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New records of Genus *Strongylium* from Malaysia (Coleoptera: Tenebrionidae)

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Key words: Tenebrionidae, *Strongylium*, Sabah, Malaysia, New records

Abstract

The current study established the taxonomical status of four different species belong to the genus *Strongylium* Kirb from Malaysian region of Sabah Kinabalu. The found species were *S. varians* Pascoe, *S. erythrocephalum* Fabricius, *S. crurale* Fairmaire and *S. forcipicolle* Fairmaire. The functional sense of the anatomy of the genus *Strongylium* was scrutinized and the evolutionary adaption to their especial habitat in Malaysian forest was also observed.

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Introduction

Malaysia is having a total landmass of 330,800 square kilometres separated by the South China Sea and further divided into two similar sized regions, Peninsular Malaysia and East Malaysia. Being a federal constitutional monarchy, the country is having 13 states and three federal territories located in Southeast Asia (Chee-Wan and Meng-Chang, 2012). The recent study regarding distribution of darkling beetles (Tenebrionidae) in Malaysia by Darya *et al.* (2016) reported the collection of 120 individual specimens belongs to 30 different species from distinctive regions. The nine genera from Stinochiinae containing 17 different species, eight genera from Tenebrioninae containing 11 different species and only one genus with a new species from Diaperinae were collected, respectively. However, a maximum number of species were observed from genera *Promethis* (four species) and *Strongylium* (five including one new species) from subfamily Stinochiinae.

The subfamily Stinochiinae is a very diverse worldwide having three tribes and only its genus *Strongylium* contains more than 1000 species and 30 other genera. Similarly, Cnodalonini contains more than 300 genera and it is the highest number of genera in any Tenebrionid tribe (Decelle, 1983; Doyen, 1989; Matthews and Doyen, 1989; Bouchard, 2000 & 2002).

The genus *Stongylium* is worldwide in distribution and is the largest genus in the family; furthermore in this connection, Gebien (1948) listed slightly over 700 species in his world Catalogue. Similarly, The New World tropics are very rich in species, there being approximately 320, but north of the Rio Grande River the genus is represented by only 10 species. Member of the genus *Stongylium* Kirby do not resemble typical Tenebrionidae. On the basis of their shape and often bright colour, they resemble to Lagriidae or a related family. However, they are true Tenebrionidae even if they are the converse of popular concepts of the family.

The Indo-Malayan are the largest numbers of higher groups belong to Tenebrionidae family but since few years back the forests of Southeast Asia have changed dramatically as a result of logging and development (Curran *et al.,* 2004; Sodhi *et al.,* 2004; Kohand Wilcove, 2008) and much affected typically Malaysian forests that caused some changes in the life and fauna and flora. However, the distribution of insect species is widely existed in Malaysia and causing economic damage to the number of plants and agricultural crops and barking beetles are one these insects those are pernicious insect pests.

In nature of damage, a few species of *Strongylium* bore into the wood of living trees at stubs or wound and tend to live in relatively hard wood (Baker, 1972; Drooz, 1985; Steiner, 1995). However, relatively few *Strongylium* are of great economic importance thus the family has attracted less attention than the other vast families and previously no any systematic work has been conducted in Malaysian tropical region. Therefore, the main objective of this study was to establish the taxonomical status of different obtained species belonging to the genus *Strongylium* Kirby, 1818inhabiting the Malaysian region of Sabah Kinabalu.

Materials and methods

The experimental procedure for collection, preservation and identification of all collected insect species in this study was same therefore general materials and methods provide a detailed explanation on the procedures, thus avoiding unnecessary repetition throughout.

Collection and preservation of insects

The current study based on different insect species of *Strongylium* and most of these insect species in this genus was large in size and collected by hand directly from different parts of Malaysia. However, few species were also obtained from Universiti Putra Malaysia (UPM), Forest Research Centre Kinabalu National Park (KNP) and Universiti Kebangsaan Malaysia (UKM).

All collected insects were brought at Department of Plant Protection, Faculty of Agriculture, UPM, Malaysia where these insects were finally pinned and preserved for further studies. All the collected insect species were put in the close glass tubes, covered with a close plastic and kept inside the refrigerator at temperature of -5 ^{o}C; thus killing and saving of specimen were assured for several days until the stapling was performed.

Identification of different collected insect species

The morphological characteristics of insect species were examined under using a Dino Lite digital microscope (AnMo Electronic Corp, Taiwan) however, the tiny structure of the insect body was observed after preparing slides and these slides were examined through Dino-Eye digital microscope (5 MP, AnMo Electronic Corp, Taiwan). In anatomical study, we followed the standard procedure given by Junk (1911), Watt (1974) and Matthews and Bouchard (2008), respectively to examine the all collected genera and species for proper identification thus all insect slides were prepared by using Canada balsam and put under a light source of 100 w to dry for three to four days to make these slides ready to examine and to draw their images. The whole body image and scale characters of the insects were observed by using Canon DSLR Camera (EOS 70 D, 55-135mm lenses, Japan). The illustration has been done by using two drawing and graphic software such as Adobe illustrator CC and Wacom Cintiq 13HD. Thus, all these above mentioned procedures were applied to identify the insect species of and their taxonomical keys were constructed.

