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The Cave Beetles from Akiyoshi-dai Karst and its Vicinities
I. A New Species of the Genus *Trechiama*[1)]

By

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At the western end of the Island of Honshu, there is a limestone plateau called Akiyoshi-dai. This is a famous karst which is the greatest and most beautiful in the Japanese Islands. The name Akiyoshi-dai has been indifferently used to all the limestone area in the Akiyoshi district. Strictly, however, it indicates a limestone plateau which is limited by the Ohta-gawa River in the east and by the Kôtô-gawa River in the west. At the south-west beyond the latter river, there lies another limestone plateau called Amagoi-dai. The whole Akiyoshi limestone area occupies about 130 sq. km. and extends circa 17 km in length of the NE–SW direction. It is natural that numerous limestone caves are found in this area. More than thirty of them have been investigated biologically up to the present, including the largest caves and deepest potholes hitherto known in the Japanese Islands.

Apart from the Akiyoshi limestone area, there are found several smaller limestone massifs in the neighbouring regions. Of these, the Zômeki limestone area, that lies on the right side of the Abu-gawa River about 20 km north-east of Akiyoshi-dai Karst, is fairly large, though there are known only a few limestone caves in this area. Finally, two limestone caves are known in Yamaguchi Prefecture to be formed in two small isolated blocks of limestone, one of which is situated in the Abu-gawa drainage area and the other in the Nishiki-gawa drainage area.

In this series of papers, the writer will enumerate the cave beetles of the Akiyoshi limestone area and its vicinities. The materials used in this study were obtained during a series of systematic surveys carried on chiefly by the present writer himself and partly by the members of the Spelaeological Society of Japan.

The writer wishes to express his hearty thanks to Prof. Kenji NAKAMURA of Kyoto University, under whose supervision the present work is carried on. Special thanks are due to Mr. Ichiro ETO of Akiyoshi as well as to the authorities of the tourist bureaus in the towns of Shûhô-chô and Mitô-chô, whose kind aids greatly facilitate the writer's investigations of the cave fauna of this district. He also wishes to acknowledge his indebtedness to the following colleagues and friends, who aided

1) Contribution No. 10 from the Spelaeological Society of Japan ; Results of the Akiyoshi Expedition 1956 of the Spelaeological Society of Japan, No. 1.

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Trechiama (s. str.) **pluto** S. UÉNO, sp. nov.

Trechus (*Trechiama*) *pluto* S. UÉNO, 1953 (in litt.), Shin Konchû, Tokyo, **6** (11), p. 44.
Trechus (*Trechiama*) *proserpina* S. UÉNO, 1953 (in litt.), Shin Konchû, Tokyo, **6** (11), p. 44; locality of the chirotype: Taishô-dô Cave in the Akiyoshi limestone area.

Length: 6.0–7.2 mm (from front margin of clypeus to anal end).

Body large in size, glabrous and depigmented. Colour reddish brown to dark reddish brown, shiny, translucent when alive; palpi and apical half of antennae yellowish brown; legs light reddish brown.

Head relatively elongate, widest at the level of the trace of eyes or more in front, so that the anterior parts of genae are nearly parallel or slightly convergent behind; frontal furrows deep and entire, not strongly curved nor angulate at middle, not widely divergent in front and fairly distant from one another; both supraorbital areas and front moderately convex; vertex well convex, limited anteriorly by a linear transverse depression which exists between frontal furrows; neck wide; eyes obliterated, the trace of them perceptible by a patch which is found behind the insertion of each antenna; genae glabrous, not expanding outwards; neck constriction fairly deep on the lateral sides; microsculpture composed mostly of wide meshes and partly of isodiametric reticulation; mandibles long and slender, slightly hooked at apices; mentum tooth large and wide, emarginate or slightly bifid at the tip, or at least distinctly truncated at the extremity; ligula rounded at apex; palpi very slender, with thin apical segments; antennae long and slender, reaching apical one-third of elytra, with segment 3 a little more than twice as long as segment 2 and a little longer than segment 4.

