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The Underground Fauna of Agyrtidae and the Subfamily Cholevinae of Leiodidae (Coleoptera) in Eastern Shikoku, Southwest Japan, with a Summary of the Habitat Diversity of Some Japanese Cholevines

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Abstract Agyrtid and cholevine leiodid beetles collected using baited deep-soil traps in eastern Shikoku, Southwest Japan, are recorded. The structure of the traps and the operation in the field are presented. *Apteroloma discicolle discicolle* (Lewis), *Catops hilleri* Kraatz, *C. miensis miensis* Nakane, *Mesocatops japonicus* (Jeannel), *Sciodrepoides tsukamotoi* Nakane, and *Ptomaphagus* (*Ptomaphagus*) *kuntzeni* Sokolowski were collected from underground non-cave habitats for the first time. The performance of the trap is discussed, and the beetles collected are discussed in relation to their habitat diversity. The dispersal of cave-dwelling cholevines in Shikoku is briefly described using a model species, *Catops hisamatsui*.

Introduction

A soil-dwelling beetle fauna may consist of a combination of litter-dwelling, soil-limited endogean and hypogean beetles and cave-dwelling beetles. So-called cave-dwelling beetles are well known to also occur habitats other than caves; *e.g.*, in the upper hypogean zone, narrow spaces of fractured rocks, and in colluvial and talus slopes (Giachino *et al*., 1998). Regarding the upper hypogean zone, it has been thought that this zone is the original habitat of terrestrial cave animals, but the zone is often reached at a depth of only 10 or 20 cm from the ground surface, because its thickness and depth from the surface change greatly according to the topography and geological features of each site (Uéno, 1987). Such variability in thickness of the upper hypogean zone may markedly affect collecting results of soil-dwelling beetles, depending on the collecting depth.

To date, cave-dwelling *Catops* and *Nemadus* species have been recorded from epigean habitats in Japan (Miyama, 1985; Nishikawa, 1992, 1995 a; Hoshina, 2006; Inagaki *et al*., 2008; Nishikawa *et al*., 2011), whereas epigean *Catops* and *Nemadus* species also from caves (Yoshida & Nomura, 1952; Hayashi, 1985; Shimano, 1999; The Japan Coleopterological Society, 2007). Actually, *Catops hisamatsui* Y. Hayashi, 1985, regarded as a cave-dweller, has also been recorded from upper hypogean habitats (Harusawa & Yamamoto, 2000; Nishikawa *et al*., 2011). It is hypothesized, based on the above records, that cave-dwelling and epigean cholevines also occur in underground non-cave habitats.

However, in order to test the above hypothesis, it is essential to device efficient methods for collecting of soil-dwelling beetles. The Tullgren funnel method is commonly used for extracting soil-dwelling beetles, but it is somewhat inefficient for collecting predaceous and scavenging beetles. One of the authors, M. Yoshida, independently devised a trapping method to effectively collect the beetles,

and made faunal investigations together with his collaborators using this method (e.g., Uéno, 2009; Ito, 2010; Yoshida & Tanaka, 2011).

In this paper, we report the underground fauna of agyrtid and cholevine leiodid beetles in eastern Shikoku, Southwest Japan. We summarize the habitat diversity of the Japanese cholevine beetles found in underground habitats, and we briefly describe the dispersal of cave-dwelling cholevines in Shikoku, using *C. hisamatsui* as a model species.

Material and Methods

Material. Specimens examined in this study have been deposited in the following museum and private collections:

EUM Ehime University Museum, Matsuyama (Masahiro Sakai and Hiroyuki Yoshitomi);
MNC Collection of Masaaki Nishikawa, Ebina, Japan;
MYC Collection of Masataka Yoshida, Tokushima, Japan;
YFC Collection of Yoshifumi Fujitani, Okayama, Japan.

All specimens excepting in the YFC were identified or revised by Y. Hayashi or M. Nishikawa, whereas those in the YFC were identified by Y. Fujitani.