Results

S. varians (Pascoe, 1883)

Material examined

Johor: Gunung Ledangmountain, 2013, Darya H.,1 male specimen. Sabah: Kinabalu Park 2008, Darya H., 1 male specimen [KCCS].

Diagnosis

Body: The body was elongated-oval with total length of 11-13mm, the width of 3.5 -4.5 mm and metallic dark blue in colour (Fig. 1).

Fig. 1. An adult of insect *S. varians*.

Head: The front was slightly punctured, concave in the middle; the compound eyes were rather large and somewhat reniform in shape. The distance between two eyes was 1.1-1.3 mm, clypeus semi-circular and the margin of the clypeus was curved. In head, the detailed illustration of antennae, mouth parts and pronotum have been described in Fig. 2.

The antennae were sub-filiform with total length of 5.3-5.4 mm and consisted of 11 segments. In the first segment of antenna (scape), the basal part was spherical and the apical part repressive elongated. The second segment (Pedicel) was slightly cubic in form, very small in size and however third and fourth segments of pedicel were same in size. The last/third segment of antenna (Flagellum) was smaller and oval in shape however it's segments from 5 - 10 were almost same in size.

In mouth parts, labrumwaso blongin form, the tormal arms mesal was not extended and epitorma was absent with a smooth surface. In labium, mentum was flat in shape with three segmentedpalps; however the third segment was very large and carried some setae.

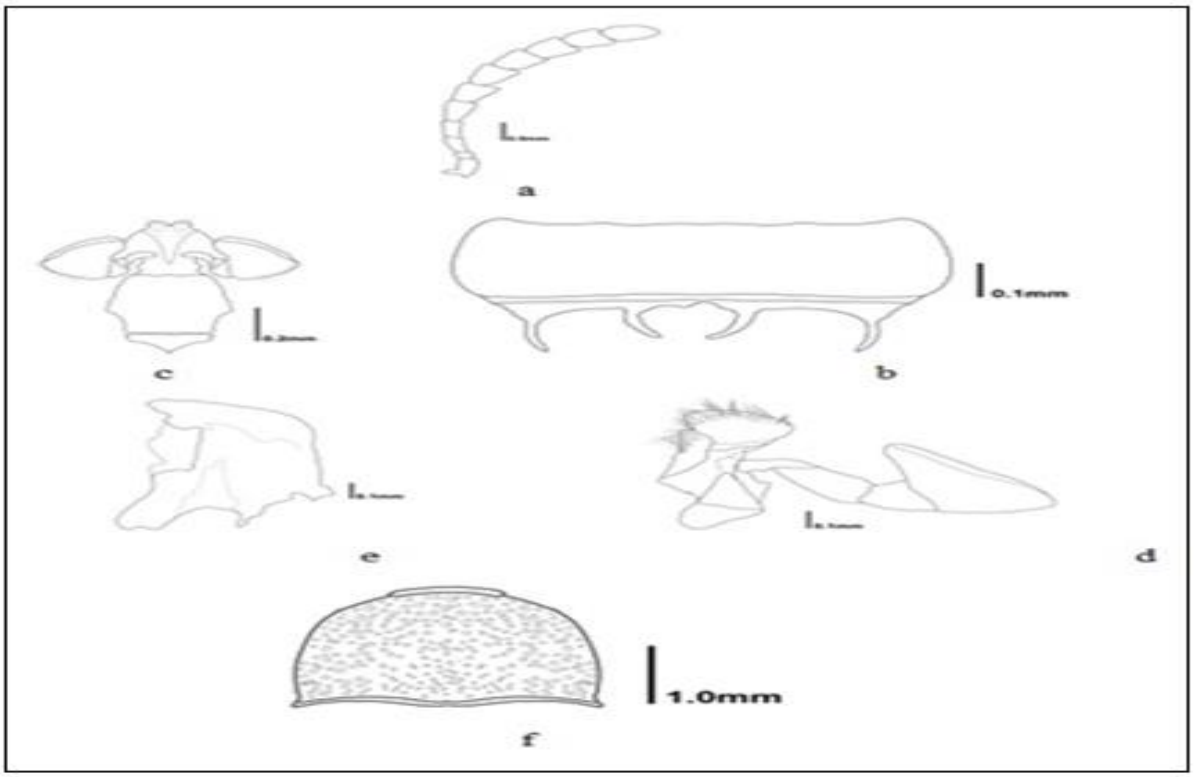

Fig. 2. Antennae mouth parts and pronotum of *S. varians* (a) antennae, (b) labrum, (c) labium, (d) Maxilla, (e) Mandibles (f) pronotum.

