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Revision of the genus *Psalitrus* d'Orchymont from Southern India and Sri Lanka (Coleoptera: Hydrophilidae: Omicrini)

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Abstract. Eight new species of *Psalitrus* are described: *P.besucheti*, *P.coccinelloides*, *P.decoratus* and *P.silvestris* from Southern India and *P.loebli*, *P.mahanuwara*, *P.serendibensis* and *P.veddha* from Sri Lanka. The two *Psalitrus* known previously from India, *P.championi* and *P.fallax*, are redescribed and lectotypes and paralectotypes are designated. For each species the aedeagus and female ectodermal genitalia are figured. For the first time among Hydrophiloidea species characters have been found in female ectodermal genitalia, thanks to staining with chlorazol black dye. The best biometric characters are selected by multiple-discriminant analysis and an identification key is given. A list of the known *Psalitrus* species is given.

Introduction

Minute terrestrial Hydrophilidae:Sphaeridiinae of the tribe Omicrini Smetana, 1975 occur in the tropics of the Neotropical, Ethiopian, Oriental, Australian and Pacific regions. Adults are mainly known to live in various decaying matter (Smetana, 1975, 1978; Malcolm, 1981; Bameul, 1986) but one species, *Litrosurus insolitus* d'Orchymont 1925b, has been reported from a termite nest (Malcolm, 1981).

The Omicrini have been extensively revised by Malcolm (1980, 1981) and thirteen genera are known, including one since described by Bameul (1990b). However, their taxonomy, phylogeny and biogeography are not fully known. Hansen (1990) has stressed that Omicrini is certainly monophyletic.

Omicrini were particularly numerous in material collected by Claude Besuchet and Ivan Löbl in Sri Lanka in 1970 and in South India in 1972. Most of these belong to the genus *Psalitrus* d'Orchymont, 1919, established for *P.vandenbosscheae* d'Orchymont described from a single specimen from Palembang, Sumatra. d'Orchymont described four more Oriental and African species between 1925 and 1932. Balfour-Browne (1948) revised the genus and described five additional species from Africa, India and Indonesia. More species were described from Mauritius by Balfour-Browne (1958), and Nigeria and Sudan by Bameul (1991).

The only available information about the biology of *Psalitrus* was the habitat of *P.villiersi* Balfour-Browne 1948, collected 'sifting moss' in a primitive forest. The genus is known from tropical regions in Eastern hemisphere, including Australia where the material still needs to be described (Hansen, 1990).

This collection of Indian and Sri Lankan *Psalitrus* is constituted of eight new species different to the two previously described Indian species. Among them, four species are the first *Psalitrus* known from Sri Lanka. A systematic revision of the Indian and Sri Lankan species has been undertaken, with special attention to their identification, and since these minute beetles are very like each other additional biometric characters were examined by statistical analysis. In addition, the morphology of female ectodermal genitalia (called 'female genitalia' in the text) of each species has been studied and we have found for the first time in Hydrophilidae that female genitalia provide characters for specific identification. The field notes of Cl. Besuchet and I. Löbl bring valuable new information about the habitats of *Psalitrus*.

Omicrini appear to be rare in collections. In fact, they are often mistaken for other microcoleoptera, e.g. Phalacridae, among unidentified material in museums. However, Omicrini are easy to separate from Phalacridae by the peculiar pentagonal shape of the head, with eyes reduced and situated on lateral prominent angles, the clypeus and labrum vertical and the antennal bases visible from above, not covered by the clypeus.

The 'classical' collecting methods are not appropriate for Omicrini. The Omicrini collected by Cl. Besuchet and I. Löbl during their journeys were obtained from litter, dead leaves and decaying vegetable matter. Samples were sifted with Winkler/Moczarski eclectors (Besuchet *et al.*, 1987) so that 10–30 kg of materials were sifted per person every 2 or 3 days (Löbl, pers. comm.).

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The low numbers of Omicrini in collections are demonstrably an artefact, given the large number of *Psalitrus* collected by Besuchet and Löbl. Large series of recently collected African, New Guinean and Australian undescribed Omicrini are preserved in The Natural History Museum, London.

The goal of this work is to provide a study of the *Psalitrus* of the Indian subcontinent and to be a guide for their identification. I hope it will encourage coleopterists to examine the female genitalia of Hydrophilidae in future taxonomic and phylogenetic works.

Depositories

The material examined is deposited in the following collections: BMNH: Department of Entomology, The Natural History Museum, London; FB: collection F. Bameul, Talence; MHNG: Département d'entomologie, Muséum d'Histoire naturelle, Geneva.

Material and Methods

Specimens were relaxed in hot water. Their abdomens were carefully removed in water and dissected with fine needles. The aedeagi were examined on microscope slides in glycerol and drawn with a drawing apparatus mounted on a compound microscope. A permanent mount was made of each aedeagus in DMHF water-soluble resin on a plastic card, which was then placed under the specimen on the pin (Bameul, 1990a).

Female genitalia were examined following Carayon (1969): the abdomen is removed from the specimen with a fine needle, and put into a 5% KOH solution at the bottom of a glass tube. One or two drops of a saturated 0.7% solution of chlorazol black E dye (C. I. Nr. 30235) in 70° GL ethanol are then added to KOH and the liquid is carefully warmed during 3–5 min to 80–90°C. The abdomen is dissected in a convenient dish in the warm solution. Female genitalia, stained dark blue, are then examined on slide in 5% KOH to prevent deformation by osmotic differences (a 1 M NaCl aqueous solution is also convenient), and examined in the same way as the aedeagi.

Morphometric measurements of body were made with an Olympus VMT4 stereomicroscope and an eyepiece micrometer at ×40 magnification with an accuracy of ±0.0125 mm. Statistical analysis was by multiple-discriminant analysis (MDA) with Mahalanobis metric. The calculations were computerized using a PC-XT compatible microcomputer with the program AFD written in BASIC by Foucart (1985).

