction weak, post-ocular lobes present and concealing posterior margin of each eye when in repose. Scutellum absent. Elytra oblong-ovate, shoulder obsolescent; striae with large punctures, 7th and 8th striae obsolete on basal fourth of elytra, 10th stria obsolescing above 2nd segment of abdomen; odd intervals more or less costate. Pygidium concealed. Legs with femora unarmed, isometric; tibiae distinctly mucronate, without spurs, with spiny setae on apical 2/3 along ventral margin; tarsi with 3rd segment bilobed; claws simple, free, each with minute seta.

Pro- and mesocoxal cavities continuous. Procoxae contiguous, lying posterior third of prosternum, anterior margin of prosternum weakly concaved. Mesocoxae almost contiguous. Metacoxae reaching lateral margin of elytra, metepisternum very narrow. First and 2nd ventrites weakly depressed in male or inflated in female, disc of 3rd to 5th ventrites finely punctate and smooth, 5th ventrite with pair of hairy tufts on posterior margin. Metendosternite without lateral arms, anterior tendons widely distant.

Terminalia. Male: 8th sternite reduced to pair of small pigmentations without setae, and with apically forked spiculum relictum, spiculum gastrale Y-shaped. Dorsal plate of tegmen bilobed both posteriorly and anteriorly, manubrium straight. Median lobe with pair of orificial sclerites, tectum narrow, less than half as long as pedon, internal sac without any large sclerites, except for pair of pigmented patches, extending beyond tip of apodemes. Female: 8th sternite Y-shaped. Spermatheca with curved cornu, more or less developed ramus and undeveloped collum.

Remarks. This apterous genus is currently endemic to Japan, and belongs to the tribe Eirrhiniini. *Caenosilapillus* was previously considered to be very rare and initially regarded as a soil-dwelling species as the holotype of the type species was collected by shifting of litter (MORIMOTO, 1984, 1993).

However, an association between this genus and ferns was initially suggested by OBERPRIELER (2014) based on personal communication with the first author, KOJIMA. Recently, *Caenosilapillus* weevils have been collected from several localities on some ferns, mainly in the mountainous areas of eastern Japan, east of the Kinki District. Further taxonomic study is required to clarify whether local speciation has occurred due to atrophy of the hind wings.

CHÛJÔ and MORIMOTO (1959) compared this genus with *Orthocetes* GERMAR, 1824, currently placed in the curculionine tribe Styphlini (ALONSO-ZARAZAGA & LYAL, 1999). However, there is no phylogenetic relationship between these taxa and the closest relative of *Caenosilapillus* is currently uncertain.

3. *Caenosilapillus babai* CHÛJÔ et MORIMOTO, 1959

(Figs. 1, 2, 5, 6 & 9–18)