Pronotum cordate and convex, about 1.45 times wider than head (the ratio variable to some extent according to individuals; its range is 1.39–1.47), usually a little wider than long but sometimes as wide as long, widest at about three-fourths from base; lateral sides moderately reflexed, with marginal gutters fairly wide before the widest part but becoming narrower posteriorly, rather strongly rounded in front and deeply sinuate behind (the curvature of lateral sides variable according to individuals); present both lateral and postangular setae, of which the former is placed at or a little behind the widest part and the latter removed a short distance before hind angle; apex slightly but widely emarginate, distinctly wider than base, i.e. 1.1–1.2 times wider than the latter[2]; front angles somewhat advanced and widely rounded; hind angles remarkably acute, well projecting both outwards and backwards; base slightly bisinuate; median line distinct, not reaching

2) The individual variation in the ratio of pronotal apex to its base is caused from the difference in the shapes of pronotal hind angles.

apex but widening near base; apical transverse impression shallow, provided with longitudinal striations; basal transverse impression very deep, wide and regularly arcuate, provided with a small longitudinal fovea on each side of median line and merging on each side into basal fovea, which is very deep, relatively small and

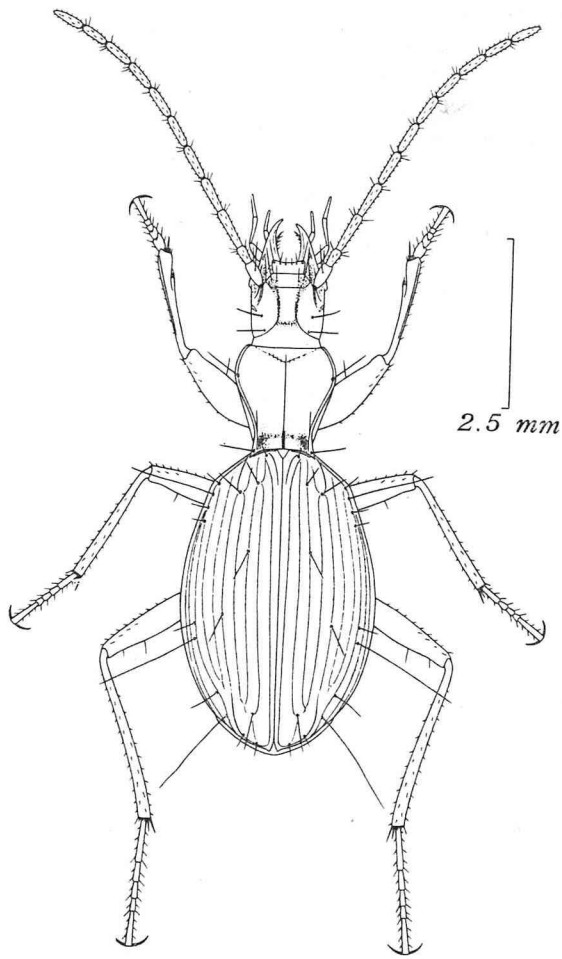


Fig. 1. *Trechiama* (s. str.) *pluto* sp. nov., f. typ., ♂, of Nakao-dô Cave.

extending anteriorly parallel with the side border; postangular carina long and moderately prominent; surface smooth, with vague transverse striations; microsculpture formed by fine transverse lines though not sharply impressed. Ventrolateral sides of prothorax expanding outwards and visible from above.

Elytra oblong-ovate and well convex, 1.75–1.85 times wider than pronotum, 1.5–1.6 times longer than wide, widest at about or a little behind middle; shoulders distinct though rounded; prehumeral borders oblique, nearly straight or very slightly emarginate; lateral sides rather widely explanate and reflexed, slightly emarginate behind shoulders, moderately rounded at middle and slightly emarginate again before apices, each one of which is usually produced as a denticle but sometimes subangulate or even rounded according to individuals; striae fairly deep throughout and evidently crenulate, stria 5 deepening near base; scutellar striole fairly long and deep; apical striole deep and not strongly curved, directed to or beyond the termination of stria 5; intervals slightly convex, the basal part of interval 5 somewhat raised though not forming a distinct carina; apical carina salient; stria 3 with two dorsal pores situated at one-tenth to one-ninth and about one-third from base respectively, preapical pore inserted at the meeting point of striae 2 and 3, stria 5 with two dorsal pores[3] placed at about one-seventh from base and a little behind middle respectively (the position of all these dorsal pores variable considerably according to individuals); microsculpture composed of fine transverse lines but nearly obliterated.