Maxilla with single lacinialuncusandpalpi consisted of four segments with apical segment that was almost triangular in form. Mandibles were pyramidal in form with one apical tooth.

Thorax: The detailed illustration of legs, elytra and aedgus of *S. varians* has been presented in Fig. 3. In thorax, pronotum was feebly transverse, nearly quadrate and sub-cylindrical. It was strongly margined at basally and anteriorly and lateral borders were round and surface with fine scattered punctures. Pro-sternum was slightly arcuate to anterior and posterior borders and prosternal process was flat.

Fore-legs: In legs, protibiae was cylindrical in shape and slightly curved. Tarsus was five segmented and possessed coarse bristles on inner side and the segments from one to four were same in size however the fifth segment was long and carried two strong claws.

Mid-leg: In mid leg, meso-tibiae were cylindricalin shape and narrow without any setae.

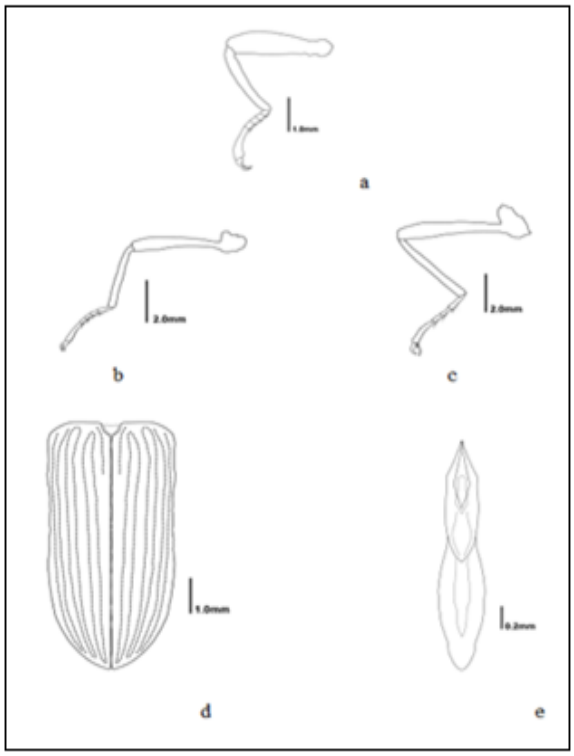

Fig. 3. Legs, elytra, aedeagus genitalia of *S. varians* (a) Fore-leg, (b) Mid-leg, (c) Hind-leg, (d) Elytra, (e) Aedeagus

The segments of the tarsus from one to four were almost same in the size and the last segment was longer.

Fig. 4. An adult insect of *S. erythrocephalum*.

Hind-leg: In hind leg, meta-tibiae were cylindricalin shape and in four segmented tarsus, the last segment was longer than reset of other segments.

Elytra: The length of elytra was 8.3-8.5 mm, dorsum was strongly convex though gently flattened in baso-medial part; disc punctato-striate, thestriae shallow and wide, the punctures large and slightly transverse; intervals finely ridged. Scutellum was triangular in shape, very weakly convex and smooth though sparsely scattered with microscopic punctures.

Aedeagus: The length of aedeagus was 2.1-2.2 mm.

S. erythrocephalum (Fabricius, 1801)

Material examined

Sabah: Kinabalu Park, 1998, Darya H., 1 male, 1 female specimen [KCCS]. Selangor: Universiti Kebangsaan Malaysia [UKM], 2002, Darya H.,1 male specimen.

Diagnosis

Body: The body was elongated-oval with total length of 20 - 22 mm, the width 7.0 - 9.0 mm and metallic dark blue in colour (Fig. 4).

Head: The front was smooth in the middle, the compound eyes were rather large and oval and very prominent golden in colour. The distance between two eyes was 0.8–0.9 mm. In head, the detailed illustration of antennae, mouth parts and pronotum have been described in Fig. 5.

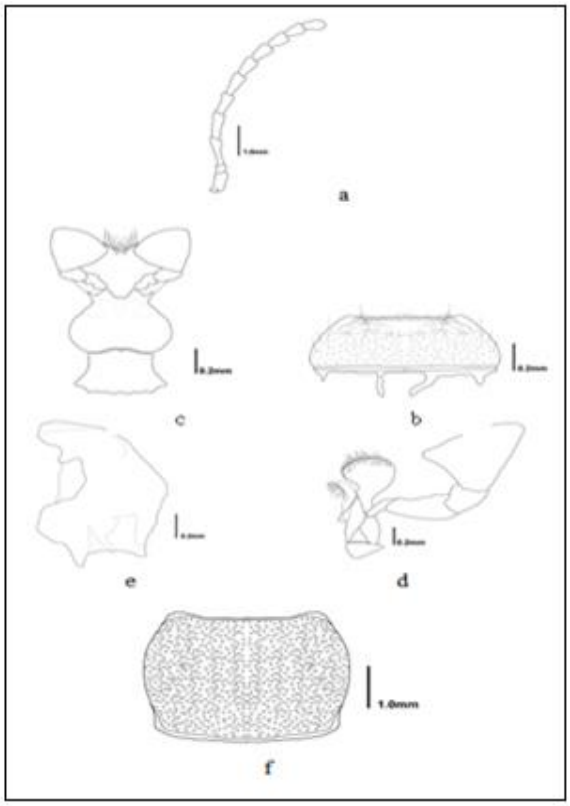

Fig. 5. Antennae mouth parts and pronotum of *S. erythrocephalum* (a) antennae, (b) labrum, (c) labium, (d) Maxilla, (e) Mandibles, (f) pronotum.