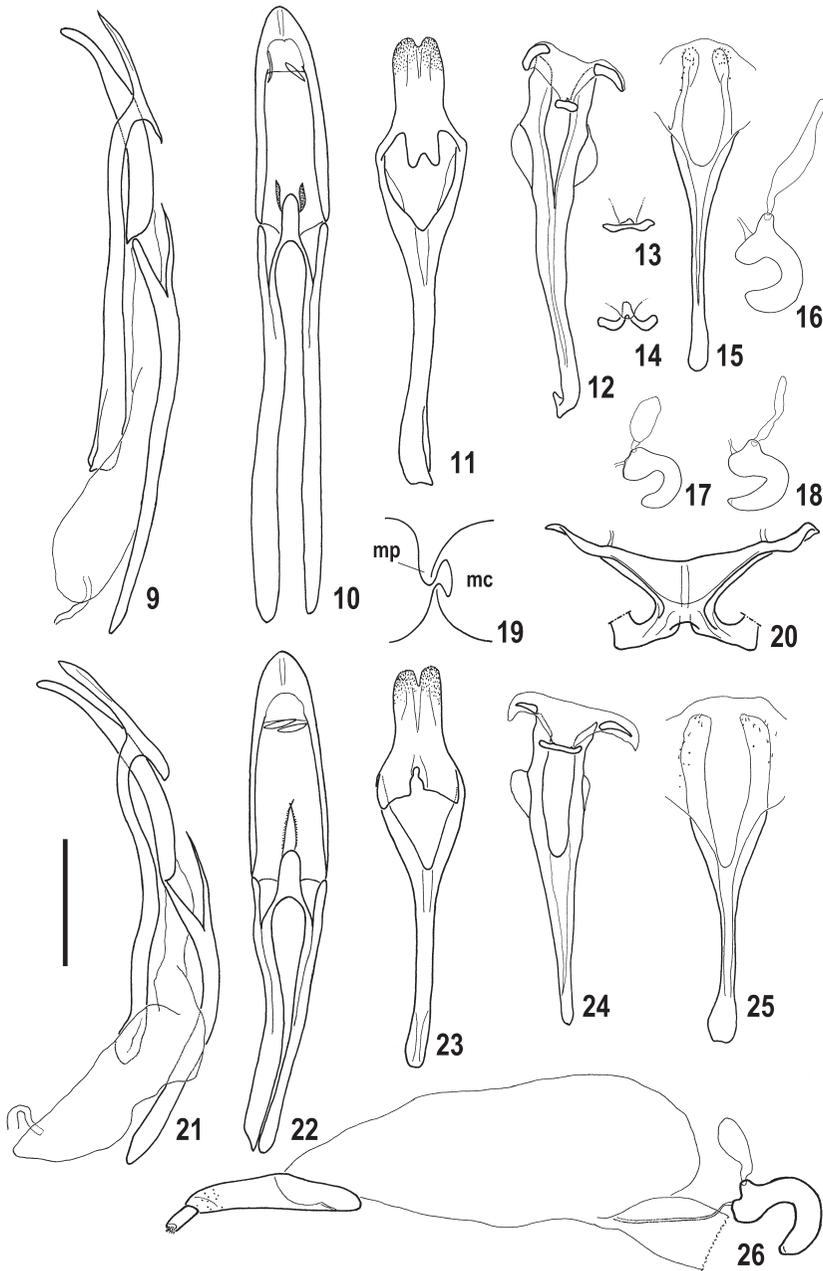
Caenosilapillus babai CHÛJÔ & MORIMOTO, 1959: 148 (by monotypy; type locality: “Miyahisa, Niigata, Pref.”); MORIMOTO, 1984: 289, pl. 57, fig. 3 (by shifting of leaf-litter; Niigata, Yamagata); 1993: 22 (Niigata, Yamagata, Iwate); CALDARA, 2011: 193 (cataloged); ALONSO-ZARAZAGA *et al.*, 2017: 112 (cataloged).

Redescription. Male and Female. Length: 4.2–5.3 mm (male); 4.2–5.7 mm (female). Brownish black, antennae and tarsi, often legs dark reddish brown, elytra with yellowish brown scales forming pair of spots on declivities of 3rd intervals and irregularly condensed to form smaller spots.

Head sparsely and finely punctate and smooth, forehead between eyes about 1.5 times as wide as narrowest part of rostrum. Rostrum as long as or slightly longer than (male) or 1.25 times as long as (female) pronotum, dorsum with median keel on basal 2/3 and with punctured several shallow sulci on each side, apical part sparsely with fine and shallow punctures. Antennae inserted at apical fourth (male) or third (female) of rostrum, scape a little longer than funicle, funicle with basal two segments subequal in length, 1.5–2.0 times as long as wide, 3rd and 4th subequal in length, a little longer than wide, 5th to 7th subequal in length, 5th and 6th as long as wide, 7th transverse; club as long as basal three segments of funicle combined, 1st segment a little longer than 2nd.

Prothorax as long as wide, widest at apical third, dorsum closely with large punctures, punctures become smaller near anterior margin. Elytra 1.6–1.7, rarely 1.5 times as long as wide, gently rounded laterally and widest behind middle, sometimes subparallel-sided behind shoulders to apical third in small individuals; striae with deep separated large punctures, punctures become smaller and striae become narrower towards apex; intervals uneven especially on costate odd intervals, 3rd interval tuberculate on declivity.