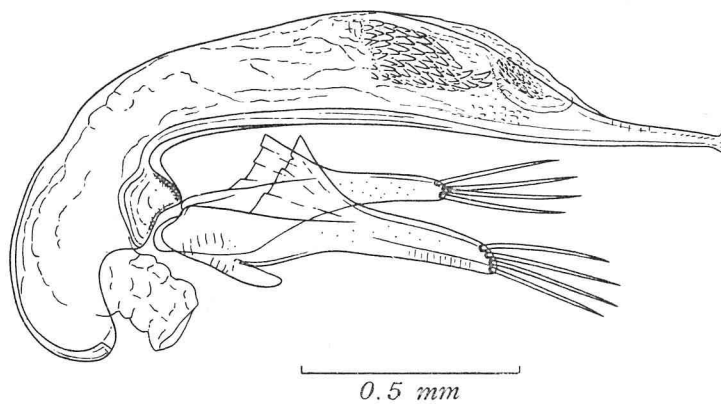


Fig. 2. Male genital organ of *Trechiama pluto* sp. nov., f. typ., of Nakao-dô Cave; left lateral view.

Ventral surface glabrous; each metacoxa with a row of setae; anal sternite provided usually with two setae on each side in the two sexes, sometimes (in the two sexes) with two setae on one side and three setae on the other side or with three setae on each side, and rarely (in ♂) with one seta on one side and two setae on the other side. Legs long and slender; protibiae deeply grooved on the external face; in ♂, segments 1 and 2 of each protarsus widely dilated and sharply produced inwards at apices.

3) In one of the type-specimens, the second dorsal pore on the fifth stria is missing on its right elytron.

Male genital organ well chitinized. Aedeagus elongate, with the basal part strongly bending towards ventral side; apex prolonged into a long beak, which is somewhat bending towards the left side and dorsally hooked at the extremity; basal part large and elongate, without sagittal aileron; lateral sides of basal orifice deeply emarginate; ventral side only slightly concave at middle. Inner sac without developed copulatory piece but with two groups of large teeth; the apical one of these two groups is compact and placed close to apical orifice; the basal group of large teeth is relatively loose, covering the left wall of the sac at a little behind middle. Styles fairly long, left style obviously wider and longer than right style, each provided with four setae at apex (rarely five setae present on one style).

Description of Mature Larva: Length: 8.4 mm (from apex of clypeal lobe to the tip of anal tube).

Body elongate and weak, with head and pronotum moderately chitinized; appendages remarkably long and slender. Colour white and translucent; head, cephalic appendages and pronotum light reddish brown.

Head moderately elongate, with lateral sides nearly parallel; neck slightly constricted; integument covered with coarse reticulation, which becomes somewhat indistinct on the disk; present on each lateral face two longitudinal carinae, of which the ventral one continues from mandibular fossa to basal foramen; cranial sutures not deeply sinuate, forming a relatively sharp angle at their meeting point; ocelli entirely absent. Clypeal lobe well projecting, indistinctly trilobed and declining anteriorly from the level of its base; median lobe subtrapezoid, with the apical margin minutely serrate; each lateral lobe provided with 6 denticles, the outer ones of which are obviously larger than the inner ones. Mandibles long and well arcuate, with retinacles prominent and hooked. Maxillae long and slender; stipes

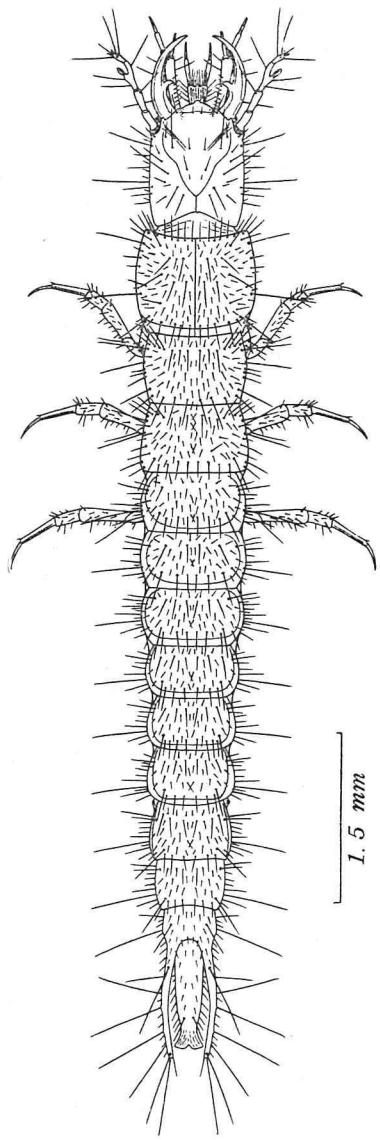


Fig. 3. *Trechiama* (s. str.) *pluto* sp. nov., f. typ., mature larva, of Kômori-ana Cave.