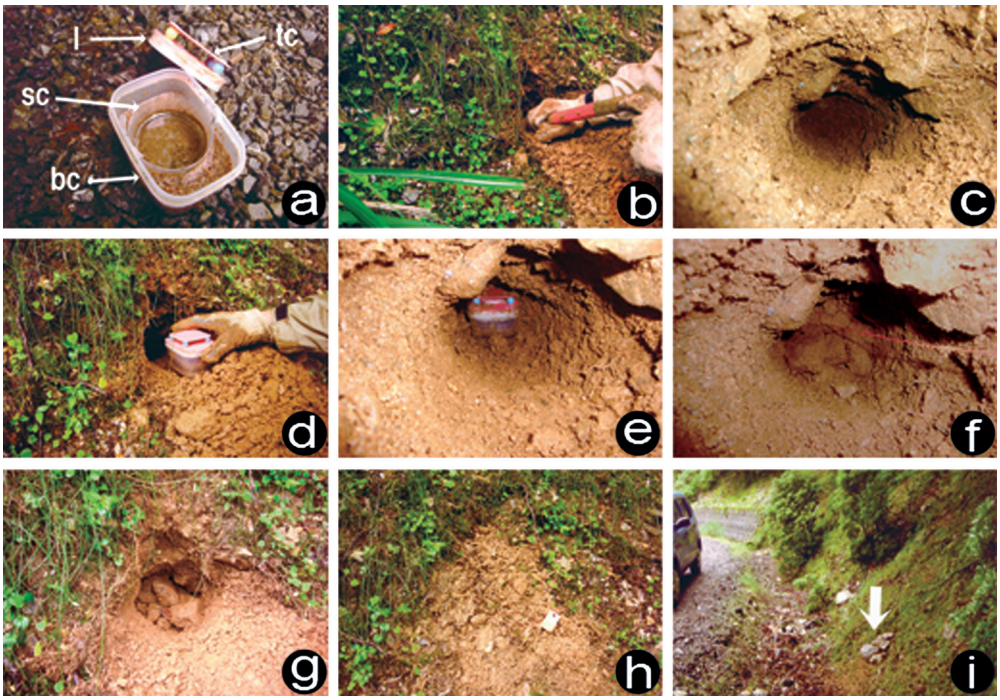

Fig. 1. Structure and use of a baited deep-soil trap. —— a, Structure of the trap (see text); b–i, the technique used for installing the trap. —— a, Parts of the trap (bc: bait container; sc: solution cup; l: lid; tc: trap cover); b–c, to set the trap, a hole is dug at a selected site; the hole is dug vertically or horizontally with an iron bar to 10–15 cm width and 40–60 cm depth; d–f, the trap is set at the end of the hole and is packed there with pebbles; for a thread leading to the trap, its other end is drawn out from the hole for a guide; g, the hole is further filled up with small stones; h, the entrance of the hole is completely coated with small stones and soil; i, stones are piled up in the entrance as a mark to find the hole (indicated by an arrow).

Methods. Collecting method and collecting sites. To collect soil-dwelling beetles, a baited deep-soil trap was newly devised for use at the level closest to their habitat (Fig. 1.a). The main body of the trap is made from a small, quadrate airtight container, and the trap includes a bait container (bc), a solution cup (sc), a lid (l) and a trap cover (tc). Several small holes are opened for drainage in the lateral sides of the bait container. The central part of the lid of the bait container is cut off in a circle, from which insects fall to the solution cup set into the container. The solution cup is filled with a preserving agent for collected insects, and the trap cover is attached to the lid to protect the trap from the soil.

The technique for installing the trap is explained in Figure 1.b–i. Twenty-two collecting sites were randomly selected in eastern Shikoku, Southwest Japan (Fig. 2; Table 1). Traps baited with chicken bone or minced dry silk worms were checked once or twice for three months after trap installation in the field.

Record of specimens collected. We followed Perreau (2000) for the classification of collected cholevines. All localities were georeferenced using the functional indication of "Watchizu," an online map provided by the Geospatial Information Authority of Japan (http://watchizu.gsi.go.jp/).

Habitat diversity of the Japanese cholevines. We searched the literature for habitat data on the Japanese cholevines; these data are compiled together with the data obtained in the present study.

Distribution of Catops hisamatsui. We searched the literature for collecting data, which include

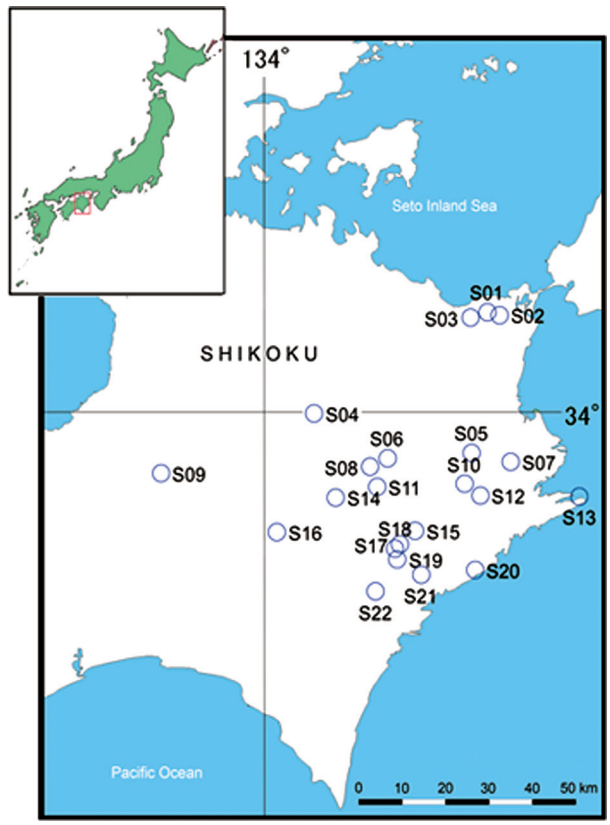

Fig. 2. Geographic location of collecting sites in eastern Shikoku, Southwest Japan. Each code corresponds to a collecting site shown in Table 1.