Specimens examined. Japan: Honshu. [Akita-ken] 1 male & 1 female, Dakigaeri-keikoku, Tazawako-machi, 31.VII.2006, I. MATOBA (KUM). [Iwate-ken] 1 female, Getô-onsen, Waga-chô, 8.VI.1986, Y. TAKAHASHI (KUM); 1 female, Toyosawa-rindô, Hanamaki-shi, 8.VI.2007, I. MATOBA (TUA). [Yamagata-ken] 9 males & 5 females, Arakawa River, Oguni-machi, 12.VI.2011, Y. FUJISAWA (TUA); 2 males & 2 females, Kotamagawa Oguni-machi, 23.VIII.2019, H. KOJIMA (TUA); 1 male, same locality, 23.VIII.2019, S. FURUHASHI (TUA). [Fukushima-ken] 13 males & 9 females, Misawa-yaiejyô, Yamato-chô, Kitakata-shi, 3.VIII.2016, Y. FUJISAWA (TUA); 1 male & 5 females, same locality, 14.VIII.2018, S. SHIMAMOTO (TUA); 5 males & 4 females, same locality, 10.X.2019, H. KOJIMA (TUA). [Gumma-ken] 1 female, Akayagawa, 22.VIII.1999, K. TAKAHASHI (KUM); 2 females, Hôshi Spa (600m), Niiharu-mura, 19.X.2001, S. NOMURA (KUM); 13 males & 5 females, Ichinokura, Minakami-machi, 8.VI.2008, H. KOJIMA (TUA). [Niigata-ken] Holotype, male, Miyahisa, 3.VI.1955, K. BABA (ELKU); 1 male, Mt. Narumi, N-Echigo, 14.VI.1970, K. BABA (KUM); 3 males, Kamikawa-chô,



Figs. 9–26. Male and female terminalia, mesosternum and metendosternite of *Caenosilapillus* spp. — 9–18, *C. babai* MORIMOTO (9–14, male; 15–18, female; 9–12, 15 & 17, Fukushima-ken; 13 & 18, Yamagata-ken; 14 & 16, Gumma-ken); 19–26, *C. morimotoi* sp. nov. (19–24, male; 25 & 26, female; Yamanashi-ken). — 9 & 21, Aedeagus and tegmen, lateral; 10 & 22, aedeagus, dorsal; 11 & 23, tegmen, dorsal; 12 & 24, sternite 8 and spiculum gastrale, ventral; 13 & 14, median column of 8th sternite; 15 & 25, 8th sternite, ventral; 16–18, spermatheca; 19, mesosternum, ventro-lateral (mp: mesosternal process; mc: mesocoxal cavity); 20, metendosternite, dorsal; 26, ovipositor. Scale = 0.5 mm.

3.VI.2000, K. TAKAHASHI (KUM); 1 male, Yomogisawa, Yuzawa-machi, 10.X.2019, S. FURUHASHI (TUA).

Distribution. Japan: Honshu (Akita, Iwate, Yamagata, Fukushima, Gumma and Niigata-ken).

Biology. Adults of this species were collected on *Arachniodes standishii* (Ryômenshida in Japanese; Dryopteridaceae).

Remarks. MATOBA (2008) recorded this species from Nara-ken, western Japan. However, based on photographic evidence of the specimen, this record is considered to have been misidentified, and his species is considered to be more closely affiliated with the following species or its allies. Taxonomic treatment of this specimen will be maintained until the material and additional specimens are obtained.

4. *Caenosilapillus morimotoi* KOJIMA et FURUHASHI, sp. nov.

(Figs. 3, 4, 7, 8, 19–26, 28 & 29)

Description. Male and Female. Length: 4.5–5.0 mm (male); 4.4–6.0 mm (female). Resembles to *C. babai* except prothorax widest at middle, elytra 1.5–1.6 times as long as wide, subparallel-sided behind shoulders to apical third, with yellowish brown lanceolate scales not condensed to form spots except on declivities of 3rd intervals, and median lobe with pedon roundly tapered apically.