The antennae were sub-filiform with total length of 7.1–7.3 mm and consisted of 11 segments. In the first segment of antenna (scape), the basal part was spherical and the apical part repressive elongated.

The second segment (Pedicel) was slightly cubic in form, very small in size and the segments from three to six were almost same in size.

The last/third segment of antenna (Flagellum) was smaller and oval in shape however it's segments from 7 - 10 were almost same in size.

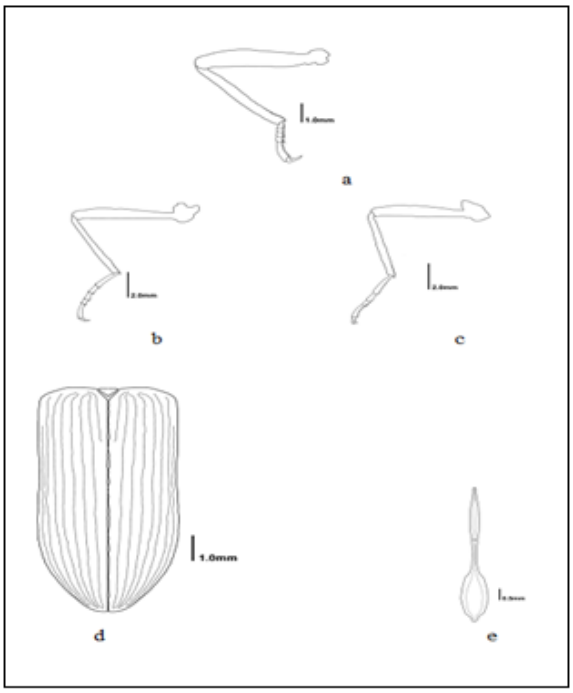

Fig. 6. Legs, elytra, aedeagus genitalia of *S. erythrocephalum* (a) Fore-leg, (b) Mid-leg, (c) Hind-leg, (d) Elytra, (e) Aedeagus

In mouth parts, labrum was oblong in form, the tormal arms mesal was not extended and epitorma was absent with a punctured surface however the anterior par was covered with setae.

Fig. 7. An adult insect of *S. crurale.*

In labium, mentum was flat in shape with three segmented palps. Maxilla with single lacinialuncus, palpi consisted of four segments with apical segment that was almost triangular in form. Mandibles were pyramidal in form with one apical tooth.

Thorax: The detailed illustration of legs, elytra and aedeagus of *S. erythrocephalum* has been presented in Fig. 6. In thorax, pronotum was feebly transverse, nearly quadrate and strongly margined at basally and anteriorly. The lateral borders were slightly round and the surface was with fine scattered punctures. Pro-sternum was slightly arcuate to anterior and posterior borders and pro-sternal process was flat.

Fore-legs: In this species, the legs are very long and reddish brown in colour. In fore-leg, pro-tibiae were cylindrical in shape. Tarsus was five segmented and possessed coarse bristles on inner side and the segments from one to four were same in size however the fifth segment was long and carried two strong claws.

Mid-leg: In mid leg, meso-tibiae were cylindrical in shape. The segments of the tarsus from two to four were almost same in the size and the last segment was longer.

Hind-leg: In hind leg, meta-tibiae were cylindrical in shape and in four segmented tarsus, the first and last segments were almost same in length.

Elytra: The length of elytra was 12.7 – 12.9 mm, dorsum was strongly convex though gently flattened in baso-medial part; disc punctato-striate, the striaes hallow and wide, the punctures large and slightly transverse; intervals finely ridged. Scutellum was triangular in shape, very weakly convex and smooth though sparsely scattered with microscopic punctures.