Table 1. Locality data for the 22 collecting sites and main habitat(s) of the members in each collection.

Code	Collecting site	Latitude (°N)	Longitude (°E)	Altitude (m)	Habitat(s) of the members
S01	Nakatani	34.1912	134.5230	120	C
S02	Munakê-dani	34.1854	134.5516	60	E & C
S03	Udatsu-goe	34.1810	134.4836	210	E
S04	Kajiyama	33.9978	134.1169	420	E
S05	Nakagoya	33.9222	134.4860	80	C
S06	Mt. Kumosô-yama	33.9119	134.2893	1120	E
S07	Shirutani	33.9053	134.5774	90	E & C
S08	Mt. Takashiro-yama	33.8960	134.2481	1400	C
S09	Mizunashi	33.8834	133.7586	180	C
S10	Ryûô-zan	33.8634	134.4697	350	E
S11	Sezu	33.8575	134.2648	450	E
S12	Minamigawa	33.8408	134.5066	120	E
S13	Kamouda	33.8388	134.7383	30	C
S14	Mt. Ôkubo-yama	33.8369	134.1674	1300	E
S15	Myôjin	33.7734	134.3536	230/260	E/E & C
S16	Befukyô	33.7709	134.0297	620	E
S17	Hirayabu	33.7477	134.3179	390	E
S18	Rokuchô	33.7394	134.3065	440	E
S19	Kainose	33.7188	134.3116	180/200	C / E
S20	Akimaru	33.6986	134.4944	180	C
S21	Okutani	33.6894	134.3681	180/220	E & C/C
S22	Shimoôuchi	33.6578	134.2608	130	E & C

(E, epigean habitat; C, cave-habitat.)

the data in the original records of *C. hisamatsui* from Shikoku. Of these records, most records from caves were for undetermined *Catops* species or *Catops ohbayashii* JEANNEL, 1954; however, we considered that these recorded beetles are probably *C. hisamatsui*, because this was described in 1985 (HAYASHI, 1985) and has not been known to occur sympatrically with other cave-dwelling *Catops* species inside caves of Shikoku. However, we excluded the species recorded as "*Catops* sp. ?" from Mikura-dô, Kochi Prefecture (ISHIKAWA, 1954), because of the uncertainty in genus identification.

Maps. Collecting sites and distribution maps were produced and edited with iMap 3 version 3.5 (Biovolution, Belgium) and Adobe Photoshop CS4 version 11.0.2 software. We used MapMap version 6.0 application software (KAMADA, 2011) to create the map layers.

Results

The baited deep-soil traps efficiently attracted soil-dwelling agyrtid and cholevine beetles. A total of 177 specimens belonging to nine species were collected from 22 sites in eastern Shikoku (Fig. 2; Table 1). The collection included one species of Agyrtidae and eight species of the leiodid subfamily Cholevinae (see List of species collected). Of these, *Catops hilleri* KRAATZ, 1877, *Catops miensis miensis* NAKANE, 1956, *Sciodrepoides tsukamotoi* NAKANE, 1956, and *Ptomaphagus* (*Ptomaphagus*) *kuntzeni* SOKOLOWSKI, 1957, all of which have hitherto been known as epigean dwellers, were unexpectedly collected from underground habitats for the first time, together with agyrtid *Apteroloma discicolle discicolle* (LEWIS 1893). *Nemadus* (*Nemadus*) *ishiharai* MIYAMA, 1985, *Nemadus* (*Nemadus*) *japanus* COIFFAIT et S.-I. UÉNO, 1955, and *Mesocatops japonicus* (JEANNEL, 1936), which have

Table 2. Habitat diversity of the Japanese cholevine beetles found in underground habitats.

Taxon	Epigean habitats (incl. leaf litter)	Underground habitats	
		Endogean/UHZ	Cave
Anemadini			
Anemadiola inordinata Szymczakowski, 1963	X		X[1]
Nemadus (*Nemadus*) *ishiharai* Miyama, 1985	X[2]	X	X
N. (*N.*) *japanus* Coiffait et S.-I. Uéno, 1955	X[3]	X	X
N. (*N.*) *uenoi* M. Nishikawa, 1995			X
Cholevini			
Catops dorogawensis Nakane, 1997			X
C. hilleri Kraatz, 1877	X	X	
C. hisamatsui Y. Hayashi, 1985	X[4]	X[5]	X
C. miensis miensis Nakane, 1956	X	X	
C. nipponensis Jeannel, 1936	X[6]		X
C. ohbayashii Jeannel, 1954	X[7]		X
C. sparcepunctatus Jeannel, 1936	X	X	X[8]
C. sonei M. Nishikawa, 1995			X
Mesocatops japonicus (Jeannel, 1936)	X	X	X[9]
Sciodrepoides tsukamotoi Nakane, 1956	X	X	
Ptomaphagini			
Ptomaphagus (*Ptomaphagus*) *kuntzeni* Sokolowski, 1957	X	X	
P. (*P.*) sp.			X[10]