Type series. Holotype: male. Japan: Honshu. [Yamanashi-ken] Kanayamadaira, Sutama-chô, 16.VII.2018, S. FURUHASHI (TUA). Paratypes. 3 males & 4 females, same data as the holotype (TUA); 1 male & 1 female, same locality as the holotype, 28.VI.2008, H. KOJIMA (TUA); 1 female, same locality as the holotype, 27.IX.2008, H. KOJIMA (TUA); 6 males & 8 females, same locality as the holotype, 23.VI.2013, H. KOJIMA (TUA); 1 male, same locality as the holotype, 15.X.2019, H. KOJIMA, by Tullgren funnel (TUA); 1 male & 1 female, Nr. Mt. Gorisan, Sutama-chô, 3.X.2016, Y. FUJISAWA (TUA); 2 males & 1 female, Nr. Mt. Mizugaki, Sumata-chô, 22–24.VII.2016, Y. FUJISAWA (TUA).

Distribution. Japan: Honshu (Yamanashi-ken).

Etymology. This new species is named after the late eminent Japanese curculionologist, Dr. Katsura MORIMOTO.

Biology. Adults of this weevil were collected on *Arachniodes standishii* and *Dryopteris crasirhizoma* (Oshida in Japanese) in the family Dryopteridaceae.

Family Curculionidae

Subfamily Baridinae

Pteridobaris MORIMOTO et YOSHIHARA, 1996

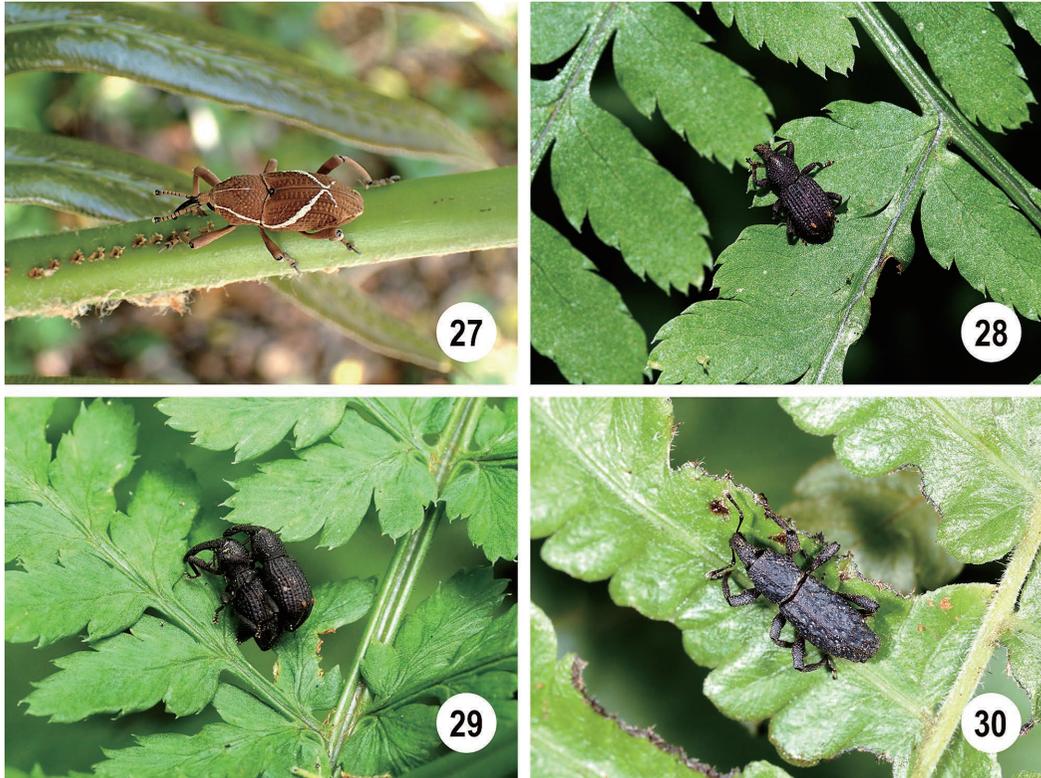
Pteridobaris MORIMOTO & YOSHIHARA, 1996: 8 (in key), 27 (type species: *Baris maritima* ROELOFS, 1875); YOSHIHARA, 2016: 11 (in key), 34.