Aedeagus: The length of aedeaguswas5.5-5.7 mm

S. crurale (Fairmaire, 1893).

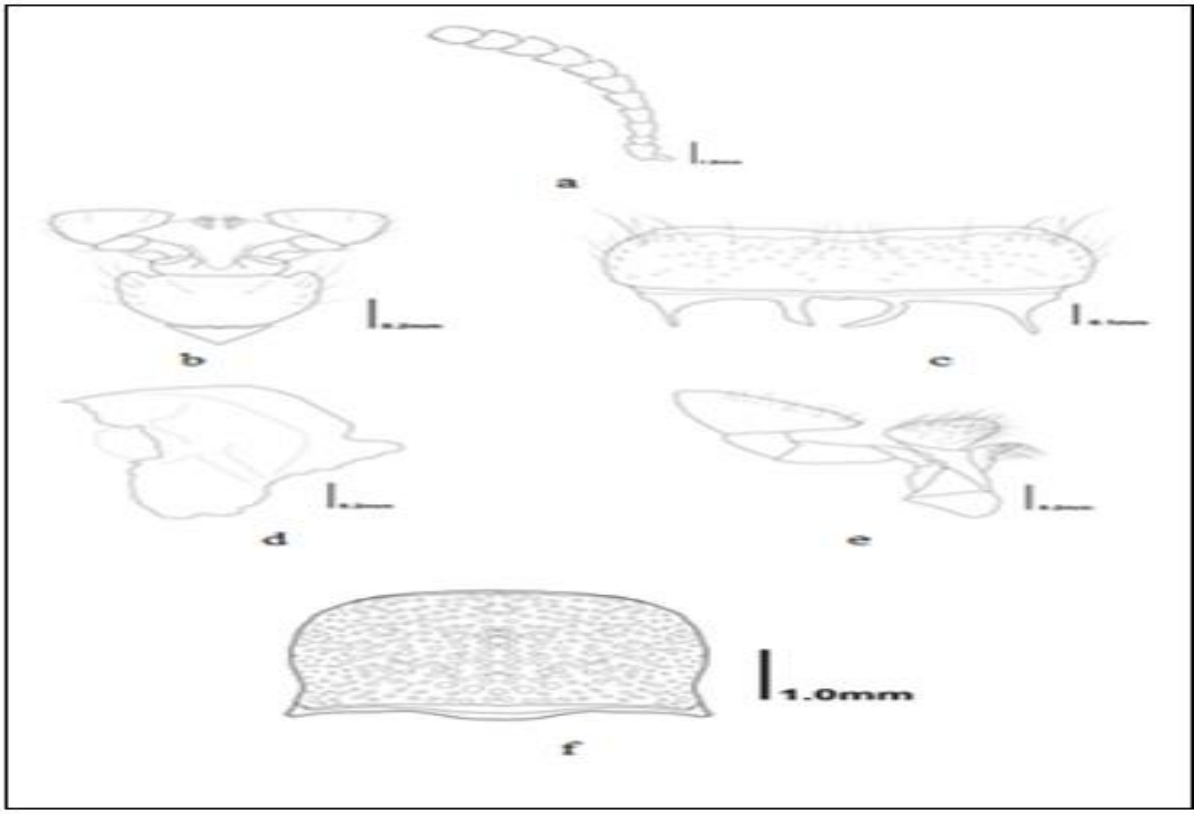

Fig. 8. Antennae mouth parts and pronotum of *S. crurale* (a) antennae, (b) labrum, (c) labium, (d) Maxilla, (e) Mandibles, (f) pronotum.

Material examined

Sabah: Kinabalu Park, 2000, Darya H., 2 male specimens [KCCS]. Selangor: Universiti Kebangsan Malaysia [UKM], 1998, Darya H., 1male specimen.

Diagnosis

Body: The total length of body was 12 - 14 mm, the width 4.5 5.5 mm and bronze in colour (Fig. 7).

Head: The front was smooth and convein the middle, the compound eyes were somewhat reniform. The distance between two eyes was 1.0 mm, clypeus was semi-circular and the margin of the clypeus was curved. In head, the specified illustration of antennae, mouth parts and pronotum have been described in Fig. 8. The antennae were sub-filiform with total length of 5.5 – 5.6 mm and consisted of 11 segments. In the first segment of antenna (scape), the basal part was spherical and the apical part repressive elongated.

The second segment (Pedicel) was slightly cubic in form, small in size and the segments from three to three and four were same in size. The last/third segment of antenna (Flagellum) was smaller and spherical in shape however it's segments from 5 - 10 were almost same in size.

In mouth parts, labrum was oblong in form, the tormalarmsmesal was not extended and epitorma was absent and the surface was covered with setae except at anterior margin that was smooth. In labium, mentum was flat in shape with three segmented palps covered with setae and the third segment was large. Maxilla with single lacinialuncus, palpi consisted of four segments with apical segment that was almost triangular in formand covered with setae. Mandibles were pyramidal in form with one apical tooth.

Thorax: The detailed illustration of legs, elytra and aedeagus of *S. erythrocephalum* has been presented in Fig. 9.

In thorax, pronotum was nearly quadrate, nearly quadrate and strongly margined at basally and slightly at anteriorly. The lateral borders were round, the surface was with scattered punctures, and pro-sternal process was flat.