remarkably long, about 7 times longer than median width; galea slender, with apical segment nearly as long as basal segment but only a half as wide as the latter; maxillary palpus of five segments, of which two proximal segments are distinctly larger than the rest; segment 1 globular; segment 2 very long, nearly as long as segments 3–5 together; segment 3 a little shorter than segments 4–5 together; segment 5 shortest, though about 4 times longer than wide. Labium subtrapezoid, contracted basally and evidently longer than wide; labial palpus long and slender, of four segments; basal segment long, more than 5 times longer than wide, evidently longer than segments 2–4 together and fully 2.5 times wider than segment 2; segment 4 longer than segment 3 but much shorter and narrower than segment 2. Antennae long and slender, of four segments; segment 2 a little longer than segment 1 and about 2.5 times longer than wide; segment 3 elongate, nearly 3 times longer than wide; apical segment about a half as long as segment 3 and more than 3 times longer than wide.

Prothorax transverse, distinctly wider than head and much shorter than meso- and metathoraces together; lateral sides gently rounded; apex widely emarginate. Scuta pubescent. Legs remarkably long and slender; femur fully 3.5 times longer than median width and a little more than twice as long as tibia; tarsus a little shorter than femur and more than 7 times longer than median width; claw slender and arcuate. Abdominal segments, anal tube and cerci pubescent. Anal tube long, about 4 times longer than basal width and gradually narrowing towards anal orifice, which forms a shape of Y. Cerci extremely slender and a little longer than anal tube, about 18 times longer than median width.

Type-specimens: Described on 17 specimens (16 adults and 1 larva), which were obtained in 8 different limestone caves. They are as listed below.

Holotype: ♂ (Nakao-dô Cave, 17–X–1955, collected by S. UÉNO). Allotype: ♀ (Nakao-dô Cave, 16–VIII–1952, by S. UÉNO). Paratypes: 3♂♂ (Nakao-dô Cave, 16–VIII–1952, by S. UÉNO); 1♂ (Nakao-dô Cave, 17–X–1955, by S. UÉNO); 1♀ (Nakao-dô Cave, 24–XI–1956, by G. IMADATÉ); 1♂ (Nakao-no-nishi-no-ana Cave, 17–X–1955, by S. UÉNO); 1♂ (Taishô-dô Cave, 15–VIII–1952, by S. UÉNO) (the chirotype of *Trechus* (*Trechiama*) *proserpina* S. UÉNO, MS.); 1♀ (Taishô-dô Cave, 13–VII–1956, by S. UÉNO); 1♂ (Suzumé-ana Cave, 14–VI–1956, by S. ANNO); 1♀ (Tanuki-ana Cave, 25–XI–1956, by K. MORIKAWA); 1♂ (Akiyoshi-dô Cave, 12–VIII–1952, by S. UÉNO); 2♂♂, 1♀ (Ohkubo-no-kômori-ana Cave, 15–VII–1956, by S. UÉNO); 1 mature larva (Kômori-ana Cave, 15–VIII–1952, by S. UÉNO).