See YOSHIHARA (2016) for other synonymy and diagnosis.

Remarks. This Oriental genus is currently monotypic, but several undescribed species are present in Southeast Asia (MORIMOTO & YOSHIHARA, 1996). Association of this genus with forked ferns has been confirmed (MORIMOTO, 1984; MORIMOTO & YOSHIHARA, 1996; YOSHIHARA, 2016).

5. *Pteridobaris maritima* (ROELOFS, 1875)

Baris maritima ROELOFS, 1875: 181 (type locality: “Japon”); MORIMOTO, 1984: 309, pl. 61, fig. 3.



Figs. 27–30. Habitus photos of Japanese fern weevils. — 27, *Cryptoderma kuniyoshii* MORIMOTO on *Woodwardia prolifera* (Satsuma-Kuroshima Is.); 28 & 29, *Caenosilapillus morimotoi* sp. nov. on *Arachniodes standishii* (Yamanashi-ken); 30, *Euthycus inaequalicollis* MORIMOTO on *Thelypteris acuminata* (Ishigaki-jima Is.).

Pteridobaris maritima: MORIMOTO & YOSHIHARA, 1996: 28; YOSHIHARA, 2016: 35 (revision); ALONSO-ZARAZAGA *et al.*, 2017: 128 (cataloged).

See YOSHIHARA (2016) for other synonymy and diagnosis.

Specimens examined. 66 exs. collected from Mie-ken (Kumano-shi) and Wakayama-ken (Hikigawa-chô, Taiji-chô) of Honshu, Kagawa-ken (Mt. Zohzusun) and Kôchi-ken (Kuroson) of Shikoku, Fukuoka-ken (Mt. Inoyama, Magaribuchi, Yame-gun, Mt. Wakasugi, Kôrasan, Mt. Hôman, Mt. Jôyama, Kumagahata), Nagasaki-ken (Mt. Yahirodake, Omura-shi), Kumamoto-ken (Ashikita) and Kagoshima-ken (Izashiki, Sata) of Kyushu (KUM & TUA).

Distribution. Japan: Honshu, Awajishima Is., Shikoku, Kyushu; China.

Biology. Adults of this weevil were collected on young shoots of *Diplopterygium glaucum* and *Dicranopteris pedata* (Koshida in Japanese; Gleicheniaceae) from April to July.

Subfamily Molytinae

Euthycus PASCOE, 1885

Euthycus PASCOE, 1885: 220 (type species: *Euthycus macilentus* PASCOE, 1885; Molytinae); MORIMOTO, 1982: 55 (in key); 97 (revision of Japanese spp.; Hylobiinae, Hylobiini); ALONSO-ZARAZAGA & LYAL, 1999: 195 (cataloged; Molytinae: Molytini); ALONSO-ZARAZAGA, 2013: 486 (cataloged).

Euthycus [sic!]: HELLER, 1922: 10 (key to spp.).

Stenanchonus VOSS, 1937: 263 (type species: *Stenanchonus angustus* VOSS, 1937).

Remarks. Association of this apterous genus with ferns was recently reported by YOSHITAKE (2016). This genus is nocturnal. Host feeding and copulation on ferns occurs at night, with resting on and in the ground occurring during the daytime. Thanatosis behavior is also observed frequently after being caught or when resting in the ground during the daytime (KOJIMA *et al.*, in press).

6. *Euthycus japonicus* HELLER, 1922

Euthycus japonicus HELLER, 1922: 11 (type locality: “Japonia septentrionali”); MORIMOTO, 1982: 97 (redescription with figures; Is. Amami-Oshima); 1984: 330, pl. 65, fig. 10; SAITÔ, 1991: 14 (Kagoshima-ken); YOSHITAKE, 2009: 12 (Kumamoto-ken); ÔGAI, 2016: 30 (Tokunoshima Is.); ALONSO-ZARAZAGA, 2013: 486 (cataloged); ALONSO-ZARAZAGA *et al.*, 2017: 478 (cataloged).