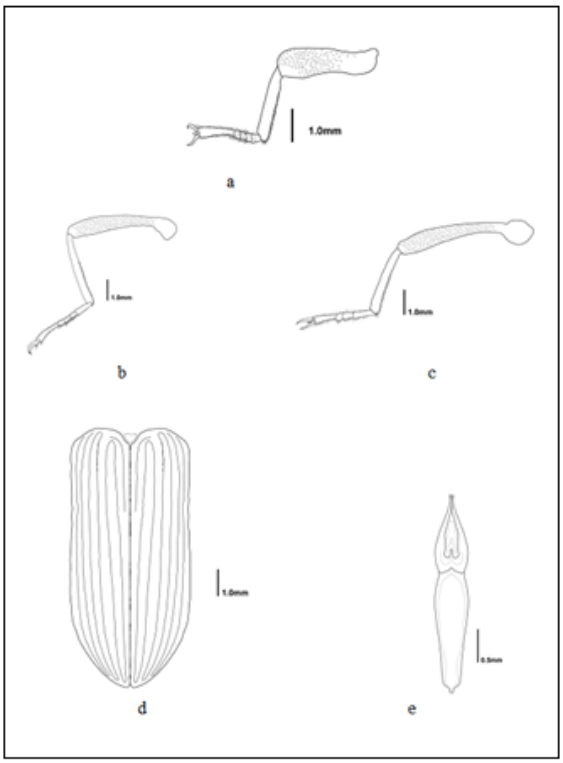

Fig. 9. Legs, elytra, aedeagus genitalia of *S. crurale*(a) Fore-leg, (b) Mid-leg, (c) Hind-leg, (d) Elytra, (e) Aedeagus.

Fore-legs: In this species, the especial character in the leg was punctured femur. In fore-leg, pro-tibiae were cylindrical in shape and possessed coarse bristles on inner side. Tarsus was five segmented and covered with sitae and the segments from one to four were same in size however the fifth segment was long and carried two strong claws and a small spur between the claws.

Mid-leg: In mid leg, meso-tibiae were narrow and cylindrical in shape without any setae. The segments of the tarsus from two to four were almost same in the size and the last segment was longer.

Hind-leg: In hind leg, meta-tibiae were cylindrical in shape and possessed coarse bristles on inner side. In four segmented tarsus, the last segment was longest.

Elytra: The length of elytra was 9.8 – 9.9 mm, dorsum was strongly convex though gently flattened in baso-medial part; disc punctato-striate, the striae shallow and wide, the punctures small and slightly transverse; intervals finely ridged. Scutellum was triangular in shape and smooth though sparsely scattered.

Fig. 10. An adult insect of *S. forcipicolle*.

Aedeagus: The length of aedeagus was 2.8- 2.9 mm.

S. forcipicolle (Fairmaire, 1900)

Material examined

Sabah: Kinabalu Park 2001, Darya H., 1female, 1 male specimen [KCCS]. Sarawak: Matang, Kuching, 2002, Darya H., 1 female specimen.

Diagnosis

Body: The body was elongated-oval with total length of 18 - 20 mm, the width 6 - 7 mm and dorsal sides were dark bronze in colour (Fig. 10).

Head: The front was slightly convex in the middle and slightly punctured. The compound eyes were rather large and reniform in shape. The distance between two eyes was 0.8–0.9 mm, clypeus semi-circular and the margin of the clypeus was curved.