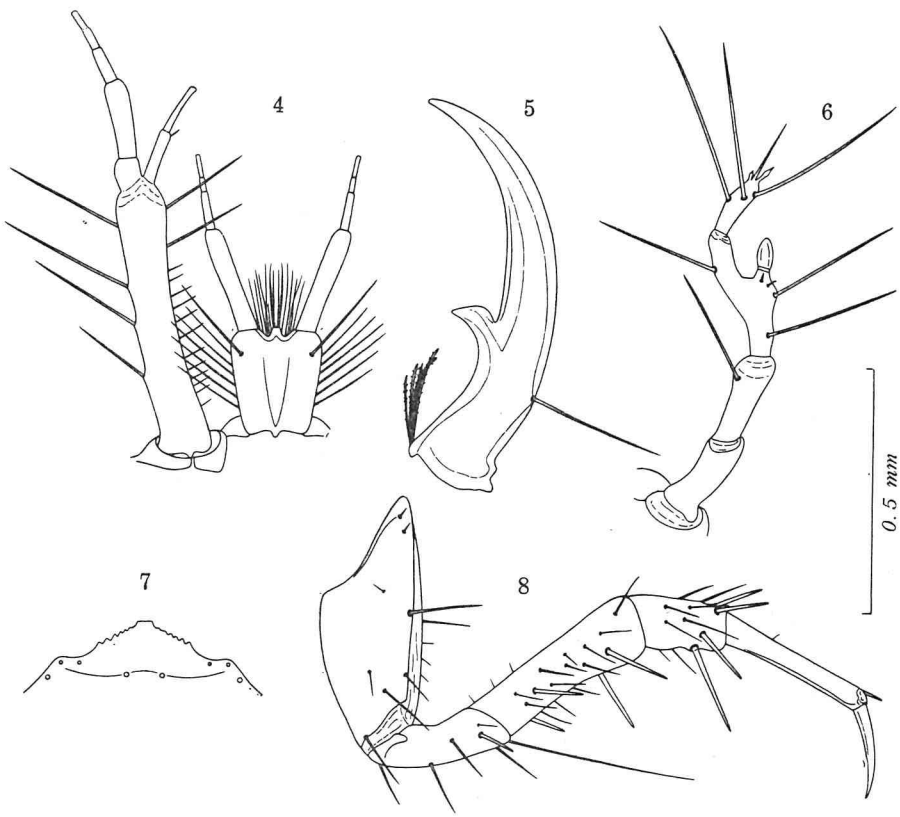
All the type-specimens are deposited in the writer's collection.

Type-localities: Two limestone caves called "Nakao-dô" and "Nakao-no-nishi-no-ana" at Aokagé-dai, Kyôwa, Shûhô-chô; a limestone cave called "Taishô-dô", at Sayama, Akagô, Mitô-chô; two limestone caves called "Suzumé-ana" and "Tanuki-ana", at Akiyoshi-dai Karst; two limestone caves called "Akiyoshi-dô"[4]

4) Sometimes called "Shûhô-dô" or "Taki-ana".

and "Kômori-ana", at Hirotani, Akiyoshi, Shûhô-chô; a limestone cave called "Ohkubo-no-kômori-ana"[5], at Ohkubo, Ohta, Mitô-chô; all in the Akiyoshi limestone area, north-east of the Kôtô-gawa River, in Yamaguchi Prefecture, western Honshu.

The present new species is the largest trechid hitherto known from Japan. It resembles *Ishikawatrechus* in its appearance and constitutes a special group within the subgenus *Trechiama* (s. str.). Its closest relative may be the group of



Figs. 4–8. *Trechiama* (s. str.) *pluto* sp. nov., f. typ., mature larva, of Kômori-ana Cave.—4. Right maxilla and labium, ventral view.—5. Right mandible, dorsal view.—6. Right antenna, dorsal view.—7. Clypeal lobe, dorsal view.—8. Right front leg, posterior face.

5) Sometimes called "Hirabara-no-ana".

Trechiama ohshimai, from which it may easily be distinguished by the peculiar shapes of pronotum and elytra as well as by the number of sexual setae on the anal sternite in the male. Further, the adaptation to cave life in the present species is more progressed than in the species belonging to the group of *T. ohshimai*.

Trechiama pluto is not abundant anywhere in its range, and is usually found under stones or rotten logs in the depths of limestone caves. An individual of it was, however, found among the roots of Sasa-bamboo thicket at the threshold of Ohkubo-no-kômori-ana Cave. This seems to be an exceptional case, but the second instance, that the beetle was found at the twilight zone in Suzumé-ana Cave, may not be unusual. The latter individual was taken in a certain depth of soil at a palaeontological excavation. Though the sunlight penetrates into the station through the large entrance of the cave, the habitat of the insect is certainly dark and wet as in the dark zone.

When the present writer published a preliminary list of the cave trechids of Japan[6], he was not acquainted with the variability of this species. He distinguished three species within the group of *T. pluto* and suggested the names *T. pluto*, *T. proserpina* and *T. kanekiyo* for them. Since then, however, it has been gradually revealed that the *Trechiama*-species found in the Akiyoshi limestone area is extremely variable in appearance, in the curvature of pronotal lateral sides, in the position of setiferous dorsal pores on elytra, in the shape of elytral apex and even in the number of sexual setae on the anal sternite. It was unfortunate that the chirotype of *T. proserpina* was at an extremity of the range of individual variation, but the accurate position of the specimen was barely clarified after a careful examination of the recent collections. At present, there remains hardly any doubt that the chirotype of *T. proserpina* is no more than a small slender individual of *T. pluto*, though the writer has failed to reobtain any of the fresh individuals identical with the chirotype.