Genus *Psalitrus* d'Orchymont

Psalitrus d'Orchymont, 1919: 123–124. Type species: *Psalitrus vandenbosscheae* d'Orchymont, 1919: 124–126, by monotypy.

The genus is well defined and it can be identified using the keys in d'Orchymont (1928), Malcolm (1980, 1981) and Hansen (1990). However, some modifications in the definition of the genus are necessary. Generic characters will not be repeated in the species descriptions. The following description is a modified version of the text by Malcolm (1981):

Form very rounded, strongly convex in side view; size not exceding 2.5 mm. Head pentagonal, transverse, with maximum width at top of eyes, explanate laterally, depressed and abruptly narrowed in front of eyes; antennal bases visible from above; eyes of average size, appearing to sit on angular lateral prominences of head; Y-suture obsolete; mentum only slightly broader than long; antennae 8-segmented (5 + 3), intermediate segments minute, club elongate with loose segments (Fig. 23); ligula and labial palpi with hair-like dense yellow setae; maxillary palpi as long as antennae, with second segment dilated, third segment shorter than fourth; head incapable of retraction within prothorax, rotation downward possible so head is hardly visible from above. Prosternum extremely short in front of procoxae, reduced to form a narrow vertical bar; mid-prosternum raised as a flat triangular plate; antennal excavations absent, antennal clubs when retracted fitted against vertical face of prosternum in front of procoxae. Pronotum finely, sparsely punctured. No pro- or mesosternal devices to lock or orient segments. Mesosternal elevation pentagonal, margined anterolaterally; mesocoxae moderately separated. Metasternum projecting between mesocoxae; metepisterna narrow; metasternal grooves, ridges, and femoral lines absent; mid-metasternum slightly, gradually raised, without pubescence. Elytra with rows of fine to moderate sized punctures parallel to suture, not striate; lateral puncture rows extending progressively nearer elytral apex; elytral margins not explanate but extended ventrally; epipleura very strongly developed, especially near bases. Procoxae contiguous; first hind tarsomere only slightly longer than second, both of similar diameter; tarsi 5-segmented (5–5–5), bearing dense hair-like setae beneath; hind tibiae narrowly cylindrical; profemoral bases angulate at point of trochanteral attachment. Abdomen with 5 visible sternites; first sternite not longitudinally carinate. Aedeagus of trilobed type, with a joint between distal part and phallobase allowing anteflexion of aedeagus. Wings lacking or with extremely reduced venation, without veins in cubito-anal region, M-Cu loop vestigial (Fig. 22).

Among these characters three are believed to be autapomorphies: the eyes are larger than in other Omicrini in spite of their location on lateral angular prominences of the head (Malcolm, 1981), the antennal clubs have loose segments (Hansen, 1990) and there is a joint between the distal part and phallobase of the aedeagus (Bameul, 1990c).

The character of elongate ligula and labial palpi bearing long hair-like yellow setae to form a licking structure was originally observed only in *Aculomicrus* Smetana, 1975. Bameul (1990b) reported it in *Nannomicrus* Bameul, 1990, and it is present among all specimens of *Psalitrus* I have

