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Authors: Tuda, Midori, and Morimoto, Katsura

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A New Species *Megabruchidius sophorae* (Coleoptera, Bruchidae), Feeding on Seeds of *Styphnolobium* (Fabaceae) New to Bruchidae

Midori Tuda[1*] and Katsura Morimoto[2]

[1]*Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka 812-8581, Japan*
[2]*Nata-danchi 20-101, Higashi-ku, Fukuoka 811-0205, Japan*

ABSTRACT—A new species *Megabruchidius sophorae* (Insecta, Coleoptera) is described from Japan (Honshu). The larval host of this bruchid is the seeds of the tree legume 'enju', or chinese scholar tree, *Styphnolobium japonicum* (a senior synonym of *Sophora japonica*), which is a new host genus to Bruchidae. *Styphnolobium* is positioned basally in molecular phylogeny of the leguminous subfamily Papilionoideae. Other members of *Megabruchidius* are known to feed on *Gleditsia*, the tree legumes that belong to the most ancestral subfamily Caesalpinioideae. Therefore, *Megabruchidius* utilizes ancestral groups of legumes as its host plants. *Megabruchidius* has been inferred to be ancestral, based on its behavior. The character state of the host for this third *Megabruchidius* species supports that the genus is ancestral, at least in the subfamily Bruchinae. We also reviewed the genera closely related to *Megabruchidius*, i.e., *Bruchidius* and *Sulcobruchus* in Bruchidini, and wrote a key to the species in the genus *Megabruchidius.*

Key words: *Bruchidius dorsalis*, *Megabruchidius dorsalis*, *Megabruchidius tonkineus*, *Acanthoscelides obtectus*, East Asia

INTRODUCTION

Species of *Megabruchidius* (subfamily Bruchinae: tribe Bruchidini) have been studied extensively in recent years. Their ecology, in terms of behavior in particular, reveals that it is unique in Bruchinae (e.g., Takakura, 1999; Shimada *et al*., 2001). After hatching, the first instar larvae of *Megabruchidius dorsalis* (Fåhraeus) (syn. *Bruchidius dorsalis*) crawl over pods and seed surfaces before boring into them (Shimada et al., 2001). This character state is considered ancestral and known only to this genus in the tribe Bruchidini as well as to species in Acanthoscelidini; *Acanthoscelides obtectus* (Say), *Acanthoscelides prosopoides* (Schaeffer), and *Algarobius prosopis* (LeConte) (Pfaffenberger and Johnson, 1976, p.23) among Bruchinae and the most ancestral subfamily Pachymerinae (Arora, 1978). Males of *M. dorsalis* contribute to female fecundity by providing nutritious secretion during courtship (Takakura, 1999) and females possess extensive accessory glands which are very small in species of Bruchinae and Kytorhininae and large in *A. obtectus* (Takakura, unpublished). *Megabruchidius* species are reported to feed on the seeds of the legumes *Gleditsia* and *Phaseolus*, which have been the only known hosts for the genus (Roelofs, 1880; Zacher, 1952; Wendt, 1980).

The new species *Megabruchidius sophorae* that feeds in seeds of *Styphnolobium japonicum* is described here from Japan. Two genera, *Bruchidius* and *Sulcobruchus*, in the same tribe Bruchidini as the present genus, are reviewed and the key to *Megabruchidius* is redefined.

DESCRIPTION

Megabruchidius sophorae sp. nov.

Black; first four segments of antennae yellowish brown; fore and middle legs except trochanters and coxae, first sternum of abdomen along caudal margin, second to fourth sterna broadly at sides, fifth sternum and pygidium reddish; hind femora often reddish on apical area; pygidium with a pair of ovate dark brown spots on apical third and often with irregular transverse small dark spots on basal third in male; female with a pair of conspicuous ovate blackish depressions in apical part, with setae dark, short, sparse, and visibly bare in contrast to the reddish area with grayish dense setae, and indefinite dark transverse band on basal third (Fig. 1a).