Remarks: 1, Fujitani (unpublished data); 2, Miyama (1985), Nishikawa (1995); 3, Fujitani (2003); 4, Hayashi (1985), Hoshina (2006), Nishikawa *et al*. (2011); 5, Harusawa & Yamamoto (2000), Nishikawa *et al*. (2011); 6, Nishikawa (1992), Hoshina (2006), Nishikawa (unpubl. data); 7, Inagaki *et al*. (2008); 8, Yoshida & Nomura (1952), Shimano (1999), Japan Coleopt. Soc. (2007); 9, Ishikawa (1959), Inagaki *et al*. (2008), Nishikawa (unpubl. data); 10, Nishikawa (1995b). All endogean/UHZ records are based on this paper, except that *C. hisamatsui* has also been recorded from UHZ. UHZ = upper hypogean zone.

been found from both epigean and cave habitats, were also collected from underground non-cave habitats. The habitat diversity of the Japanese cholevine beetles found from underground habitats is summarized in Table 2.

According to literatures, there have been a number of records of *Catops hisamatsui* from Shikoku. Based on the combination of the previous and present data (List of species collected; Fig. 3; Appendices 1 & 2), it is revealed that this species has a very wide distribution range in Shikoku (though no record from Kagawa Prefecture).

The collecting sites can be divided into two types based on the present results and those of previous studies. In one type of collecting site, both epigean and cave-dwellers were collected, whereas in another, only one type of beetle was collected (Table 1).

List of Species Collected

Species first recorded from an underground non-cave habitat are indicated by an asterisk (*). The depth from the ground surface where the trap was installed is shown together with the type of bait in parentheses at each end. All specimens are deposited in MYC. KT, Kôji Tanaka leg.; MY, Masataka Yoshida leg.; CB, trap baited with chicken bone; SW, trap baited with minced dry silk worms.

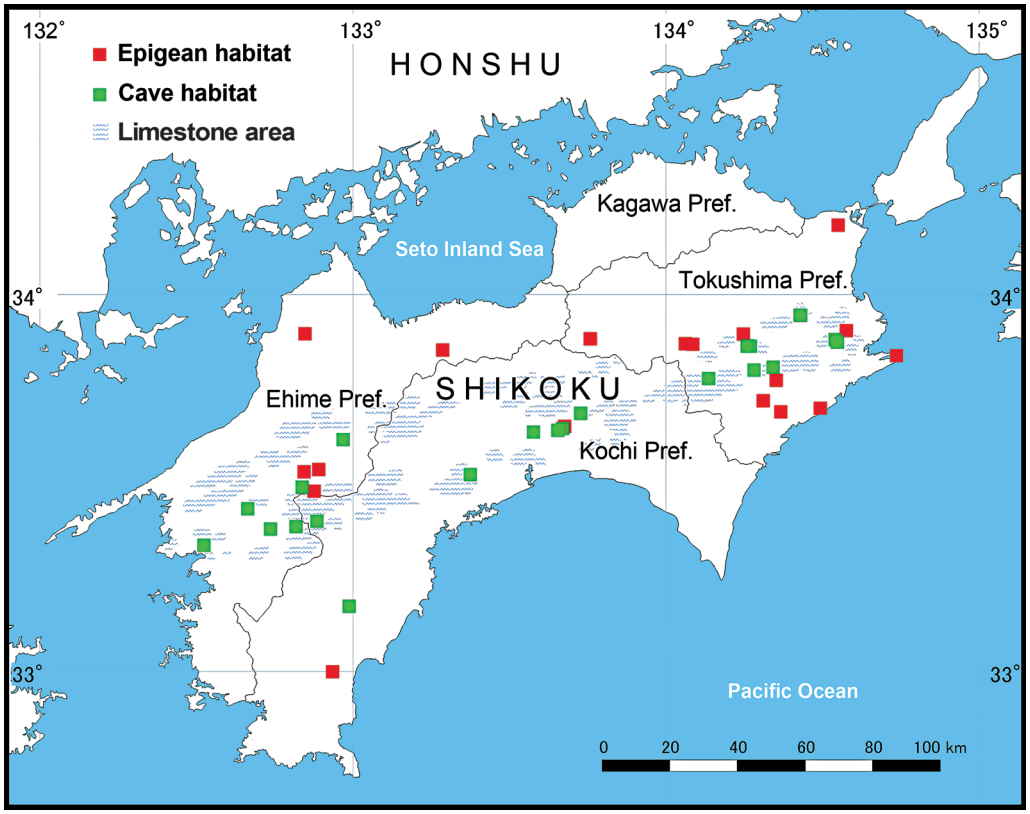

Fig. 3. Geographic distribution and habitat of *Catops hisamatsui* Y. Hayashi in Shikoku, Southwest Japan. The present data (List of species collected; Appendix 2) and literature records (Appendix 1) are combined. Limestone areas are modified from Kawamura (2003, fig. 5.8.1).