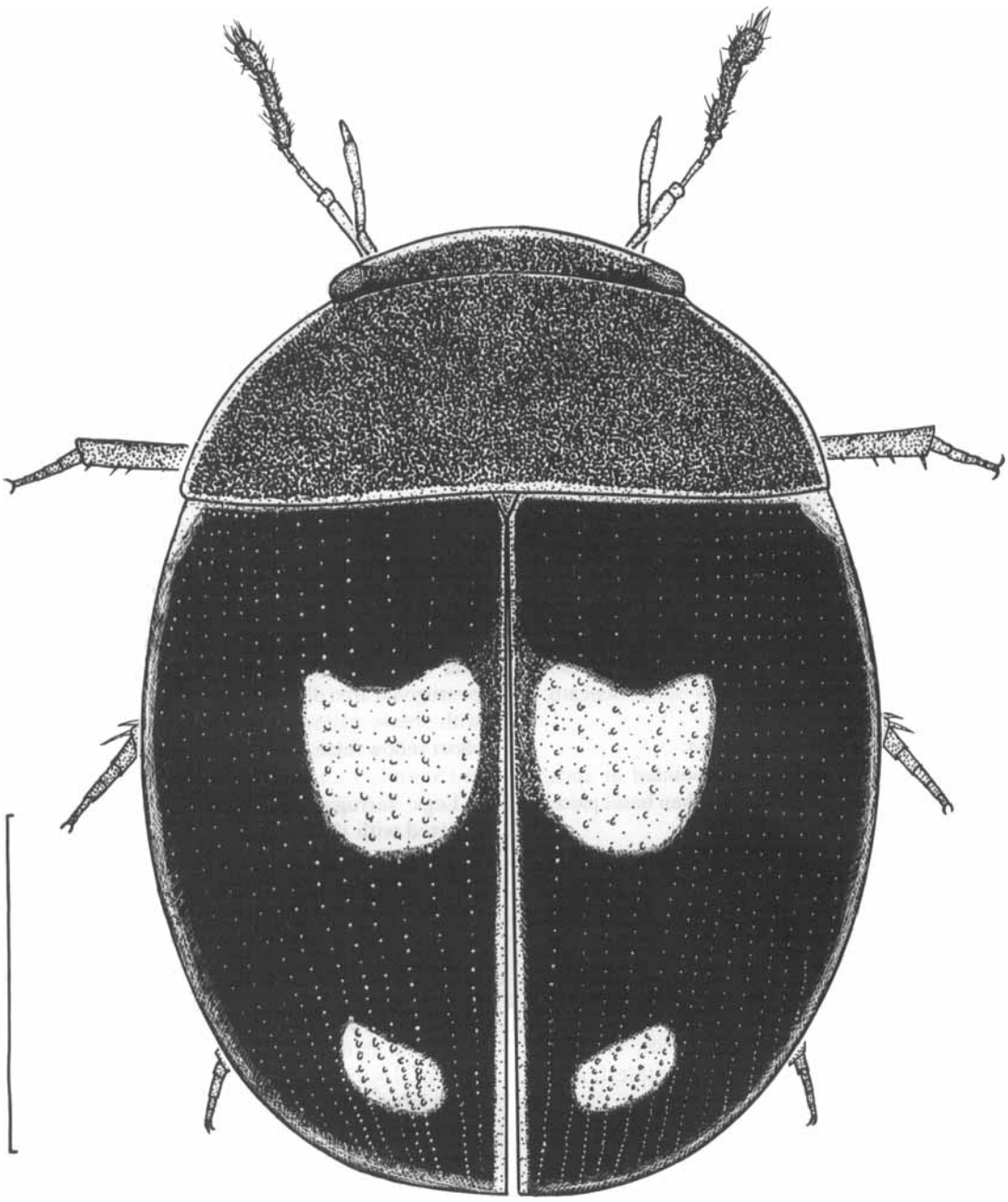


Fig. 1. *Psalitrus coccinelloides* sp.n. Scale 0.5 mm.

seen. Hansen (pers. comm.) has observed this character among several genera of Omicrini, e.g. *Paromicrus* Scott, *Omicrogiton* d'Orchymont and *Litrosurus* d'Orchymont. It could be a general feature of Omicrini.

Psalitrus silvestris sp.n.

Length: 1.275 mm; width: 0.925 mm. Oval, regularly convex, brown, very finely and sparsely micropunctate.

Head brown with two paler spots in front of eyes. Labrum large, yellow to testaceous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum brown, paler on edges, shining, very convex,

transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra brown, paler along the suture and on external margin, convex, their widest point near base. Main punctation formed by about 20 rows of large punctures quite close each other; punctation finer in scutellar and humeral regions than elsewhere, but not obsolete. Sutural stria obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression not reaching edges of pronotum and delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull at centre, shining laterally, microreticulate; central pentagonal area distinctly elevated, lines and ridges absent, with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wingless.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 4) with median lobe pointed at apex, longer than parameres; parameres longer than basal piece, bilobed at apex.

Female genitalia (Fig. 15) with oval spermatheca (L = 110 µm, l = 65 µm), nodulus not clearly defined, ramus short, infundibulum short, spermathecal duct short (L ≈ 71 µm), spermathecal gland spherical, duct of the spermathecal gland: L = 83 µm.

Etymology: the name is given since all the specimens were collected in forest.

Holotype, ♂, INDIA: Kerala, Cardamom Hills, between Pambanar and Peermade, 950 m, by sieving in forest, near a river, 5.xi.1972 (*Besuchet & Löbl*) (MHNG).

Paratypes, 1 ♀, same data as holotype; 1 ♂, Kerala, Cardamom Hills, Muttapatti near Munnar, 1700 m, by sieving in forest, at foot of a group of tree fern, 24.xi.1972 (*Besuchet & Löbl*); 1 ♂, Tamil Nadu, Palni Hills, Berijam Lake, 23 km West of Kodaikanal, 2150 m, by sieving in a rhododendron forest, 14.xi.1972 (*Besuchet & Löbl*) (MHNG; FB).

Psalitrus serendibensis sp.n.

Length: 2.012 mm; width: 1.450 mm. Rounded, regularly and highly convex, dark-brown to black, finely and sparsely micropunctate.

Head rufous. Labrum large, yellow to testaceous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, shining, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely but distinctly micropunctate, points larger and closer than on pronotum. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum darkly rufous, paler along anterior and lateral margins, shining, very convex, transverse, very finely and sparsely micropunctate. Sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum rufous, small, forming an equilateral triangle.

Elytra black, rufous along the suture and external margin, very convex, their widest point near base. Main punctation formed by about 20 rows of rather large points quite close each other; punctation finer in scutellar and humeral regions than elsewhere, but not obsolete and well visible. Sutural stria obsolete, practically not visible, even in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside rufous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull at centre, shining laterally, microreticulate; central pentagonal area distinctly elevated, lines and ridges absent, with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wingless.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 6) long, with median lobe longer than parameres, tip very large and dilated; parameres longer than basal piece, bent at apex.

Female genitalia (Fig. 12) with spermatheca oval (L = 105 µm, l = 67 µm), ramus distinctly larger than nodulus, short infundibulum (L = 27 µm), spermathecal duct rather long and slender (L ≈ 160 µm), spermathecal gland nearly spherical, duct of the spermathecal gland: L = 85 µm.

Etymology: named from Serendib, former name of Sri Lanka given by Arabian navigators.

Holotype, ♂, SRI LANKA: Central, Hatton, 1400 m, wooded mountain east of the city, by sieving in forest, 9.ii.1970 (*Besuchet & Löbl*) (MHNG).

Paratypes, 35 ex., same data as holotype (MHNG; FB).

Psalitrus veddha sp.n.

Length: 1.500 mm; width: 1.000 mm. Broadly oval, regularly convex, ferrugineous, very finely and sparsely micropunctate.

Head ferrugineous. Labrum large, yellow, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the

antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum ferrugineous, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra ferrugineous, convex, their widest point near base. Main punctation formed by about 20 rows of points quite close to each other; punctation quite large, well impressed, regular, finer in scutellar and humeral regions than elsewhere. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull at centre, shining in lateral areas, microreticulate; central pentagonal area feebly elevated, lines and ridges absent, with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wings present.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 9) with median lobe longer than parameres, spatulate, its sides narrowed from top to base; parameres as long as basal piece.

Female genitalia (Fig. 19) with oval elongate spermatheca (L = 140 µm, l = 68 µm), ramus larger than nodulus, short infundibulum (L = 32 µm), spermathecal duct long (L = 160 µm), duct of the spermathecal gland: L = 60 µm.