* Corresponding author: Tel. +81-92-642-3038;
FAX. +81-92-642-3040.
E-mail: tuda@grt.kyushu-u.ac.jp

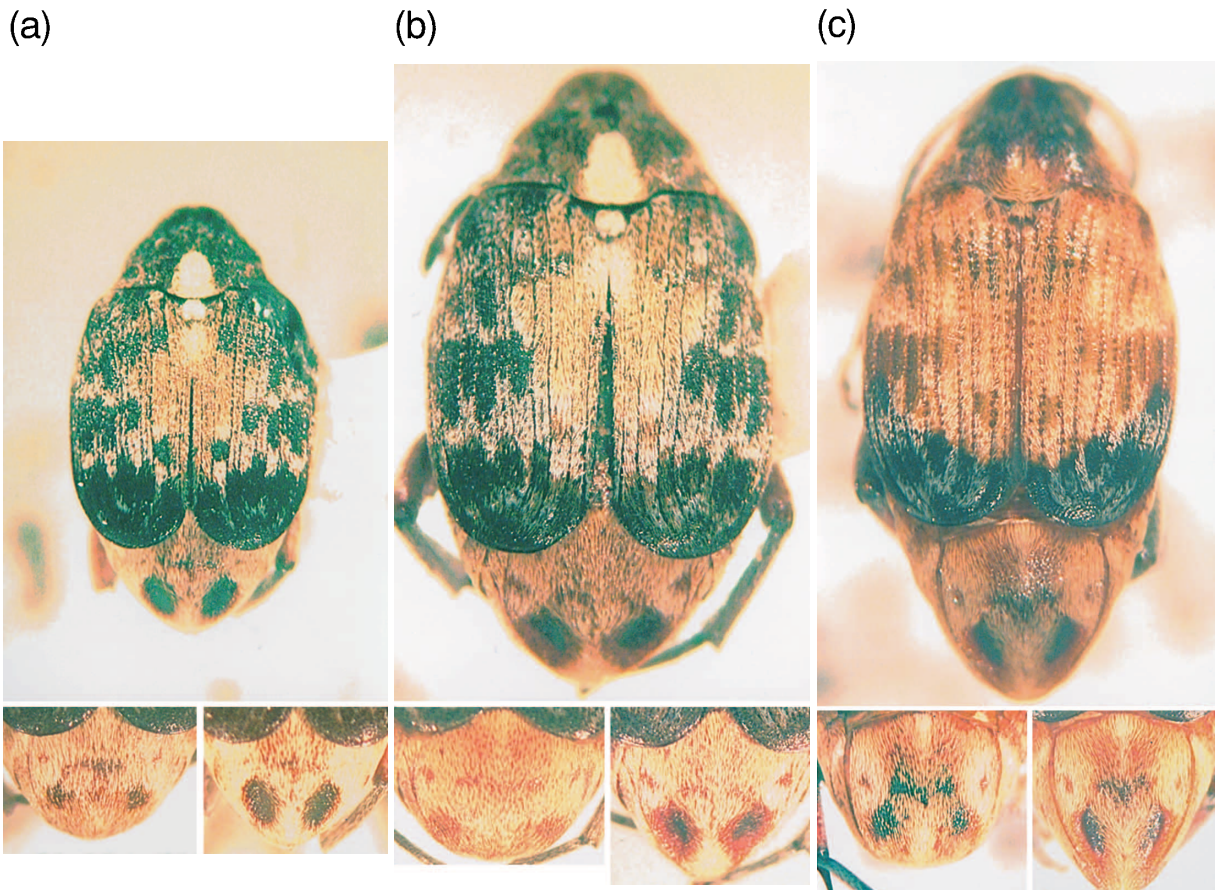

Fig. 1. Dorsal view. (a) *Megabruchidius sophorae*. Lower panel: pygidium of male (left) and female (right). (b) *Megabruchidius dorsalis* (Fåhraeus). Lower panel: pygidium of male (left) and female (right). (c) *Megabruchidius tonkineus* (Pic). Lower panel: pygidium of male (left) and female (right).