Family **Agyrtidae**
Subfamily Pterolomatinae
Apteroloma discicolle discicolle (Lewis, 1893)*

Tokushima Pref.: 1 ♂, Udatsu-goe, 210 m in alt., Orino, Kitanada-chô, Naruto-shi, 5～11–V–2008, MY (50 cm; SW).

Family **Leiodidae**
Subfamily Cholevinae
Tribe Anemadini
Nemadus* (*Nemadus*) *ishiharai Miyama, 1985*

Tokushima Pref.: 5 ♂♂, 3 ♀♀, Shimoôuchi, 130 m in alt., Aikawa, Kaiyô-chô, Kaifu-gun, 8–II～1–III–2009, KT (40 cm; SW).

Nemadus* (*Nemadus*) *japanus Coiffait et S.-I. Uéno, 1955*

Tokushima Pref.: 1 ♂, Nakagoya, 80 m in alt., Tanano, Katsuura-chô, 23–II～30–III–2008, MY (40 cm; SW); 1 ♂, Shirutani, 90 m in alt., Kumadani-chô, Anan-shi, 4～14–V–2008, KT (40 cm; SW).

Tribe Cholevini

Catops hilleri KRAATZ, 1877*

Tokushima Pref.: 30 ♂♂, 23 ♀♀, Kajiyama, 420 m in alt., Anabuki-chô, Mima-shi, 26–X～9–XII–2008, KT (40 cm; SW); 1 ♀, Mt. Ôkubo-yama, 1,300 m in alt., Iwakura, Kisawa, Naka-gun, 24–VIII～28–IX–2008, MY (50 cm; SW); 1 ♂, Minamigawa, 120 m in alt., Wajikigô, Naka-chô, Naka-gun, 9～22–III–2008, KT (40 cm; SW); 1 ♂, 2 ♀♀, Rokuchô, 440 m in alt., Kawamata, Kaminaka, Naka-chô, 16～30–XII–2007, KT (40 cm; SW); 2 ♀♀, Okutani, 180 m in alt., Mugi-chô, Kaifu-gun, 18–I～1–III–2009, MY (40 cm; SW); 1 ♀, same locality, 1～15–III–2009, KT (40 cm; SW); 4 ♂♂, 1 ♀, Shimoôuchi, 130 m in alt., Aikawa, Kaiyô-chô, Kaifu-gun, 8–II～1–III–2009, MY (50 cm; SW); 3 ♂♂, 2 ♀♀, same data but KT (40 cm; SW).

Catops hisamatsui Y. HAYASHI, 1985

Tokushima Pref.: 1 ♀, Nakatani, 120 m in alt., Bandô, Ôasa-chô, Naruto-shi, 11–II～16–III–2008, MY (50 cm; SW); 1 ♀, Munakê-dani, 60 m in alt., Ôtani, Ôasa-chô, Naruto-shi, 21–XII–2008～11–I–2009, MY (50 cm; SW); 1 ♀, same data but KT (40 cm; SW); 10 ♂♂, 3 ♀♀ (incl. 3 teneral ♂♂), Shirutani, 90 m in alt., Kumadani-chô, Anan-shi, 4～14–V–2008, KT (40 cm; SW); 5 ♂♂, 3 ♀♀, same data but 14–II～15–III–2009; 1 ♀, Kamouda, 30 m in alt., Tsubaki-chô, Anan-shi, 23–II～30–III–2008, KT (30 cm; SW); 1 ♂, Mizunashi, 180 m in alt., Nishiu, Yamashiro-chô, Miyoshi-shi, 16–IX～9–XII–2008, KT (40 cm; SW); 1 ♀, Mt. Takashiro-yama, 1,400 m in alt., Kisawa, Naka-gun, 13～30–X–2008, MY (50 cm; SW); 1 ♂ (teneral), Myôjin, 260 m in alt., Fukamori, Kaminaka, Naka-chô, Naka-gun, 4～20–IV–2008, KT (40 cm; SW); 1 ♀, Kainose, 180 m in alt., Kaiyô-chô, Kaifu-gun, 20–IV～3–V–2008, KT (40 cm; SW); 1 ♀, Akimaru, 180 m in alt., Hiwasa, Minami-chô, Kaifu-gun, 22–II～15–III–2009, MY (50 cm; SW); 1 ♂, 1 ♀, Okutani, 180 m in alt., Mugi-chô, Kaifu-gun, 12–IV～3–V–2008, MY (40 cm; SW); 1 ♂, same data but 220 m in alt.; 9 ♂♂, 10 ♀♀ (incl. 2 teneral ♀♀), same data but (50 cm; CB); 1 ♂, 6 ♀♀, same locality, 18–I～1–III–2009, MY (40 cm; SW).