Etymology: this new species is named after the Veddhas, a very old ethnic group of Sri Lanka mainly inhabiting Central and Uva provinces of the island.

Holotype, ♂, SRI LANKA: Inginiyagala, collecting at light near Resthouse, 12.ii.1970 (*Besuchet & Löbl*) (MHNG).

Paratypes, 3 ex., same data as holotype; 1 ex., same data and locality, collected on the edge of a canal, under grass; 1 ex., Eastern, Kantalai, 2.ii.1970 (*Besuchet & Löbl*) (MHNG; FB).

Psalitrus loebli sp.n.

Length: 1.200 mm; width: 0.925 mm. Oval, regularly convex, black, very finely and sparsely micropunctate.

Head dark brown. Labrum large, yellow to testaceous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, rufous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum dark brown, paler on sides, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra black, dark brown along external margins and suture, convex, their widest point near base. Main punctation formed by about 20 rows of points quite close to each other; punctation obsolete in scutellar and humeral regions. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous to dark brown, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation dark brown, its centre rufous, distinctly margined. Metasternum dark brown, dull at centre, shining in lateral areas, microreticulate; central pentagonal area distinctly elevated, lines and ridges absent, with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wings often present but reduced.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 3) with median lobe parallel-sided; parameres longer than basal piece.

Female genitalia (Fig. 14) with oval short spermatheca (L = 73 µm, l = 49 µm), short infundibulum (L = 22 µm) and long spermathecal duct (L = 168 µm), duct of the spermathecal gland: L = 37 µm.

Etymology: I am glad to name this species from Dr Ivan Löbl, of the Muséum d'Histoire naturelle, Geneva, specialist in Coleoptera Scaphidiidae.

Holotype, ♂, SRI LANKA: Western, Yakkala, by sieving in a cultivated area, at a hill bottom, 14.i.1970 (*Besuchet & Löbl*) (MHNG).

Paratypes, 14 ex., same data as holotype; 3 ex., Sabaragamuwa, 2 miles east of Kalawana, by sieving at the bottom of a rock face, at forest edge, 20.i.1970 (*Besuchet & Löbl*); 1 ex., Sabaragamuwa, Kuruwita, road to Bopath Ella Falls, by sieving at the foot of a big banan, 21.i.1970 (*Besuchet & Löbl*) (MHNG; FB).

Psalitrus championi d'Orchymont

Psalitrus championi d'Orchymont, 1925: 160; 1928: 81 (catal.); Champion, 1925a: 169–171, Figs 1, 2; Balfour-Browne, 1948: 385–386, Fig. 6.

Type locality: Nilgiri Hills (India).

Length: 1.200 mm; width: 0.975 mm. Oval, regularly convex, orange to ferrugineous, very finely and sparsely micropunctate.

Head ferrugineous. Labrum large, yellow to testaceous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum ferrugineous, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra ferrugineous, convex, their widest point near base. Main punctation formed by about 20 rows of points quite close to each other; punctation obsolete in scutellar and humeral regions. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull at centre, shining in lateral areas, microreticulate; central pentagonal area distinctly elevated (Fig. 24), lines and ridges absent; with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wings present.

No visible secondary sexual dimorphism.

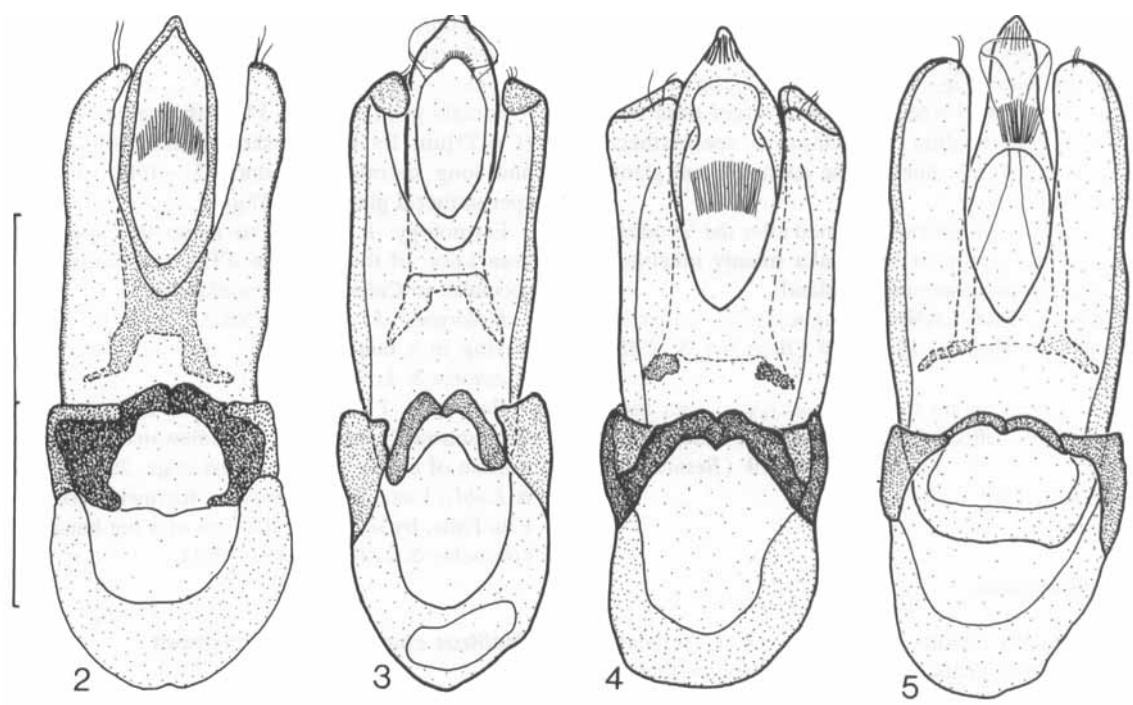
Aedeagus (Fig. 8) with median lobe spatulate, large, acuminate at apex, longer than parameres, with a Y-shaped corona; parameres rounded at tip, as long as basal piece.