Vestiture blackish or brownish black on head, pronotum and elytra, with grayish and whitish patches as follows: head immaculate; pronotum with a definite triangular white antescutellar patch, with a small narrow short white patch in the middle behind anterior margin, with scattered grayish hairs transversely in the middle and longitudinally at sides; scutellum whitish as antescutellar patch; elytra with three grayish bands and large median conjoined brownish gray patch on first to third intervals in elongate hexagonal shape, of which on first interval for entire length, on second interval not reaching the anterior and posterior ends, on third interval fills between the median and posterior bands, patch usually whitish behind scutellum as far as the median band and posterior part on third interval, anterior transverse band oblique from a little behind humerus extending medially to scutellum and enlarged at base on third interval, median band terminates laterally on ninth interval, continued longitudinally with posterior band on fourth interval and often on sixth interval, posterior band zig-zag shaped, pointed anteriorly on fourth, sixth and eighth intervals, often with an additional band in front of apical margin, that is long on third interval, short on the junction of fifth to seventh intervals and on ninth interval; the bands variable in size, in cases when bands broad two black ovate patches enclosed between bands on third, fifth, seventh, and ninth intervals respectively (Fig. 1a). Underside evenly clothed with grayish hairs, except for the dense whitish mesepimera, antero-dorsal and postero-dorsal corners of metepisterna, and lateral part of hind coxae.

Head densely punctate, frons between eyes weakly convex in the middle and terminates with a weak transverse tubercle in front of the faint contraction in both sexes. Antennae almost of the same shape and length in both sexes, reaching slightly beyond posterior angles of pronotum, first to third segments cylindrical, fourth segment slightly dilated distally, fifth to tenth serrate, fifth segment as long as broad, sixth to tenth broader than long (Fig. 2a). Pronotum 1.2 times as broad at base as long, campanulate, slightly constricted in a curve from sharp hind corners close to anterior margin and roundly narrowed at apex on each side, no denticles at sides, dorsum very densely punctate, evenly and weakly convex, with weak short depression at base in front of third interval and a broad shallow and indefinite depression medial to the posterior corner, posterior lobe flat. Scutellum circular. Elytra about as long as broad, dorsal surface even, third, fifth and seventh intervals broader than the

