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Description of a New Species Allied to *Leptocarabus procerulus* (Chaudoir) (Coleoptera, Carabidae), with Notes on the Taxonomy of the Related Species

Kinji Kimura

17–8, Kitashinagawa 5, Shinagawa-ku, Tokyo 140, Japan

and

Jirô Komiya

18–9, Takanawa 4, Minato-ku, Tokyo 108, Japan

Synopsis As a result of a comparative study of the male and female copulatory organs, *Leptocarabus procerulus*, one of the commonest and wide ranging carabids of Japan, has been proved to comprise two distinct species: *L. procerulus* and *L. kumagaii* sp. nov. which is described in this paper. Relationships among the related species of Japan are also discussed from this point of view.

In the taxonomy of the subtribe Carabina in the family Carabidae, the male genitalic features are used as diagnostic characters of primary importance. In certain groups, the endophallus of the male copulatory organ bears a chitinized appendage, which is particularly well developed in the species belonging to the subgenus *Ohomopterus* (genus *Carabus*) and called "copulatory piece", the shape of which is characteristic of each species or subspecies. However, in the species belonging to the genus *Leptocarabus* and its allies, the copulatory piece is absent, and therefore, the structure of the endophallus of aedeagus has attracted little attention. The female characters of the external genitalia have never been used for the taxonomy of *Leptocarabus*.

Upon examining a good series of specimens of *Leptocarabus procerulus* and its allied species collected at many localities in Japan, we noticed that one of the endophallic structures which Kurnakov (1959) named "aggonoporius", and the inner plate of the vaginal apophysis of the female external genitalia (see Ishikawa, 1972), both the characters almost completely overlooked by former workers, could be used for taxonomic characters at the specific level. In this respect, the taxonomic treatment proposed by Ishikawa (1962, 1966) as to the specific rank in the subgenus *Leptocarabus* agrees in general to that based upon the above mentioned characters, except that *L. procerulus* comprises two distinct species, one of which is apparently undescribed.

In the present paper, a description for the new species is given, with notes on these genitalic structures as diagnostic characters for the species of *Leptocarabus*. Here, *Leptocarabus* is treated as a full genus, because it was excluded from the genus

Carabus by ISHIKAWA (1973), and *Adelocarabus* is assigned to *Leptocarabus* as a subgenus.

Before going further, we express our sincere gratitude to Dr. Ryôsuke ISHIKAWA of the National Science Museum (Natural History Institute), Tokyo, for his guidance and advice not only in the course of the present work but also in all the way of our entomological studies. We are also indebted to Mr. Kyôichi NISHIKAWA, Tokyo, Mr. Kentaro NAKATOMI, Tokyo, and Mr. Hideki ISHIZUKA, Tokyo, who offered a number of valuable specimens with useful data for our studies. As to the reference as well as to the material, we owe to Mr. Terutsune ABE, Tokyo, Mr. Takashi OKUMURA, Yokohama, and Mr. Kuniaki SUGA, Tokyo, the co-workers in the study of Carabidae.

Leptocarabus kumagaii KIMURA et KOMIYA, sp. nov.

Carabus (*Leptocarabus*) *procerulus procerulus*: NAKANE, 1962 (in part), Ins. Jap. Carabidae 1, pp. 52–53, 84, 86.