Female genitalia (Fig. 18) with oval spermatheca (L = 107 μm, l = 61 μm), short infundibulum (L = 44 μm), spermathecal duct rather long and large (L = 178 μm), spermathecal gland spherical, duct of the spermathecal gland: L = 85 μm.

Distribution: known only from the Nilgiri Hills, Tamil Nadu state, India, and the Ouchterlony Valley, Barwood Estate (1070 m), India (Champion, 1925a).

Habitat: no data available.

Specimens examined: LECTOTYPE (present designation): '♂'/'Type' [round label with red margin]/'Lectotype' [round label with blue margin]/'Nilgiri Hills. [underlined by a yellow line] H.L. Andrewes'/'Andrewes Bequest. B.M. 1922-221'/'Psalitrus championi, 1925. d'Orch.'/'A. d'Orchymont det. 1925, Psalitrus championi sp.n. Type (left hand), Cotype (right hand, fixed on its back)' [in d'Orchymont's handwriting]/'Psalitrus championi d'Orch., LECTOTYPE, F. Bameul des. 1990' + 41 PARALECTOTYPES, same labels as lecto-



Figs 2–5. *Psalitrus* spp., aedeagus. 2, *P.besucheti* sp.n.; 3, *P.loebli* sp.n.; 4, *P.silvestris* sp.n.; 5, *P.fallax* Balfour-Browne. Scale 0.2 mm.

type except: 'Paralectotype' [round with blue margin]/ 'Psalitrus championi, PARALECTOTYPE, F. Bameul des. 1990' (BMNH).

Psalitrus mahanuwara sp.n.

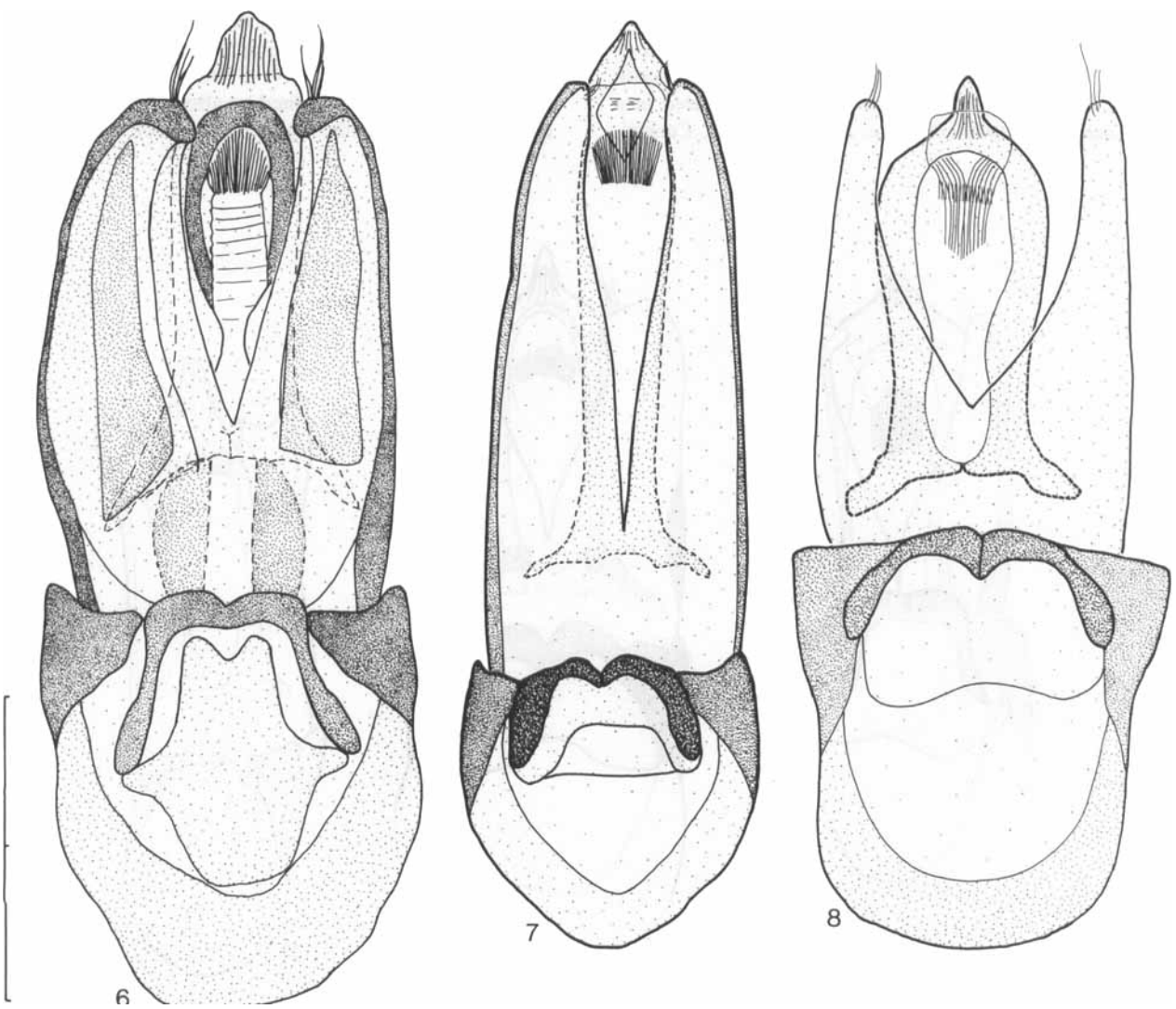
Length: 1.425 mm; width: 0.950 mm. Broadly oval, regularly convex, rufous, very finely and sparsely micropunctate.