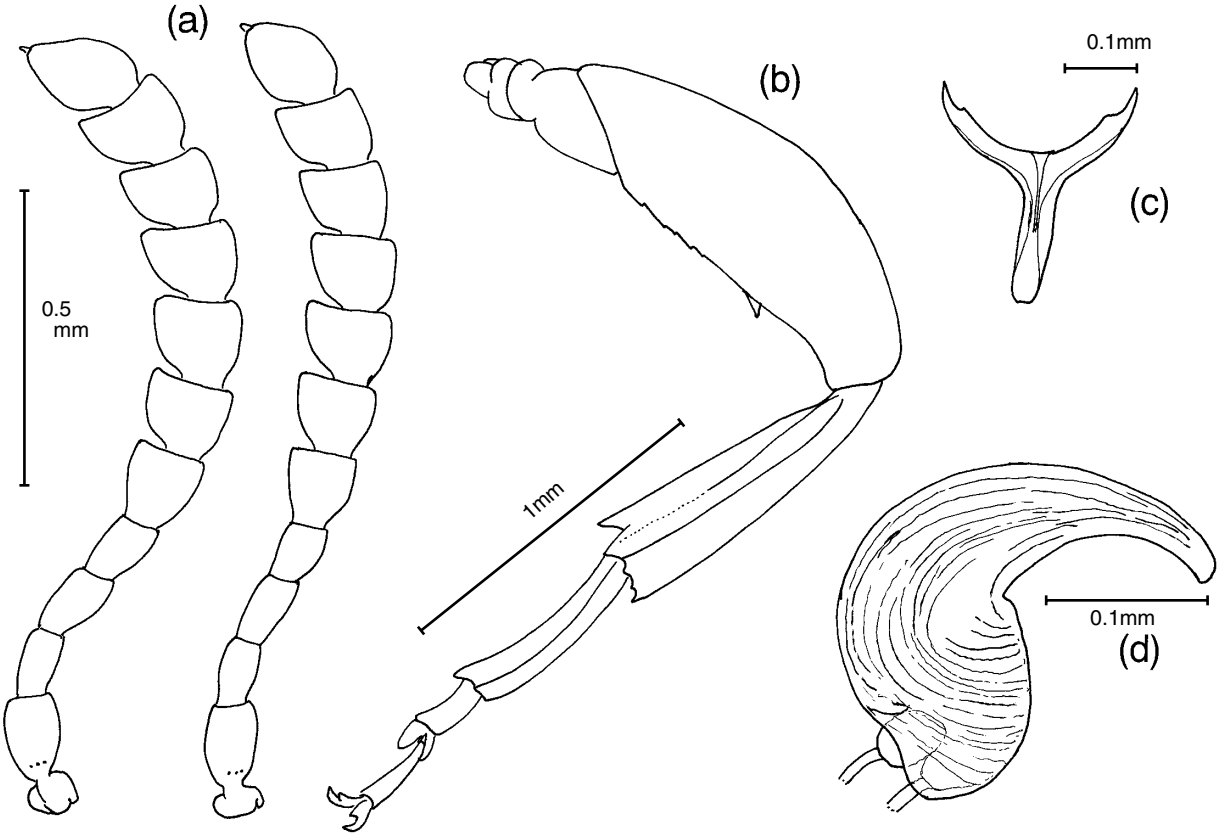

Fig. 2. *Megabruchidius sophorae.* (a) Antenna of male (left) and female (right). (b) Hind leg. (c) Male ninth sternum. (d) Spermatheca.

neighboring intervals, tubercles at the bases of fourth and fifth intervals barely recognizable.

Hind femora slender, sulcate on ventral surface with carinate external and internal margins, the sulcus as pubescent as nearby areas and becoming narrower and shallower towards the base, with a small but clearly visible spine and five to seven minute denticles on basal half of internal margin (Fig. 2b). Hind tibiae straight, with two lateral carinae and a ventral carina, lateroventral carina obsolete on apical third, mucro as long as lateral coronal spinule. Hind tarsi with first segment longer than the remaining segments combined, with distinct lateral and ventral carinae.

Venter of abdomen with first sternum behind coxa longer than second sternum, but shorter than second and third sterna combined.

Male. Pygidium about as long as broad, almost flat on basal half, weakly and broadly convex behind blackish patches (Fig. 1a, lower panel). First abdominal sternum with an oval pubescent patch at the middle on basal half, fifth sternum emarginate. Male genitalia with median lobe subtruncate at apex with rounded corners; internal sac consists of six areas, first area around ostium densely roughened extending apically, second area with short and robust roughened areas extending laterally, third area bulging, with sparse transparent roughened areas on basal half, fourth area with dense roughened areas and visibly dark in transparent light, fifth area without roughened areas, sixth area surrounding gonopore with a circular sclerite and short cylindrical area with dense asperities (Fig. 3a, b); lateral lobes weakly incurved, dilated internally towards apex, pubescent on inner side (Fig. 3c).

Female. Pygidium 1.1~1.2 times as long as broad, with a pair of large and black depressions on apical area (Fig. 1a, lower right panel). Fifth abdominal sternum arcuate caudally, much longer than fourth sternum.

Length (excluding head): 3.3~4.3 mm.

Distribution: Japan (Honshu: Tsukuba City and Sakai City).

Holotype: male (Type no. 3175, Kyushu Univ.), Takezono, Tsukuba City, Ibaraki Pref., pods collected on Oct. 22 and emerged in Nov., 1995, Yuichi Furukawa.

Paratypes: 2♂2♀, same data as holotype; Azuma 4-chôme, Tsukuba City, emerged from pods collected on Oct. 2, 1996, 3♂2♀, Yuichi Furukawa; Kasuga 1-chôme, Tsukuba City, emerged from pods collected on Oct. 4, 1996, 4♂3♀, Yuichi Furukawa and Yukihiko Toquenaga; Campus of Osaka Women's University, Daisen-machi, Sakai City, Osaka Pref., 2♂, pods collected on Oct.11, and emerged on Nov. 20, 2000, M. Ishihara.

Host plant: *Styphnolobium japonicum* (L.) Schott (senior synonym of *Sophora japonica* L.). That they feed in seeds of this plant was confirmed by emergence of the adults from seeds collected. This leguminous species is native to northern China and was introduced into Japan presumably about