Specimens examined. Japan: Kyushu. [Kumamoto-ken] 1 male, Hitoyoshi, 8.IX.2008, N. TAKE-DA & Y. MATSUBARA, by pit-fall trap (NIAES). Ôsumi Isls. [Yakushima Is.] 1 male, Anbô-rindô (750 m), 17.VII.2001, H. HOSHINA, by shifting leaf-litter (KUM); 1 female, Hanyama, 250 m alt., 25.VIII–28.IX.2007, T. YAMAUCHI *et al.*, by Malaise trap (TUA). 2 males, Kankake, 220 m alt., 26.IX.–24.X.2006, T. YAMAUCHI *et al.*, by Malaise trap (TUA); 1 male, same locality, 27.X–28.XI.2006, T. YAMAUCHI *et al.*, by Malaise trap (TUA); 1 male, same locality, 30.VII–25.VIII.2007, T. YAMAUCHI *et al.*, by Malaise trap (TUA); 1 male, Mt. Aikodake, 150 m alt., 25.IX–23.X.2006, T. YAMAUCHI *et al.*, by Malaise trap (TUA); 1 male, same locality, 26.X–27.XI.2006, T. YAMAUCHI *et al.*, by Malaise trap (TUA); 1 female, same locality, 2.V.–5.VI.2007, T. YAMAUCHI *et al.*, by Malaise trap (TUA); 1 male, same locality, 2.XI–1.XII.2007, T. YAMAUCHI *et al.*, by Malaise trap (TUA). Ryukyus. [Amami-Ôshima Is.] 1 female, Yuwan, 5.IV.1958, M. TAKAHASHI (KUM); 1 male & 1 female, Mt. Yuwan, 16–18.VII.1963, C. M. YOSHIMOTO (KUM); 2 females, same locality 30.VII.1963, L. GRESSITT (KUM); 1 female, Sumiyô, 9.VIII.1963, T. OKADA (KUM); 1 male, Chûrindô, nr. Kinsakubaru, 16–17.V.2007, H. YOSHITAKE, on *Ctenitis subglandulosa* (NIAES); 1 male, Chinase, Naze-shi, 2.VII.2011, H. SAWADA (TUA).

Distribution. Japan: Kyushu (Kumamoto-ken), Ôsumi Isls. (Yakushima Is. — new record), Ryukyus (isls. of Amami-Ôshima and Tokunoshima).

Biology. An adult of this weevil was collected by the third author from *Ctenitis subglandulosa* (Katsumouinode in Japanese; Dryopteridaceae) on Amami-Ôshima Island. Adult weevils were also collected by Malaise traps on Yakushima Island.

Remarks. Body length (7.8–10.5 mm; 6.5–8.7 mm in *E. inaequalicollis*) overlaps with next species, *E. inaequalicollis*, but antennae with the 7th segment of the funicle trapezoidal, pronotum with a medial irregular carina on apical two-thirds, and elytra with the 3rd and 5th intervals convex with dense granules in this species. As the examined specimens from Kyushu and Yakushima Island seem to be slightly different from those from the islands of Amami-Ôshima and Tokunoshima, further study is needed to confirm their taxonomic identity.

7. *Euthycus inaequalicollis* MORIMOTO, 1982

(Fig. 30)

Euthycus inaequalicollis MORIMOTO, 1982: 98 (type locality: “Okinawa”); MATOBA, 1983: 7 (Yonaguni-jima Is.); MORIMOTO, 1984: 330; HORI, 1986: 229 (on *Thelypteris acuminata*); ALONSO-ZARAZAGA, 2013: 486 (cataloged); YOSHITAKE, 2016: 45 (biology); ALONSO-ZARAZAGA *et al.*, 2017: 478 (cataloged).

Table 1. Adult host plants of Japanese fern weevils.