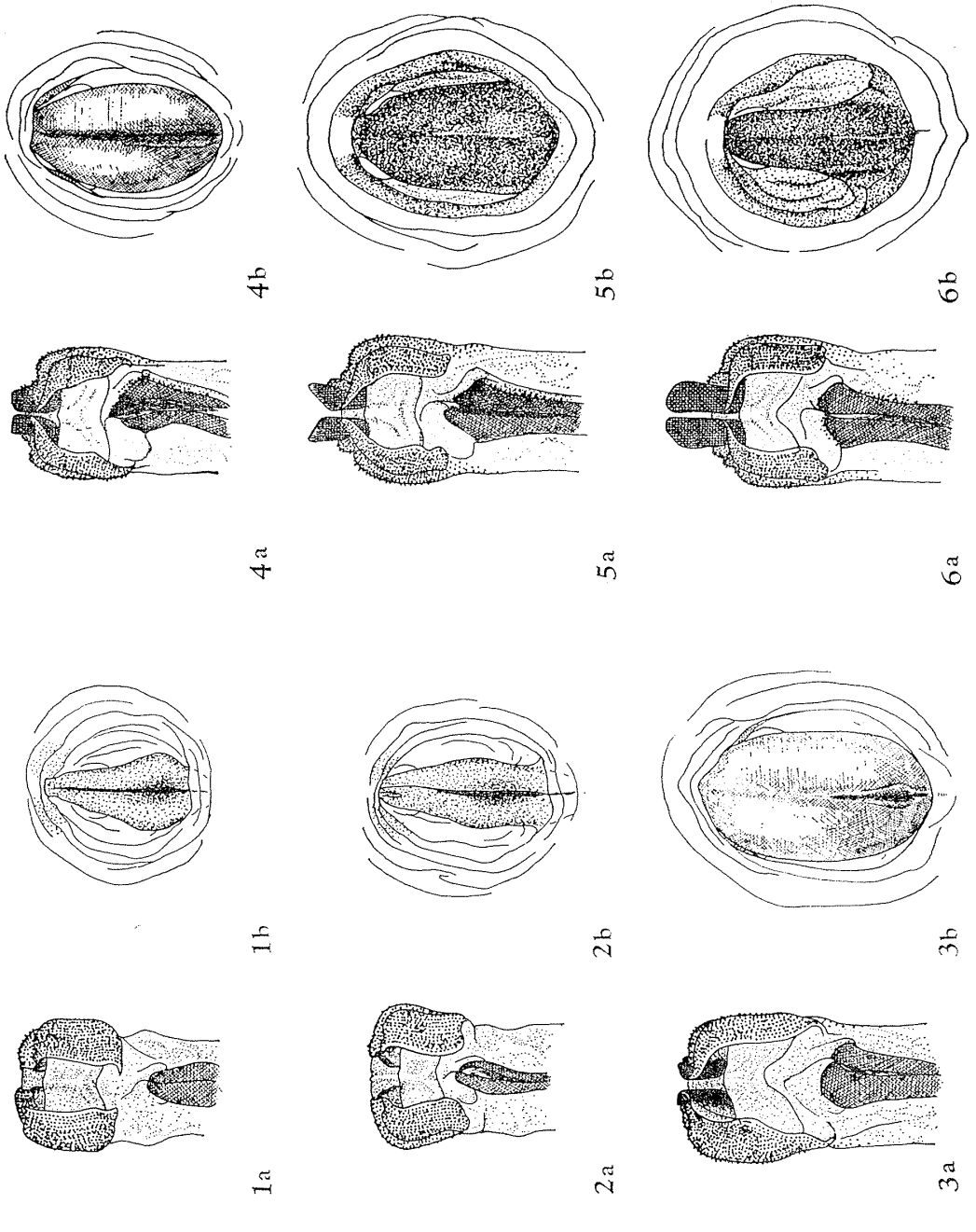
Carabus (*Leptocarabus*) *procerulus*: ISHIKAWA, 1962 (in part), Kontyû, Tokyo, **30**: 110, 113, figs. 11, 12.

This new species is very closely similar to *L. procerulus* (CHAUDOIR, 1862), and they have always been confused with each other. So, it is not possible to distinguish them in the literature unless the specimens on which the records were based can be examined. However, the range of distribution of the present species is more restricted than that of *procerulus*, approximately to the Pacific side of the Chûbu and Kinki Districts of central Honshu. Moreover, the localities where they are sympatric are restricted, so we can guess to which one belongs with a fair degree of accuracy by the localities where the specimens were collected.

Specific characters. Length of body: ♀ 28–36 (mean 32.1) mm. ♂ 28–34 (mean 30.8) mm. Width of elytra: ♀ 10.5–14.5 (mean 12.1) mm. ♂ 10.2–12.5 (mean 11.1) mm.