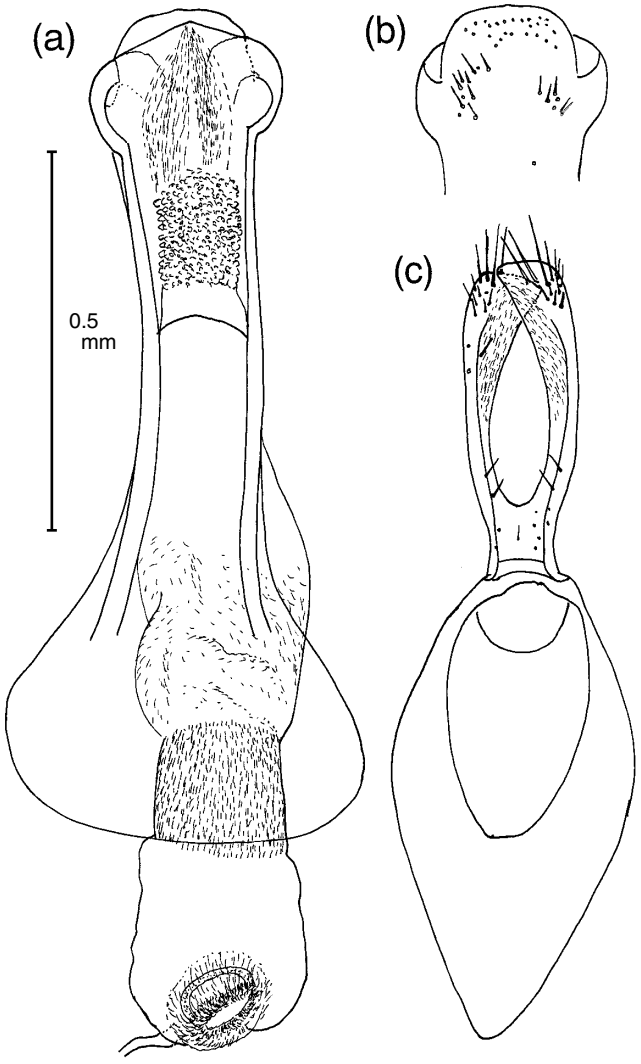

Fig. 3. Male genitalia of *Megabruchidius sophorae*. (a) Median lobe and internal sac, dorsal aspect. (b) Apex of median lobe, ventral aspect. (c) Lateral lobes.

the time when Buddhism was introduced to Japan (Makino, 1967), in the sixth century.

Etymology. The name is derived from the generic name of the host, 'enju' *Sophora japonica*, a synonym of *Styphnolobium japonicum*.

Diagnosis. *Megabruchidius sophorae* is similar to *Bruchidius urbanus* (Sharp, 1886) and *B. serricollis* Morimoto, 1990 in general appearance, size, structures of antennae and genitalia, but the pygidium has a pair of deep and black depressions in females (Fig. 1a, b, lower panels). This is the third species of the genus and extremely similar to *M. dorsalis* in structures, coloration and scaly patterns except for smaller size. The known species can be separated by the character states in the key as follows.

Key to species of *Megabruchidius*

1 Hind tibiae with long hook extending apically a little beyond the middle of first tarsal segment; reddish yellow to reddish brown, elytra with blackish apex; body length excepting head 4.3–5.3 mm. Distribution: Vietnam, Germany (introduced), Hungary (introduced). Host: *Gleditsia triacanthos* L..

Megabruchidius tonkineus (Pic, 1904) (Fig. 1c)

Hind tibiae with hook very short, almost as long as coronal denticle; pronotum and elytra blackish. **2**

2 Larger, 4.4~5.8 mm in length (excluding head); pygidium immaculate or with a pair of indefinite dark patches in male; basal segments of antennae, anterior two pairs of legs, apical part of hind femora and venter reddish; male genitalia with median lobe broadly arcuate at apex. Distribution: Japan, Taiwan, China, Taiwan, India, Italy (introduced). Host: *Gleditsia japonica* Loddiges ex W. Baxter, in J. Loudon, *Gleditsia sinensis* Lam., *Gleditsia rolfei* Vidal, *Gleditsia triacanthos.*

Megabruchidius dorsalis (Fåhraeus, 1839) (Fig. 1b)

Smaller, 3.3~4.3 mm in length (excluding head); pygidium with a pair of blackish patches in male; pale parts yellowish brown, with denser whitish vestiture; male genitalia with median lobe subtruncate with rounded corners at apex. Distribution: Japan (Honshu). Host: *Styphnolobium japonicum*.