Catops miensis miensis NAKANE, 1956*

Tokushima Pref.: 1 ♀, Kajiyama, 420 m in alt., Anabuki-chô, Mima-shi, 26–X～9–XII–2008, KT (40 cm; SW); 1 ♂, 1 ♀, Mt. Kumosô-yama, 1,120 m in alt., Kamiyama-chô, 13～30–X–2008, MY (40 cm; SW); 2 ♀♀, Myôjin, 230 m in alt., Fukamori, Kaminaka, Naka-chô, Naka-gun, 23–XI～8–XII–2007, KT (40 cm; SW); 2 ♂♂, Rokuchô, 440 m in alt., Kawamata, Kaminaka, Naka-chô, 16～30–XII–2007, KT (40 cm; SW); 1 ♂, Okutani, 180 m in alt., Mugi-chô, Kaifu-gun, 18–I～1–III–2009, MY (40 cm; SW).

Mesocatops japonicus (JEANNEL, 1936)*

Tokushima Pref.: 1 ♀, Ryûô-zan, 350 m in alt., Nishitani, Ôsaka, Itano-chô, 1～29–VI–2008, MY (50 cm; SW); 1 ♂, 1 ♀, Shirutani, 90 m in alt., Kumadani-chô, Anan-shi, 4～14–V–2008, KT (40 cm; SW); 1 ♂, Sezu, 450 m in alt., Kakeban, Kisawa, Naka-chô, 20–IV～3–V–2008, KT (40 cm; SW); 6 ♂♂, 2 ♀♀, Mt. Ôkubo-yama, 1,300 m in alt., Iwakura, Kisawa, Naka-gun, 24–VIII～28–IX–2008, MY (50 cm; SW); 1 ♀, Myôjin, 260 m in alt., Fukamori, Kaminaka, Naka-chô, Naka-gun, 4～20–IV–2008, KT (40 cm; SW); 1 ♂, 1 ♀, Hirayabu, 390 m in alt., Kawamata, Kaminaka, Naka-chô, 4～20–IV–2008, KT (40 cm; SW); 1 ♂, 6 ♀♀, Kainose, 200 m in alt., Ogawa, Kaiyô-chô, Kaifu-gun, 28–III～20–IV–2008, KT (40 cm; SW). Kôchi Pref.: 1 ♀, Befukyô, 620 m in alt., Monobe, Kami-shi, 10–VIII～12–IX–2008, MY (50 cm; SW).

Sciodrepoides tsukamotoi NAKANE, 1956*

Tokushima Pref.: 1 ♀, Munakê-dani, 60 m in alt., Ôtani, Ôasa-chô, Naruto-shi, 21–XII–2008～11–I–2009, KT (40 cm; SW).

Tribe Ptomaphagini

Ptomaphagus (***Ptomaphagus***) ***kuntzeni*** SOKOLOWSKI, 1957*

Tokushima Pref.: 1 ♂, Shirutani, 90 m in alt., Kumadani-chô, Anan-shi, 4～14–V–2008, KT (40 cm; SW). Kôchi Pref.: 2 ♂♂, Befukyô, 620 m in alt., Monobe, Kami-shi, 10–VIII～12–IX–2008, MY (50 cm; SW).

Discussion

Baited deep-soil trap. Coleopterists have devised several types of baited deep-soil traps, but the usage of these traps is fairly recent (OWEN, 1995; LÓPEZ & OROMÍ, 2010; GIACHINO & VAILATI, 2010; FRESNEDA *et al*., 2011). Most of these traps seem to have been designed to attract dwellers only in a specific target layer, using a cylindrical long pipe. YOSHIDA's trap described herein does not use such a pipe, and it is thus compact and easy to carry. However, dwellers of several layers seem to possibly be attracted together when the trap was installed at the bottom of a vertical hole. The specimens listed were collected by the trap at the bottom of a vertical hole (Fig. 1.b–i shows a horizontal hole), and consequently, the determination of their dwelling layer (Table 2) might be somewhat ambiguous. Nevertheless, it is expected that this powerful trap method will be accepted and widely used by coleopterists to clarify soil-dwelling beetle fauna.

Consideration of the species collected. Most species of the agyrtid genus *Apteroloma* are less wet-adapted and generally found in forests or open habitats, with the exception that some species are common along snow-runoff streams in alpine habitats (NEWTON, 2005). Little is known about the habitat of *Apteroloma discicolle discicolle*. This species is alate but usually found under stones at high elevation (e.g., LEWIS, 1893). Further, it has been reported that this species is abundant under debris accumulated in gutters along newly constructed mountain roads in a montane zone during a relatively short period of a few years (NISHIKAWA, 1997). This suggests that the gutters probably played a role as a trap, and the species may also dwell in underground habitats, because the layers of a slope on the mountain-side of the road are often exposed. The present specimen was taken by the trap installed at 50 cm below the surface, and its collecting site, Udatsu-goe at an altitude of 210 m, is unexpectedly lower in elevation than those of the previously recorded sites despite their southern location. If this species' ordinary habitat of lower elevations is limited to underground, this is interesting as an example of habitat isolation, because a study hypothesized that the habitat of agyrtids is ecologically cornered as a result of competition with carabids and silphids (NEWTON, 1997).