Body generally larger and broader than *procerulus*, and in this respect it may be compared with *L. kyushuensis cerberus* (ISHIKAWA) and *L. nakatomii* (ISHIKAWA), though differing in the shape of body. In external features, it is barely distinguishable from *procerulus* decidedly, but the most reliable character may be the extension of the granules composing the umbilicate series which in this species are less developed than in *procerulus*, seldom reach near apices of elytra and usually disappear at/or slightly beyond the middle; whereas they extend separately on line near apices in *procerulus*.

Male genitalia. Aedeagus robust and strong; in dorsal view somewhat constricted before median orifice; the opposite side of the membraneous area compressed laterally; end piece compressed dorso-ventrally, with its dorsal surface fairly flat, without a sublateral depression near the membraneous area; the aggonoporius with a pair of well sclerotized lateral lobes termed apical plates which are longer than those of *procerulus*, and tongue-shaped, their apical outer corners broadly rounded



Figs. 1–6. Genitalia of *Leptocarabus*; 1a–6a, apical part of endophallus; 1b–6b, inner plate of vaginal apophysis. —— 1, *Leptocarabus* (*Adelocarabus*) *arboreus* (LEWIS); 2, *L.* (*A.*) *exilis* (BATES); 3, *L.* (*L.*) *kyushuensis* (NAKANE); 4, *L.* (*L.*) *hiurai* (KAMIYOSHI et MIZOGUCHI); 5, *L.* (*L.*) *procerulus* (CHAUDOIR); 6, *L.* (*L.*) *kumagaii* KIMURA et KOMIYA, sp. nov.

(Fig. 6 a), but not pointed as in *procerulus* (Fig. 5 a).

Female genitalia. The bottom of the vagina broadly shagreened as in *procerulus*, but the inner plate of the vaginal apophysis distinctly narrower (Fig. 6 a), though strongly sclerotized as in the former.

Distribution. Central Honshu ranging from Hyôgo Prefecture eastward to Shizuoka Prefecture, for the greater part on the Pacific side. The range appears to be subdivided into two parts by the Bay of Ise and the Nôbi Plain where it is replaced by *procerulus*. The eastern range covers the region between Mt. Ashitakayama in the east and Mt. Funatsukiyama in the west, extending northward along the valley of the river Fujigawa to Ichikawadaimon in the Kôfu Basin, Yamanashi Prefecture, and along the valley of the river Tenryûgawa to Tagiri near Iida City, Nagano Prefecture. The western range covers the greater part of the Kii Peninsula and extends northward to Mt. Hyônosen, on the borders between Hyôgo and Tottori Prefectures. In the last mentioned region, *kumagaii* was collected at the same localities together with *kyushuensis nakatomii* and *procerulus*, though it is uncertain if they were found at the same habitats. The sympatry with *procerulus* was confirmed at Mt. Ashitakayama in Shizuoka Prefecture, and at Kôbe City in Hyôgo Prefecture.

This new species is named in memory of our friend, the late Mr. Yukiaki KUMAGAI.

Holotype: ♂ Fujinomiya City, Shizuoka Pref. ii–12, 1961, leg. K. KIMURA (deposited at present in coll. K. KIMURA).