Megabruchidius sophorae **sp**. nov. (Fig. 1a)

DISCUSSION

Megabruchidius was established with *Megabruchidius bifoveolatus* n. sp. as the type species of this genus by Borowiec (1984), and he (1987) synonymized *M. bifoveolatus* with *Bruchus dorsalis* Fåhraeus. The systematic position of *Megabruchidius* was hypothesized by Borowiec (1984, 1987) as being close to *Bruchidius* or *Sulcobruchus*, but his definition of *Sulcobruchus* is probably erroneous. *Sulcobruchus sauteri*, the type species of the genus, is characteristic in having the following features: the second to fourth abdominal sterna short in both sexes, combined length of these sterna apparently shorter than the first sternum behind coxa, first sternum with an oval, flat, velvety and large disk at the middle in male (Fig. 4a); antennae not sexually dimorphic; hind femora sulcate, the sulci bare on apical third, gradually becoming shallower basally, internal margin carinate for entire length, not dentate, carina on external margin obsolete on basal third; pygidium simple in both sexes; male genitalia with lateral lobes sclerotized subconically at apex and an oval patch behind apex on the internal face, median lobe with a pair of elongate sclerites at apex (vide Morimoto, 1990, fig. 1).

Bruchidius comprises heterogeneous species at present as Borowiec (1987) stated "it is impossible to present a unit genus diagnosis and also difficult to divide *Bruchidius* into smaller genera because some species are intermediate between species group, and several species have also some characters in common with other Old World Acanthoscelidini". The polymorphic state of this genus was

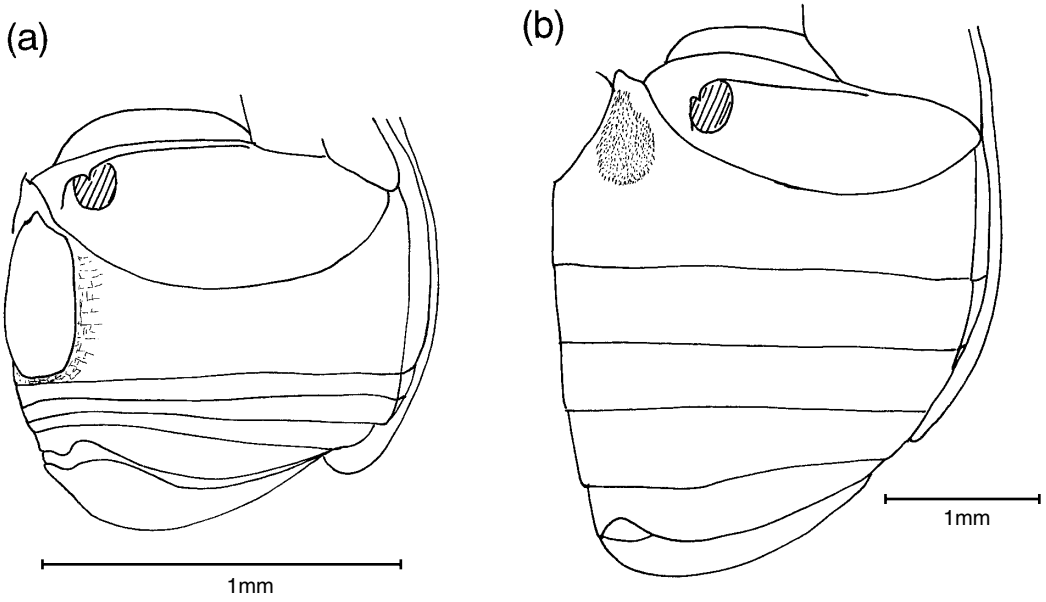

Fig. 4. Male abdomen, lateroventral view. (a) *Sulcobruchus sauteri* and (b) *Megabruchidius dorsalis*.

also pointed out by Bridwell (1946). Schilsky (1905) divided this genus into two groups by the presence or absence of tubercles at the base of the elytra. Chûjô (1937) divided it into six species groups, but his contribution was not generally known because his paper was written in Japanese and published close to the World War II. Out of these six groups, two were already separated from *Bruchidius* to the other genera, *Conicobruchus* and *Megabruchidius*. Borowiec (1988) divided it into 12 groups, and only distinguished *Bruchidius* from *Acanthoscelides* on the range of distribution in his key (1987, p. 155), although he noted the synonymy of the two tribes Acanthoscelidini and Bruchidini (Borowiec, 1984). Using the structure of the male genitalia, beetles of *Bruchidius* can be divided into two groups.