Head rufous. Labrum large, ferrugineous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum rufous, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum rufous, small, forming an equilateral triangle.

Elytra rufous, convex, their widest point near base. Main punctation formed by about 20 rows of points quite close to each other; punctation obsolete in scutellar and humeral regions. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull at centre, shining in lateral areas, microreticulate; central pentagonal area distinctly elevated, lines



Figs 6–8. *Psalitrus* spp., aedeagus. 6, *P.serendibensis* sp.n.; 7, *P.mahanuwara* sp.n.; 8, *P.championi* d'Orchymont. Scale 0.2 mm.

and ridges absent; with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wingless.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 7) long, median lobe longer than parameres; parameres clearly longer than basal piece.

Female genitalia (Fig. 17) with oval elongated spermatheca (L = 150 µm, l = 60 µm), nodulus bulbous, duct of the spermathecal gland: L = 71 µm.

Etymology: the name of this new species is derived from the Ceylonese words Maha Nuwara ('The Big City'), another name for Kandy, the type locality.

Holotype, ♂, SRI LANKA: Central, Kandy, 600 m, Udawattekele Sanctuary, by sieving in virgin forest, 19.i.1970 (*Besuchet & Löbl*) (MHNG).

Paratypes, 9 ex., same data as holotype; 36 ex., same locality, by sieving at forest edge, 22.i.1970 (*Besuchet & Löbl*); 20 ex., Central, Kandy, 700 m, wooded hills south of the lake, by sieving of dead leaves accumulated in a large hole, 14.ii.1970 (*Besuchet & Löbl*); 2 ex., Central, Peradeniya, 550 m, by sieving in the forest near Agriculture experimental station, 19.i.1970 (*Besuchet & Löbl*) (MHNG; FB).

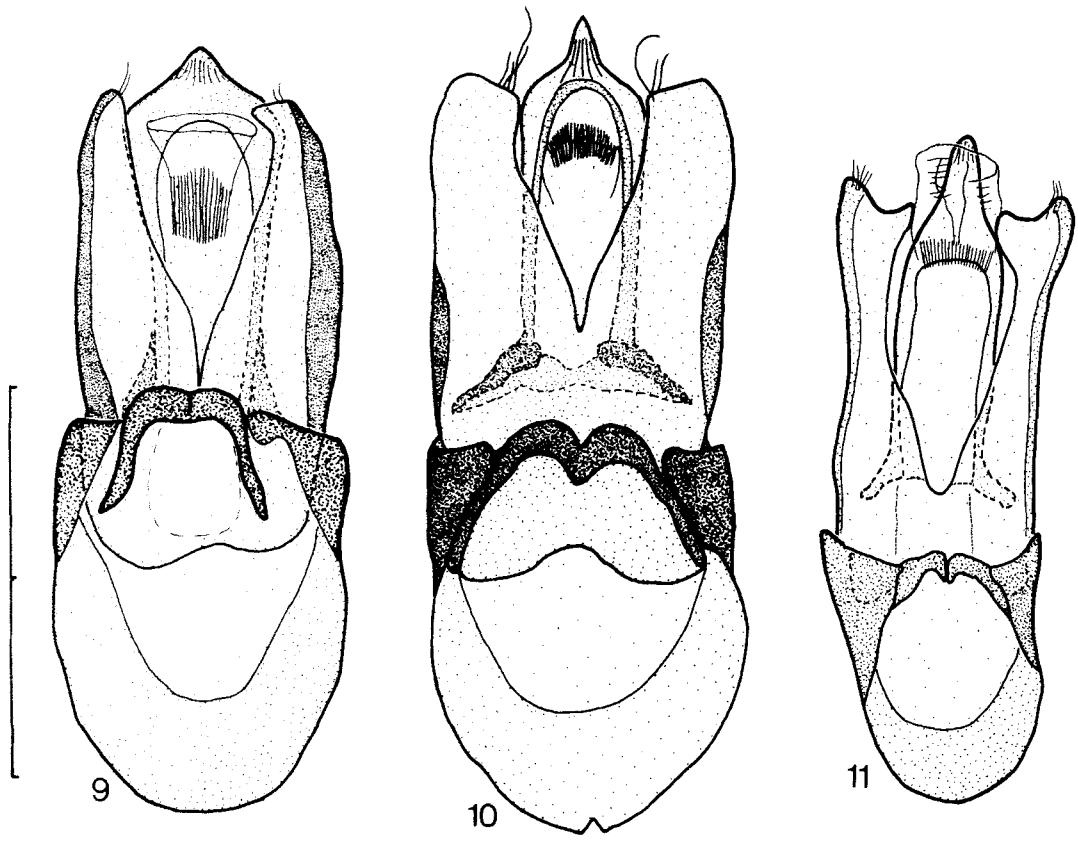
Psalitrus besucheti sp.n.

Length: 1.125 mm; width: 0.850 mm. Oval, regularly convex, dark brown to ferrugineous, very finely and sparsely micropunctate.

Head ferrugineous. Labrum large, yellow to testaceous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum ferrugineous, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra ferrugineous, convex, their widest point near base. Main punctation formed by about 20 rows of points quite close to each other; punctation obsolete in scutellar



Figs 9–11. *Psalitrus* spp., aedeagus. 9, *P.veddha* sp.n.; 10, *P.coccinelloides* sp.n.; 11, *P.decoratus* sp.n. Scale 0.2 mm.

and humeral regions. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull at centre, shining in lateral areas, microreticulate; central pentagonal area feebly elevated (Fig. 25), lines and ridges absent; with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wings present.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 2) with median lobe acuminate at tip, feebly dilated laterally, longer than parameres; parameres curved at tip, longer than basal piece.

Female genitalia (Fig. 13) with oval spermatheca (L = 98 μm, l = 51 μm), the nodulus globular, very short infundibulum (L = 22 μm), spermathecal duct very long and large (L = 160 μm), spermathecal gland elongate oval, duct of the spermathecal gland: L = 73 μm.