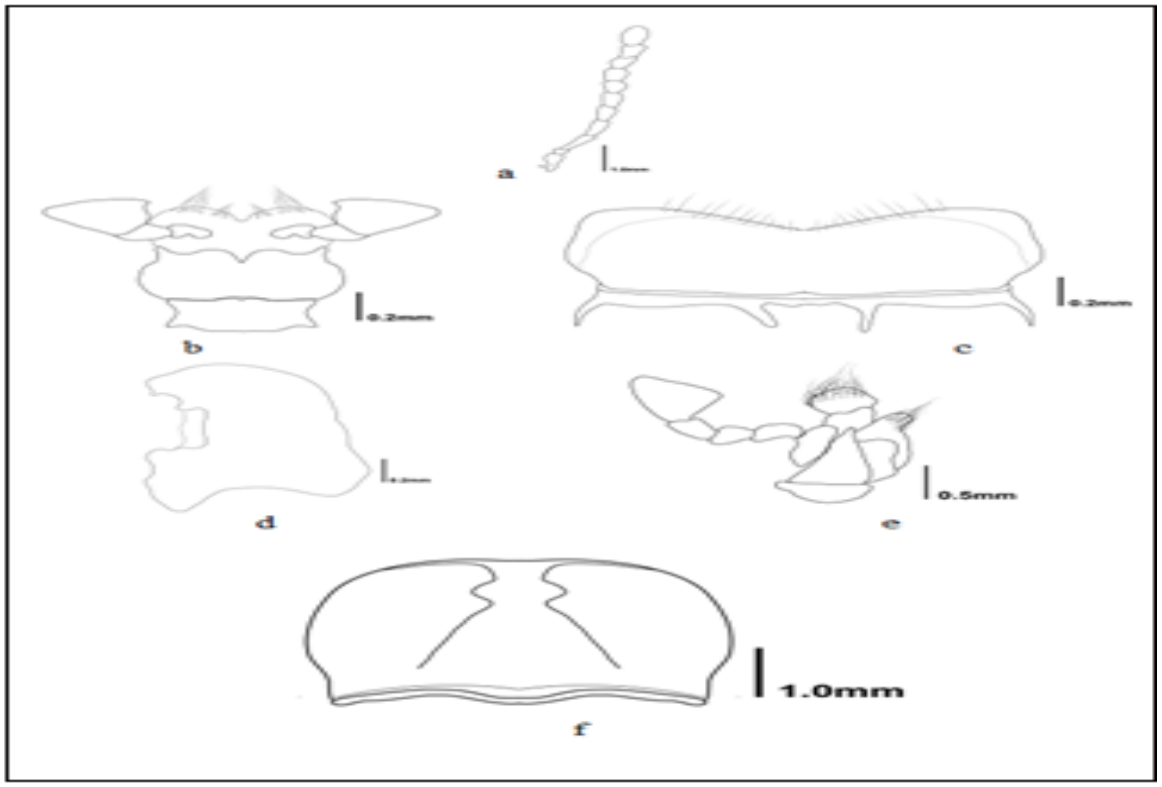

Fig. 11. Antennae mouth parts and pronotum of *S. forcipicolle* (a) antennae, (b) labrum, (c) labium, (d) Maxilla, (e) Mandibles, (f) pronotum.

In head, the specified illustration of antennae, mouth parts and pronotum have been described in Fig. 11. The antennae were sub-filiform with total length of 6.0–6.2 mm and consisted of 11 segments. In the first segment of antenna (scape), the basal part was spherical and the apical part repressive elongated. The second segment (Pedicel) was very small in size however the third segment was very long and the segments from four to six were same in size. The last/third segment of antenna (Flagellum) was smaller and oval in shape however it's segments from 7 - 10 were almost same in size.

In mouth parts, labrum was oblong in form, the tormal arms mesal were not extended and epitorma was absent and the surface was covered with short setae at the anterior margin. In labium, mentum was flat in shape with three segmented palps and the third segment was large and carried some setae. Maxilla with single lacinialuncus, palpi consisted of four segments with apical segment that was almost triangular in form. Mandibles were pyramidal in form with one apical tooth.

Thorax: The detailed illustration of legs, elytra and aedeagus of *S. forcipicolle* has been presented in Fig. 12. In thorax, pro-notum was very distinctive part that strongly margined at basally and the lateral borders were round. The surface was with two very large prominent lobes which almost divide the pro-notum into two parts. Pro-sternum was slightly actuate to anterior and posterior borders and pro-sternal processed flat.

Fore-legs: The legs in this species are special characteristics due to the reddish brown colour of the femur at their basal parts and changing from the half part until the tarsus that was black in colour. In fore-leg, pro-tibiae were cylindrical in shape and the tarsus five segmented. The first and last segments of fore-legs were same in the length however the fifth segment was long and carried two strong claws and a small spur between the claws.

Mid-leg: In mid leg, meso-tibiae were narrow and cylindrical in shape without any setae.

The segments of the tarsus from one to four were almost same in the size and the last segment was longer.

Hind-leg: In hind leg, meta-tibiae were cylindrical in shape. In four segmented tarsus, the first and last segments were almost same in length.

Elytra: The length of elytra was 12.7 – 12.9 mm, dorsum was strongly convex though gently flattened in baso-medial part; the striae shallow and wide, the punctures were very large and slightly transverse; intervals finely ridged. Scutellum was triangular in shape.

Aedeagus: The length of aedeagus was 2.8-2.9 mm.

Discussion

There have been for last few years, a series of a bigger Tenebrionid is known from the Cameron Highlands (Malaysia) and after a detailed study it was observed to be a new genus and new species of the Pycnocerini. Three species had been described by Ferrerand Moraagues (2000) and four species of Aediotorix by Bates (1868) in the oriental regions (Philippines, Indonesia and Malaysia).

The bright colours and unusual patterns of many of the species have attracted collectors who ordinarily pass over the more prosaic and drab species which constitute most of the family. In many *Strongylium* species, males are smaller and more slender, frequently have longer antennae and sometimes have abdominal stern with a depression (flat in females), in some species the eyes are widely separated in the female and practically contiguous in the male.

There are also differences in the density and in the length of setae on other the pro-tibia or pro-femur and some males have patches of short, dense setae on the meta-sternum that are absent in females. The most sexual dimorphism observed in *Strongylium* has not been spectacular.