Adult host ferns	Associated weevil species (Family names abbreviated)
Gleicheniaceae	
<i>Dicranopteris pedata</i>	<i>Pteridobaris maritima</i> (CUR)
<i>Diplopterygium glaucum</i>	<i>Cryptoderma fortunei</i> , <i>C. kuniyoshii</i> (DRY); <i>Pteridobaris maritima</i> (CUR)
Lindsaeaceae	
<i>Odontosoria chinensis</i>	<i>Cryptoderma kuniyoshii</i> (DRY)
Dennstaedtiaceae	
<i>Microlepia strigosa</i>	<i>Cryptoderma kuniyoshii</i> (DRY)
<i>Pteridium aquilinum</i>	<i>Cryptoderma fortunei</i> (DRY)
Thelypteridaceae	
<i>Thelypteris acuminata</i>	<i>Cryptoderma kuniyoshii</i> (DRY); <i>Euthycus inaequalicollis</i> (CUR)
<i>T. torresiana</i> var. <i>clavata</i>	<i>Cryptoderma fortunei</i> (DRY)
Blechnaceae	
<i>Woodwardia prolifera</i>	<i>Cryptoderma kuniyoshii</i> (DRY)
Dryopteridaceae	
<i>Arachniodes standishii</i>	<i>Caenosilaphillus babai</i> ; <i>C. morimotoi</i> (ERI)
<i>Ctenitis subglandulosa</i>	<i>Euthycus japonicus</i> (CUR)
<i>Dryopteris crassirhizoma</i>	<i>Caenosilaphillus morimotoi</i> (ERI)

Abbreviations. CUR: Curculionidae; DRY: Dryophthoridae; ERI: Eirrhiniidae.

Specimens examined. Japan: Ryukyus. [Okinawa-jima Is.] Holotype, male, Okinawa, VII.1960, S. KUNIYOSHI (ELKU); 1 ex., Yonahadake, 29.V.1978, H. MAKIHARA (KUM); 6 males & 3 females, Mt. Nagodake, Nago-shi, 16.VIII.2019, H. YOSHITAKE (NIAES). [Ishigaki-jima Is.] 1 female, 1983, MASAKI (paratype; KUM); 1 female, Mt. Omotodake, 25–30.IV.1997, K. TAKAHASHI (KUM). [Iriomote-jima Is.] 2 males, 8.VII.1995, K. TAKAHASHI (KUM); 1 male & 1 female, Shirahama-rindô, 30.V.1998, K. TAKAHASHI (KUM); 1 male, Airagawa, 18.V.2010, K. AKITA (TUA). Taiwan. 1 male, Hungyeh Wenchuan, Hualien Hsien, 13.VI.1976, H. MAKIHARA (paratype; KUM).

Distribution. Japan: Ryukyus (isls. of Okinawa-jima, Ishigaki-jima, Iriomote-jima and Yonaguni-jima); Taiwan.

Biology. Adults of this weevil were collected on leaves of *Thelypteris acuminata* (Thelypteridaceae) at night all year around.

Remarks. This species is distinguished from *E. japonicus* by having antennae with the 7th segment of the funicle subglobular, pronotum with a fine median carina along almost entire length except at the base, and elytra with the 3rd and 5th intervals costate at the base.

Discussion

Weevil associations with ferns

Pteridophagy, or fern-feeding, is not very common among weevils and the number of lineages that are monophagous or oligophagous with respect to pteridophytes is restricted. These lineages are members of Eirrhiniidae and Curculionidae (i.e., Baridinae, Cyclominae and Molytinae). In Eirrhiniidae, the Palaearctic genus *Grypus* GERMAR (Eirrhiniini) is known to associate with horsetail, *Equisetum* (Equisetaceae), and the New World genera *Cyrtobagous* HUSTACHE and *Stenopelmus* SCHOENHERR (Tanyspnyrini (= Stenopelmini)) with water fern, *Salvinia*, and aquatic fern, *Azolla* (both in Salviniaceae), respectively (OBERPRIELER, 2014). In Curculionidae, the Oriental baridine genus *Pteridobaris* is known to be associated with forked ferns, Gleicheniaceae (YOSHIIHARA, 2016), and the Neotropical