Etymology: I dedicate this new *Psalitrus* to Dr Claude Besuchet, of the Muséum d'Histoire naturelle, Geneva.

Holotype, ♂, INDIA: Kerala, Cardamom Hills, Mundakayam, 100 m, by sieving in a *Hevea* plantation, 9.xi.1972 (*Besuchet & Löbl*) (MHNG).

Paratypes, 69 ex., same data as holotype; 11 ex., Kerala, Cardamom Hills, Valara Fall, 46 km south-west of Munnar, 450–500 m, by sieving in the forest near the river, 25.xi. 1972 (*Besuchet & Löbl*) (MHNG; FB).

Psalitrus fallax J. Balfour-Browne

Psalitrus championi d'Orchymont; Champion, 1925b: 260 [misidentification].
Psalitrus fallax J. Balfour-Browne, 1948: 384–385, Fig. 5.
Type locality: Kumaon, Haldwani District (North India).

Length: 1.350 mm; width: 0.975 mm. Oval, regularly convex, orange to ferrugineous, very finely and sparsely micropunctate.

Head ferrugineous. Labrum large, yellow to testaceous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

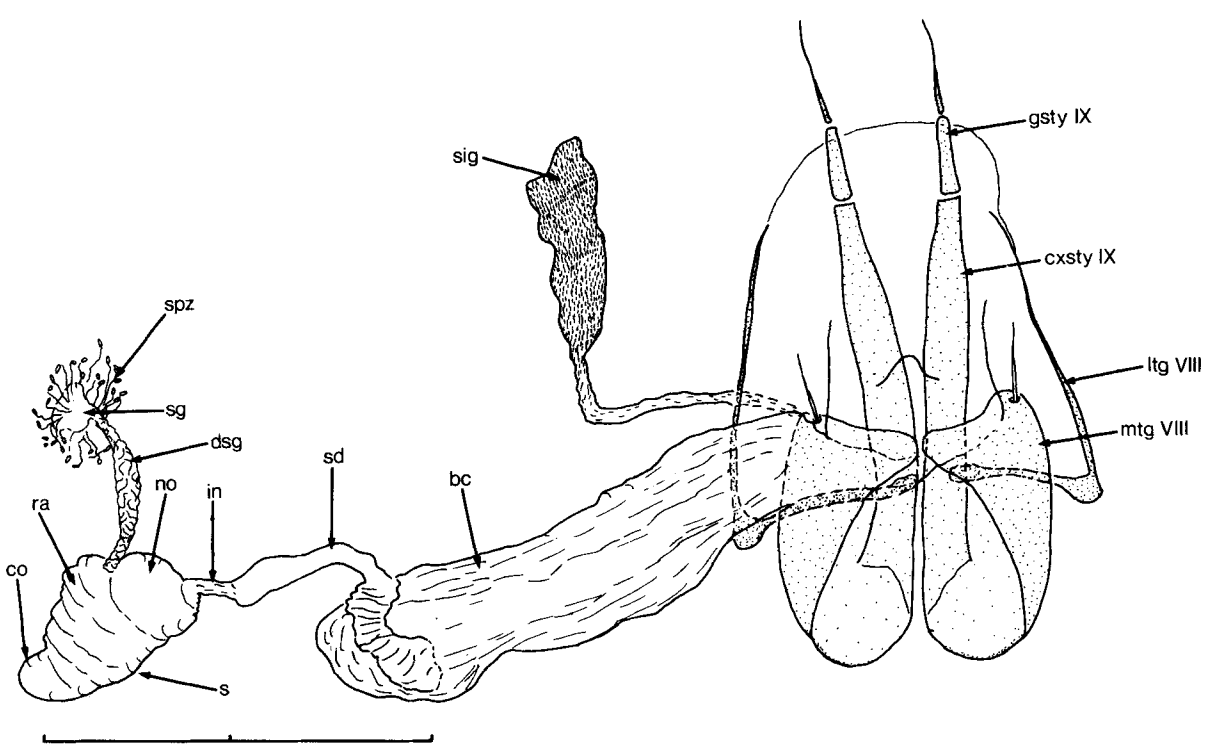


Fig. 12. *Psalitrus serendibensis* sp.n., ♀ ectodermal genitalia. *bc*, bursa copulatrix; *co*, cornu; *cxsty IX*, coxostylus IX; *dsg*, duct of the spermathecal gland; *gsty IX*, gonostylus IX; *in*, infundibulum; *ltg VIII*, laterotergite VIII; *mtg VIII*, mediotergite VIII; *no*, nodulus; *ra*, ramus; *s*, spermatheca; *sd*, spermathecal duct; *sg*, spermathecal gland; *sig*, silk gland; *spz*, spermatozoa; Scale 0.2 mm.

Pronotum ferrugineous, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra ferrugineous, convex, their widest point near base. Main punctation formed by about 20 rows of points quite close to each other; punctation obsolete in scutellar and humeral regions. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum shining, microreticulate; central area feebly elevated, almost at the same level than the lateral areas (Fig. 26); lines and ridges absent; with sparse yellow setae, except at centre. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wings present.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 5) with median lobe concave on edges near apex, longer than parameres; parameres rounded at tip, subparallel laterally, longer than basal piece.

Female genitalia (Fig. 16) with oval spermatheca (L = 110 μm, l = 78 μm), ramus larger than nodulus, short infundibulum (L = 21 μm), spermathecal duct short (L ≈ 24 μm), with a lateral diverticulum, spermathecal gland nearly spherical, duct of the spermathecal gland: L = 76 μm.

Distribution: known only from Kumaon, Haldwani district, North India (Balfour-Browne, 1948).

Habitat: no data available.