Four epigean cholevines were unexpectedly collected from underground habitats; all of cholevines that have hitherto been found from caves of Shikoku were caught by the trap, suggesting that they seem to facultatively inhabit both endogean and hypogean habitats. In addition, some of the cholevines previously found in epigean habitats are expected to be found in such habitats in future investigations. HOSHINA (2006) pointed out that the Japanese *Catops* species described as cavernicolous are not clearly so by a strictly biospeleological definition. Accordingly, we expand HOSHINA's view on such *Catops* species to all Japanese cholevines, which are found in caves but do not exhibit any cave-adapted feature except somewhat reduced eyes (GIACHINO *et al*., 1998).

The distribution of *C. hisamatsui* has been clarified, in contrast to that of other Japanese cave-dwelling *Catops* species; there are 42 known localities of *C. hisamatsui* in Shikoku, and there are 26

in western Honshu (Hiroshima and Okayama Prefectures) (NISHIKAWA & FUJITANI, unpubl. data). This species has been known to feed mainly on bats' fresh droppings and guano, but sometimes they feed on decaying dead small animals (OKUSHIMA, 1994, as *C. ohbayashii*; NISHIKAWA & FUJITANI, unpubl. observation). From the viewpoint of its main food resource, it is expected that *C. hisamatsui* occurs widely in Shikoku, where there are transversely ranged limestone areas with many caves inhabited by bats (except for Kagawa Prefecture; Fig. 3). Wideness in habitat use (see Table 2) and a possible high dispersal ability (incidental dispersal by flight is surmised from NISHIKAWA *et al*., 2011) of the species might promote expansion in its distribution.

The two types of collecting sites (see Table 1) may correspond to a variation in the depth of the upper hypogean zone, as we hypothesized in the Introduction. However, based solely on the present results, it is not clear whether the difference between the two types of collecting sites depends on underground conditions.

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要　　約

西川正明・林　靖彦・吉田正隆・藤谷美文：四国東部における地下のツヤシデムシとチビシデムシ相（コウチュウ目ツヤシデムシ科，タマキノコムシ科チビシデムシ亜科），および日本産チビシデムシ数種の生息場所の多様性．―― 地下ベートトラップを使用して得られた，四国東部産のツヤシデムシ科及びチビシデムシ亜科甲虫9種を，トラップの地表からの設置距離，ベートの種類のデータを付して報告した．なお，地下ベートトラップ法は，著者の１人の吉田によって独自に考案されたものなので，トラップ本体と設置の実際についてを詳細に記し，このトラップの効果を論じた．さらに，地下から得られている日本産チビシデムシの生息場所の多様性を表3にまとめ，この調査で新たに得られた知見と課題を示した．また，シコクチビシデムシを例として四国の洞窟に居住するチビシデムシの分散を論じた．

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Appendix 1. List of localities of *Catops hisamatsui* in Shikoku according to the literature.
Localities within a prefecture are arranged from north to south and from west to east. Geographic coordinates and the synonymous name of a cave are indicated in brackets. Sources are indicated in parentheses.

Ehime Pref.:

Kuroiwa-dô Cave [ca. 33.6157°N 132.9686°E; 400 m in alt.] (Ishikawa, 1954, as *Catops* sp.; Hayashi, 1985, as the type locality of *Catops hisamatsui* Y. Hayashi).

Odamiyama [ca. 33.5359°N 132.8908°E] (Harusawa & Yamamoto, 2000).

Hondani [ca. 33.5300°N 132.8436°E] (Harusawa & Yamamoto, 2000).

Rakan-ana Cave [ca. 33.4889°N 132.8375°E; 720 m in alt.] (Kawasawa, 1969, as *C. ohbayashii*; Harusawa & Yamamoto, 2000).

Ryu'un-shônyudô Cave [closed at present; ca. 33.4314°N 132.6637°E] (Hayashi, 1985).

Anagami-shônyûdô Cave [=Anagami-dô; ca. 33.3840°N 132.8180°E] (Hayashi, 1985).

Ana-no-gozen Cave [ca. 33.3346°N 132.5236°E; 250 m in alt.] (Ishikawa. 1954, as *Catops* sp.).

Tokushima Pref.:

Zenjô-kutsu Cave [=Senjô-no-kutsu or Kanjô-no-kutsu; ca. 33.9462°N 134.4302°E; ca. 650 m in alt.] (Kiuchi & Yoshida, 1969, as *C. ohbayashii*).

Hobashira-no-iwaya Cave [ca. 33.9461°N 134.4309°E; ca. 650 m in alt.] (Kiuchi and Yoshida 1969, as *C. ohbayashii*).

Ryû-no-iwaya Cave [ca. 33.8812°N 134.5418°E; 200 m in alt.] (Kiuchi & Yoshida, 1969, as *C. ohbayashii*).

Ryû-no-iwaya Cave [ca. 33.8743°N 134.5490°E; 470 m in alt.] (Ishikawa, 1954, as *Catops* sp.).

Myôjin-daiichi-dô Cave [=Myôjin-no-kutsu; ca. 33.8645°N 134.2611°E; ca. 650 m in alt.] (Kiuchi & Yoshida, 1969, as *C. ohbayashii*).