First group: lateral lobes slender, almost parallel-sided, barely notched at apex, neither pubescent nor setose along inner margin; median lobe very slender, with triangular sclerite at apex; internal sac roughened, with sclerite(s) in the middle. This group is composed of *B. lautus* and *B. japonicus* (vide Morimoto, 1990, figs. 2 and 3), and several species in India (vide Arora, 1977).

Second group: lateral lobes deeply notched beyond the middle from apex, more or less incurved, usually pubescent along the inner margin; median lobe rather robust, often with triangular sclerite at apex, internal sac roughened or spinous, often without sclerite in the middle. Many species (vide Arora, 1977; Borowiec, 1987, 1988; Morimoto, 1990).

The male genitalia of *Megabruchidius* are similar to the second group, but the apex of median lobe is broadly rounded or subtruncate.

The above-mentioned genera can be identified by the characters in the following key.

1 Second to fourth abdominal sterna very short, their combined length distinctly shorter than first sternum, first sternum with a median flat large disk in male, fifth sternum bisinuate at caudal margin in male (Fig. 4a); hind femora sulcate, both external and internal margins carinate, external carina obsolete at base, carinae unarmed; pygidium immaculate, evenly haired, simple in both sexes. ***Sulcobruchus***

First abdominal sternum longer than second, but shorter than second and third sterna combined (Fig. 4b); hind femora usually with a tooth on the internal carina; pygidium often maculated by the different density or arrangement of hairs and/or dark patches. **2**

2 Pygidium with a pair of conspicuous large, oval and blackish depressions in female (Fig. 1, lower panels); antennae not sexually dimorphic (Fig. 2a); median lobe broadly rounded or subtruncate at apex, not triangularly pointed (Fig. 3a). ***Megabruchidius***

Pygidium at most with a pair of faint and indefinite depressions in female; antennae often sexually dimorphic; male genitalia usually triangular at apex. ***Bruchidius***

In *Megabruchidius*, in contrast with *Sulcobruchus*, fifth sternum is concave in an arc at caudal margin in male (Fig. 4b), hind femora with several minute denticles on internal carina between the base and tooth (Fig. 2b).

Interestingly, morphological as well as molecular character states suggest a close phylogenetic relationship of *Megabruchidius* with *Acanthoscelides obtectus*, a stored-product pest of *Phaseolus* beans (Tuda and Takakura, unpublished). The genus *Acanthoscelides* is heterogeneous (e.g., Johnson, 1970; Tuda *et al*., 2001) and *A. obtectus* forms a subgroup with a few other species in the New World that feed on *Phaseolus* (Johnson, 1970, 1990). The first-instar larvae of *Megabruchidius* after hatching wander over

surfaces of pods and seeds before boring into them (Shimada *et al*., 2001), whereas those of *Callosobruchus* and *Bruchus* bore into pods/seeds as they hatch. This larval behavior is considered ancestral and has been observed in Pachymerinae and Acanthoscelidini (eg., *A. obtectus,* Pfaffenberger and Johnson, 1976; Arora, 1978). Therefore, *Megabruchidius* is ancestral, at least in Bruchinae.

Phaseolus sp., reported as the host of *M. tonkineus (*Wendt, 1980), probably is an unnatural host for the species but indicates affinity of *Megabruchidius* to the New-World leguminous genus, which might also associate the bruchid group with the New-World *Acanthoscelides* specializing on *Phaseolus*.

Styphnolobium japonicum, the host plant of *M. sophorae*, is native to China. It is the only species in Asia from the genus *Styphnolobium*, and the majority of species from the genus inhabit Central and North America (Sousa and Rudd, 1993). There are two possibilities of the native range of *M. sophorae*: One is that *M. sophorae* is native to China and was brought to Japan with the host. The other is that *M. sophorae* is native to Japan (and China). The latter is possible only if the present species was (or is) capable to use a native legume, that is, to recognize it as a plant to deposit eggs, and to develop by feeding on it. Since no other hosts are known for *M. sophorae*, the former is more likely at the moment.

It was shown that the phylogenetic position of the leguminous genus *Styphnolobium* is at the base of Papilionoideae by a recent molecular study (Kass and Wink, 1997). The other species of *Megabruchidius* utilize *Gleditsia* species as hosts which belong to the most ancestral subfamily, Caesalpinioideae, in Fabaceae. The association of *Megabruchidius* with ancestral legumes and the ancestral type of larval behavior support the hypothetical basal position of *Megabruchidius* in Bruchinae.

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