Spilman (1959) prepared notes on *Edrotes*, *Leichenum*, *Palorus*, *Eupsophulus*, *Adelium* and *Strongylium*. Kulzer (1966) revised the Australian and Papuan species of the tribe Strongiliini. Triplehorn and Spilman (1973) reviewed *Strongylium* of America north of Mexico. Kaszab (1977) worked on the Tenebrioniade of the Papuan region, with special reference to the tribe Strongyliini. Triplehorn (1985) illustrated a remarkable example of sexual dimorphism in *Strongylium*. Ivie and Triplehorn (1986) described a new species *Strongyliumpaddai* from the Puerto Rican Bank. Endrody-Younga (1989) prepared a world revision of the genus *Anomalipus*. Ferrer (1996) contributed towards the knowledge of Tenebrionidae from Kenya. Masumoto (1996) studied the Asian strongyliini and described seven new *Strongylium* species from Thailand, Laos and Taiwan (*Strongylium yasuhikoi*, *S. andoi*, *S. girardianum*, *S. jae*, *S. kerleyi*, *S. miwai* and *S. yukae*).

Masumoto (1999) elaborated the three species-groups of the genus *Strongylium* from Southeast Asia and described the species *Strongylium cochinchinense*, *S. crockerense*, *S. kalimantanense*, *S. keningauense*, *S. kimanisense*, *S. mindanaoense*, *S. miyakei*, *S. palawanense*, *S. rufifemoratum*, *S. sabahense*, *S. sabahinsigne*, *S. sulawesiense*, *S. taoi*, *S. wallacei* and *S. wiseetingum*. Palmer (1998) worked on taxonomy, phylogeny, and biogeography of a species-group of West-Mediterranean *Tentyria*.

Kato (1998) reviewed *Strongylium* from the Philippines. Masumoto (1999) worked on *Strongylium* from Southeast Asia.

The distribution of these species found in this study was widely existed in Malaysia and causing economic damage to the number of plants and agricultural crops thus necessity to conduct a study on these species.

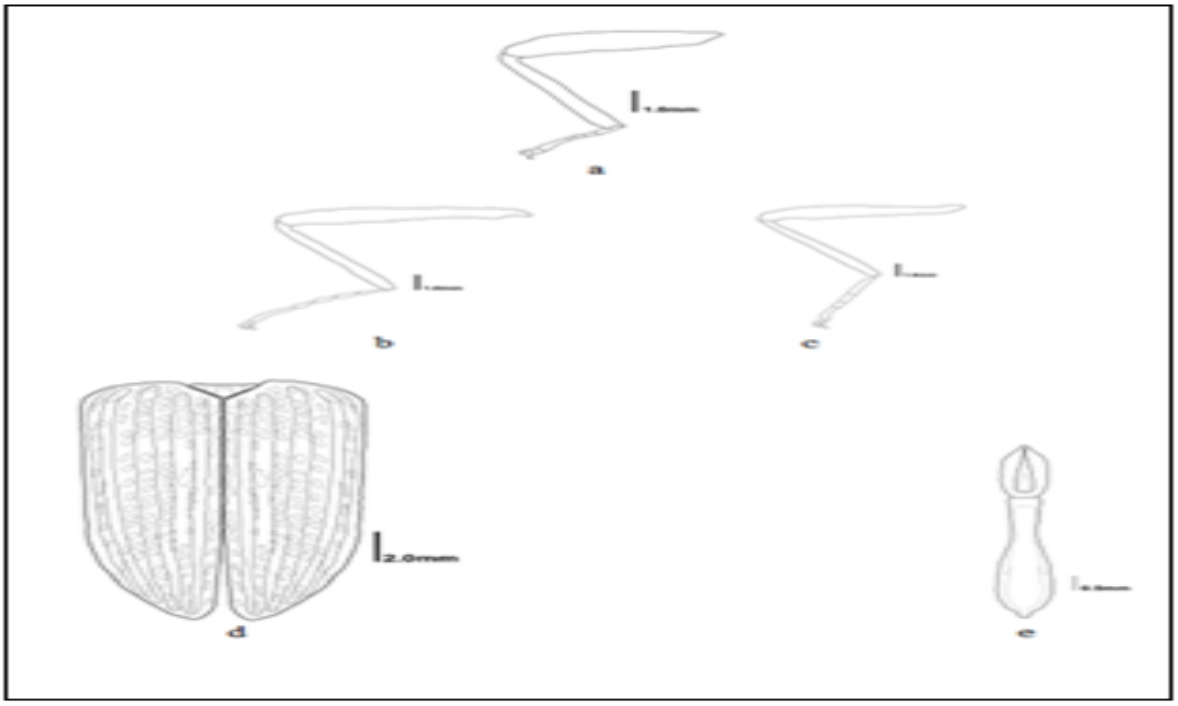

Fig. 12. Legs, elytra, aedeagus genitalia of *S. forcipicolle* (a) Fore-leg, (b) Mid-leg, (c) Hind-leg, (d) Elytra, (e) Aedeagus.

These species were almost distributed in every state of Malaysia. The study has also shown that the mountain area was the most abundant for these beetles however some species rarely found in the lower elevations and required more depth study.

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I pay my especial thanks to Dr. Julio Ferrer from National History Museum of Sweden for helping me to identify these insect species.

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