genera *Lamprobaris* CHAMPION and *Lissobaris* CHAMPION (Madopterini) with ferns, but which fern species is uncertain (PRENA *et al.*, 2014). In Cyclominae, the Australian genus *Neosyagrius* LEA (Notiomimetini, formerly in Rhythirrhinini) is known to be associated with maiden-hair fern, *Adiantum* (Pteridaceae) (MARSHALL, 1922). In Molytinae, Gondwanan genera, such as *Megacolabus* BROUN (New Zealand), *Rystheus* BROUN (New Zealand), *Syagrius* PASCOE (Australasia) and *Germainius* KUSCHEL (Chile) (all in Phrynixini), are known to be associated with ferns (LYAL, 2014).

In this study, *Cryptoderma* (Dryophthoridae), *Caenosilapillus* (Eirrhinidae, Eirrhinini), and *Euthycus* (Curculionidae, Molytinae, Molytini) are newly enumerated as fern weevils. *Cryptoderma* is the first representative of Dryophthoridae known to be associated with ferns. The family is mainly associated with terrestrial monocotyledons, such as palms, bananas, orchids and grasses (ANDERSON & MARVALDI, 2014). *Caenosilapillus* is the third representative of Eirrhinidae known to be associated with ferns. This family is also mainly associated with monocotyledons, particularly semiaquatic and aquatic taxa (OBERPRIELER, 2014). The phylogenetic affinity of *Caenosilapillus* is uncertain, but the genus is not considered to be related to other erirrhinid genera associated with ferns. *Euthycus* is the second member of the curculionid subfamily Molytinae known to be associated with ferns. This genus is one of the most taxonomically diverse weevil subfamilies and include the majority of the wood-boring taxa (OBERPRIELER *et al.*, 2007); the biological traits of this subfamily are also very diverse. *Euthycus* is not considered to be related to Gondwanan fern weevil genera of Phrynixini mentioned above.

All of the associations between the aforementioned weevil taxa and ferns are regarded as having occurred secondarily, that is, after a host shift from their ancestral association with angiosperms, most likely from monocotyledons, as was proposed by OBERPRIELER *et al.* (2007) and OBERPRIELER (2014). Further, this association with ferns may have evolved independently in each taxon.

Association between Japanese weevils and ferns

In Japan, the association between weevils and ferns is recognized in three families, four genera and seven species. The adults of these taxa utilize ten genera and eleven species in six families of ferns as host plants (Table 1). A wide range of fern families (five of six families) are utilized by the dryophthorid genus *Cryptoderma*, while the hosts utilized by other weevil groups is restricted to one or two fern families.

Regarding the larval biology of the Japanese weevil taxa, no information is available on larval habitat except that the baridine weevil *Pteridobaris maritima* may be a stem-borer. Due to their adult body size of fern weevils, which can reach 10.0–17.0 mm in length, the underground parts of ferns, such as the underground stem (rhizome) may serve as their habitat. In addition to their cryptic larval habitats, the nocturnal behavior of these species, certainly in *Euthycus* species complicates elucidation their biology. Further study will be required in order to thoroughly understand the relationship between weevils and ferns.

Lastly, except for species of *Pteridobaris*, three of the four Japanese weevil genera that are known to be associated with ferns are apterous. Although the reason for this is currently uncertain, it may be attributed to the preference of ferns for stable humid forest habitats.

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要 約

小島昭弘・古橋紗瑛・吉武 啓・宮本 太：日本産のシダを利用するゾウムシ類(鞘翅目ゾウムシ上科)。——日本におけるシダ植物利用のゾウムシをリストアップするとともに、成虫の加害植物記録をまとめた。イネゾウムシ科の1新種フタホシニセイネゾウムシ *Caenosilapillus morimotoi* KOJIMA et FURUHASHI, sp. nov. を含む、3科4属7種のゾウムシを確認し、計6科10属11種のシダ植物を成虫が利用していることが明らかとなった。これらゾウムシ類のシダ植物への適応は、被子植物からの二次的な寄主転換の結果と考えられている。

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