As for the specimens, for which the writer suggested the name *Trechus kanekiyo*, they may as well be regarded as conspecific with *T. pluto*. They are, however, different in some features from the typical form of the latter species. The writer is, therefore, of the opinion at present that the specimens may form a distinct subspecies, the description of which will be given on the following page.

No adult specimen of this new trechid has been taken in Kômori-ana Cave, notwithstanding the repeated careful surveys made by the present writer and his collaborators. There seems, however, not to be any doubt that the larval specimen, which was found under a large stone in the depth of Kômori-ana Cave, may be the larva of *T. pluto* (f. typ.). The filiation may be understood both from its large size and from the distributional pattern of the cave trechids in the Akiyoshi limestone area.

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6) S. UÉNO, 1953, Shin Konchû, Tokyo, **6** (11), pp. 44-45.

Trechiama (s. str.) **pluto kanekiyo** S. UÉNO, subsp. nov.

Trechus (*Trechiama*) *kanekiyo* S. UÉNO, 1953 (in litt.), Shin Konchû, Tokyo, **6** (11), p. 44.

Distinguished from the typical form chiefly by the absence of the proximal one of dorsal pores on elytral stria 3.

Body form similar to that of the small slender individuals of the typical form; length: 6.0–6.6 mm (from front margin of clypeus to anal end). Pronotum relatively narrow, with lateral sides moderately rounded in front, about 1.45 times wider than head and about as wide as long; apex a little narrower than that in the typical form, 1.05–1.1 times wider than base. Elytra with shoulders less prominent and more widely rounded, prehumeral borders more oblique than those in the typical form; apex always angulate and produced as a denticle; stria 3 with a single dorsal pore at about one-third from base, proximal pore always absent; in the holotype, a second dorsal pore present on right elytron at about middle of stria 3; in one of the paratypes from Hanaji-no-oh-ana Cave, an additional dorsal pore present on stria 3 of left elytron at about two-thirds from base; stria 5 with two dorsal pores as in the typical form. Anal sternite with one or two setae on each side in ♂. Male genital organ similar to that of the typical form.

Female unknown.

Type-specimens: Described on 4 specimens, which were obtained in 2 different limestone caves.

Holotype: ♂ (Kanekiyo-ana Cave, 17–VIII–1952, collected by S. UÉNO). Paratypes: 1♂ (Kanekiyo-ana Cave, 17–VIII–1952, by M. UOZUMI); 2♂♂ (Hanaji-no-oh-ana Cave, 18–VIII–1952, by S. UÉNO and M. UOZUMI).

All the type-specimens are preserved in the writer's collection.

Type-localities: A limestone cave called "Kanekiyo-ana", at Katata, Beppu, Shûhô-chô, and a limestone cave called "Hanaji-no-oh-ana", at Kawara, Isa, Miné City; both the caves are situated in the Akiyoshi limestone area, south-west of the Kôtô-gawa River, in Yamaguchi Prefecture, western Honshu.

This new subspecies appears to be rare. The writer and his colleagues investigated Kanekiyo-ana Cave for three times, viz. on August 17th, 1952, October 17th, 1955, and November 24th, 1956, but they succeeded to obtain two individuals of the beetle only once on their first visit. They were found under decayed rice straw which was brought in the cave from the outside and left on the muddy floor in its depth. In Hanaji-no-oh-ana Cave, only two teneral individuals were taken in spite of their great efforts. They were walking on the wet stalagmitic wall of a narrow winding corridor.

It is interesting that the Kôtô-gawa River, which runs through the Akiyoshi limestone area and does not prevent the disperal of *Rakantrechus etoi*[7], appears to be a barrier to the distribution of *T. pluto*. The river has isolated the species into two different subspecies, of which the one, the typical form, spreads over the north-eastern part of the river and the other, *T. pluto kanekiyo*, over the south-western part of it.

7) The description of this new species will be given in the second part of this series of papers.