Paratypes: 3 ♀♀, 3 ♂♂, the same data as the holotype; 2 ♀♀, 2 ♂♂, ditto, iii–12, 1961, leg. K. KIMURA; 3 ♂♂, Okuyama, north of Lake Hamanako, Shizuoka Pref. ii–5, 1961, leg. K. KIMURA & S. TSUYUKI; 5 ♀♀, 3 ♂♂, Mt. Funatsukiyama, Aichi Pref. xii–15, 1963, leg. J. KOMIYA; 2 ♀♀, 3 ♂♂, Tagiri, Ina, Nagano Pref. xii–20, 1964, T. OKUMURA; 2 ♀♀, 4 ♂♂, Mt. Shiraiyama, Mie Pref. i–13, 1963, leg. K. KIMURA; 5 ♀♀, 3 ♂♂, ditto, iii–20, 1964, leg. J. KOMIYA; 1 ♀, 5 ♂♂, ditto, ix–20, 1968, leg. K. KIMURA & J. KOMIYA; 3 ♀♀, 4 ♂♂, ditto, iii–16, 1969, leg. K. KIMURA; 2 ♀♀, 4 ♂♂, Mt. Asamayama, nr. Ise City, Mie Pref. ix–24, 1968, leg. K. KIMURA & J. KOMIYA; 6 ♀♀, 1 ♂, Mt. Oishigamine, Wakayama Pref. i–15, 1962, leg. K. KIMURA; 25 ♀♀, 21 ♂♂, Mt. Kintaijiyama, Kawachinagano City, Osaka Pref. i–1, 1969, leg. T. OKUMURA; 26 ♀♀, 32 ♂♂, Mt. Kongôzan, Osaka Pref. xii–10, 1959, leg. R. ISHIKAWA.

Notes on the Relationships among the Species Related to *L. procerulus* Based upon Genitalic Characters

Leptocarabus (*Adelocarabus*) *arboreus* (LEWIS, 1882) (Fig. 1 a, b) and *L.* (*A.*) *exilis* (BATES, 1883) (Fig. 2 a, b)

These two species are very closely related to each other fundamentally as NAKANE (1962) and ISHIKAWA (1962) suggested, and are not distinct specifically from each other. There is no definite difference in genitalic characters between them so far

as we have examined. In the male genitalia, the endophallus of the aedeagus has no chitinized aggonoporius, and in the female ganitalia, the inner plate of the vaginal apophysis is very weakly chitinized and pigmented only along its median line, and is covered with a thin membrane (Fig. 1 b, 2 b).

ISHIKAWA (1972) removed *Carabus arboreus* to the subgenus *Adelocarabus* from the subgenus *Leptocarabus*. He does not particularly remark on the relationship of these species, but we understand that they have been regarded as conspecific.

Fig. 7. Distribution of *Leptocarabus procerulus* (open circles) and *L. kumagaii* (closed circles) in Honshu and Kyushu.

Leptocarabus kyushuensis (NAKANE, 1960) (Fig. 3 a, b)

Aedeagus with the aggonoporius usually distinct though very small and weakly chitinized. Female genitalia with the inner plate of the vaginal apophysis weakly chitinized, leathery, less pigmented and shrunk when dried; the surface of the surrounding, wrinkled membrane less shagreened and rather smooth.

Leptocarabus hiurai (KAMIYOSHI et MIZOGUCHI, 1960) (Fig. 4 a, b)

Aedeagus with the aggonoporius well chitinized laterally, rectangularly truncate apically, but shorter than those of *procerulus*. Female genitalia similar to those of *kyushuensis*.

Leptocarabus kyushuensis and *L. hiurai* are thus closely related to each other, and practically not distinguishable by the female genitalic characters, though sufficiently different in the male genitalic characters. In some other respects, *L. kyushuensis* resembles *arboreus* and *exilis*, while *L. hiurai* is related to *procerulus*, though they are constantly different from each other and considered distinct species as ISHIKAWA stated (1962, 1966).

Leptocarabus procerulus (CHAUDOIR, 1862) and *L. kumagaii* sp. nov.

These two species are nearer to each other than to any other species, but are distinct as their sympatry at certain localities and conspicuous genitalic differences in both sexes show.

Aedeagus with apical plates of the endophallus well chitinized, elongate, their inner margins obliquely truncate in *procerulus* (Fig. 5 a), while they are tongue-shaped in *kumagaii* (Fig. 6 a). Female genitalia with the bottom of the vagina broadly shagreened with the inner plate of the vaginal apophysis evenly, uniformly chitinized, broad oval in *procerulus* (Fig. 5 b), but much narrower in *kumagaii* (Fig. 6 b).

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