Myôjin-daini-dô [ca. 33.8637°N 134.2620°E; ca. 600 m in alt.] (Kiuchi & Yoshida, 1969, as *C. ohbayashii*).

Tôgen-daiichidô Cave [ca. 33.8599°N 134.2792°E] (KAWANO *et al*. 1971, as *C. ohbayashii*).
Tôgen-daisandô Cave [ca. 33.8596°N 134.2800°E] (KAWANO *et al*. 1971, as *C. ohbayashii*). Gongen-dô Cave [ca. 33.8274°N 134.2821°E; ca. 560 m in alt.] (KIUCHI & YOSHIDA, 1969, as *C. ohbayashii*).
Himise-dô Cave [ca. 33.8078°N 134.3435°E; ca. 300 m in alt.] (KIUCHI & YOSHIDA, 1969, as *C. ohbayashii*).
Oriu-daini-dô Cave [ca. 33.7776°N 134.1371°E; ca. 600 m in alt.] (KIUCHI & YOSHIDA, 1969, as *C. ohbayashii*).
Kochi Pref.:
Ganigoe-no-kin'udô Cave [ca. 33.6355°N 133.5772°E; 350 m in alt.] (HAYASHI, 1985).
Nishimata-dô Cave [ca. 33.6852°N 133.7280°E; ca. 500 m in alt.] (SONE & KAWASAWA, 1999, as *C. ohbayashii*).
Shiroiwa-no-ana Cave [ca. 33.6450°N 133.6702°E; 320 m in alt.] (KAWASAWA *et al*., 1978).
Tengyôji-dô Cave [=Tanuki-ana; destroyed; ca. 33.6401°N 133.6549°E; ca. 320 m in alt.] (KAWASAWA et al., 1978).
Miyanotani-no-kanaudô Mine [ca. 33.1723°N 132.9881°E] (HAYASHI, 1985).
Tadenokawa−Nakamura [ca. 32.9984°N 132.9349°E; 8 m in alt.]−Shimoda, Kochi Pref. (NISHIKAWA *et al*., 2011).

Appendix 2.

List of specimens examined of *Catops hisamatsui* from Shikoku other than those of the present investigation. Localities within a prefecture are arranged from north to south and from west to east.

Ehime Pref.: 1 ♀, Tamatani-machi [ca. 33.8966°N 132.8467°E], Matsuyama-shi, 23–IV–2002, T. KURIHARA leg. (EUM); 1 ♂, Komi [ca. 33.8535°N 133.2871°E], Yamadani-mura, 2–X–1994, L. LI leg. (EUM); 4 ♂♂, 5 ♀♀, Kuroiwa-dô Cave [ca. 33.6157°N 132.9686°E] Mikawa-mura, Kamiukiana-gun, 10–II–1992, H. KARUBE leg. (MNC); 1 ♂, 1 ♀, same locality, 3–V–2004, H. KAMEZAWA leg. (MNC); 1 ♂, Rakan-ana Cave [ca. 33.4889°N 132.8375°E], Higashiuwa-gun, Nomura-chô, 8–IX–1996, T. BEPPU leg. (MNC); 1 ♂, same locality, 24–IX–1997, T. SHIMADA leg. (YFC); 2 ♂♂, same locality, 2–V–2004, H. KAMEZAWA leg. (CMN); 71 ♂♂, 75 ♀♀, same locality, 23–IX–2008, Y. FUJITANI leg. (YFC); 1 ♀, Ônogahara [ca. 33.4785°N 132.8758°E], Beech forest, 6–X–1984, Y. HONDA leg. (EUM); 2 ♂♂, 3 ♀♀, Kurosegawa-dô Cave [ca. 33.3778°N 132.7363°E], Shirokawa, 19–II–1992, H. KARUBE leg. (MNC).

Tokushima Pref.: 1 ♀, Mt. Tônomaru, 1500 m in alt. [ca. 33.8704°N 134.0628°E], Kuwadaira, Ichiu, Tsurugi-chô, Mima-gun, 23–V～31–VII–2010, M. YOSHIDA leg. (fowl trap) (MYC); 1 ♂, Mt. Maruzasa-yama, 1,410 m in alt. [ca. 33.8689°N 134.0862°E], Tsuzurô, Ichiu, Tsurugi-chô, Mima-gun, 11–VI～6–VIII–2000, M. YOSHIDA leg. (fowl trap) (MYC).

Kochi Pref.: 5 ♂♂, 6 ♀♀, Kurumaba-dô Cave [32.4019°N 132.8841°E; 524 m], Miyanono, Yusuhara, 17 ～ 18–II–1992, H. KARUBE leg. (MNC); 1 ♀, Wakamiya [ca. 33.6505°N 133.6765°E], Tosayamada, 3–XI–1999, T. BEPPU leg. (MNC); 5 ♂♂, 1 ♀ (incl. teneral 2 ♂♂), Ishida-dô Cave [ca. 33.5224°N 133.3754°E; 92 m], Hidaka-mura, Takaoka-gun, 23–IV–1992, Y. ITO leg. (MNC).