Specimens examined: LECTOTYPE (present designation): '♂'/'Type' [round with red margin]/'Haldwani Dist., Kumaon, India. H.G.C.'/'G.C. Champion. B.M. 1926-481' [upside down]/'Psalitrus championi d'Orch.' [in handwriting]/'Psalitrus fallax Type!, J. Balfour-Browne det.'/'Lectotype' [round with blue margin]/'Psalitrus fallax J.B.B., LECTOTYPE, F. Bameul des. 1990' + 1 PARALECTOTYPE: '♂'/'Cotype' [round with yellow margin]/'Haldwani Dist., Kumaon, India. H.G. Champion., Brit. Mus., 1925-42.'/'E.M.M. 1925. det. G.C.C.'/'Psalitrus championi d'Orch.' [in handwriting]/'Psalitrus fallax Cotype!, J. Balfour-Browne det.'/'Paralectotype' [round with blue margin]/'Psalitrus fallax J.B.B., PARALECTOTYPE, F. Bameul des. 1990' (BMNH).

Psalitrus decoratus sp.n.

Length: 1.200 mm; width: 0.900 mm. Oval, regularly convex, orange to ferrugineous, very finely and sparsely micropunctate.

Head ferrugineous. Labrum large, ferrugineous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, ferrugineous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum ferrugineous, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra convex, their widest point near base, ferrugineous, with a dark rufous C-shaped macula, extending in three first quarters of the length, reaching anterior edge and suture. Main punctation formed by about 20 rows of points quite close to each other; punctation obsolete in scutellar and humeral regions. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull, shining in lateral areas, microreticulate; central pentagonal area distinctly elevated; lines and ridges absent; with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, with spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wings present.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 11) with median lobe longer than parameres, not pointed at apex; parameres bifurcate at tip, longer than basal piece.

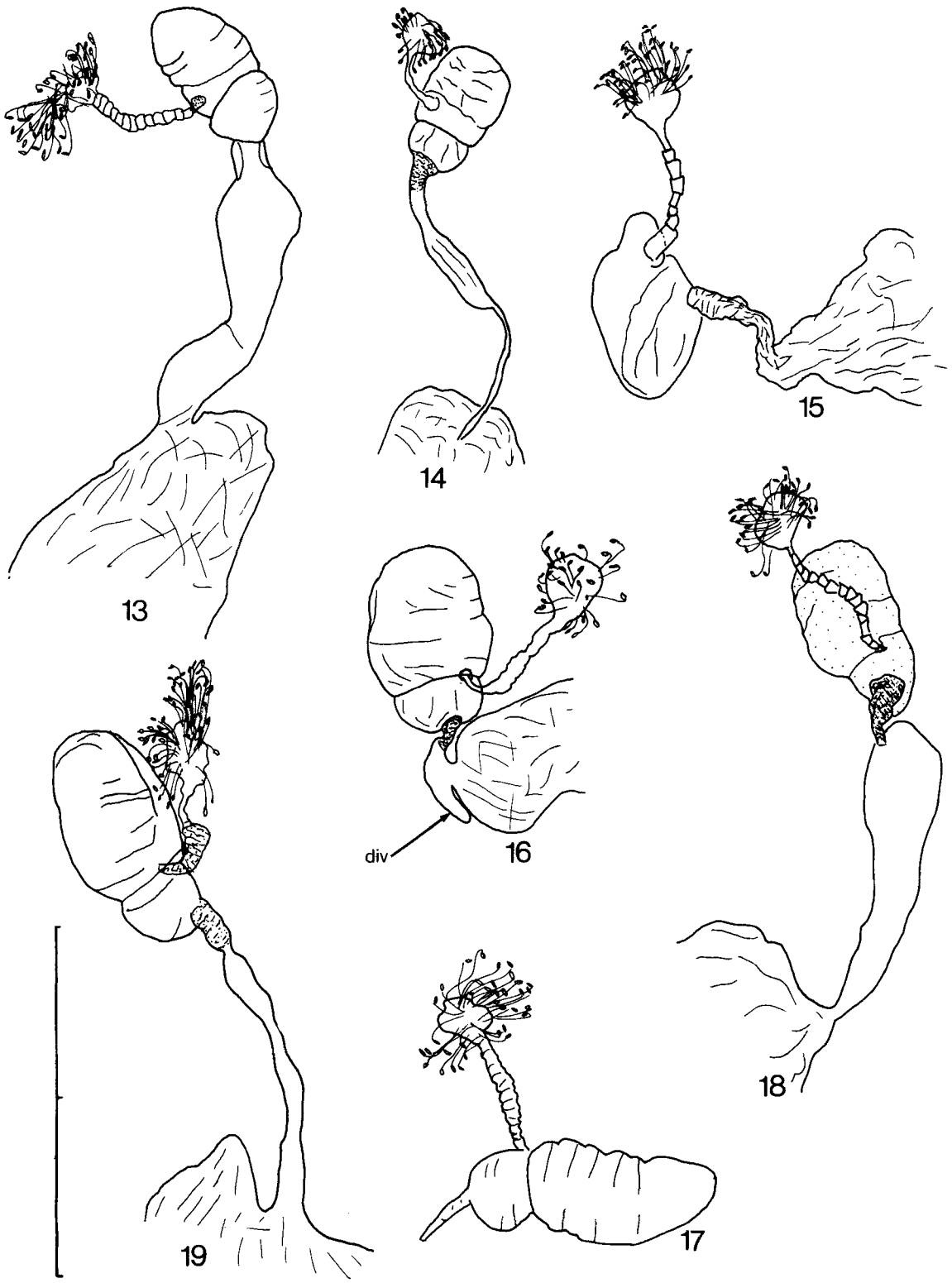
Female genitalia (Fig. 21) with large oval spermatheca (L = 141 μm, l = 32 μm), short infundibulum (L = 34 μm), short spermathecal duct (L ≈ 50 μm), spermathecal gland reduced, duct of the spermathecal gland: L = 98 μm.

Etymology: named in reference to the peculiar elytral pattern of this new species.

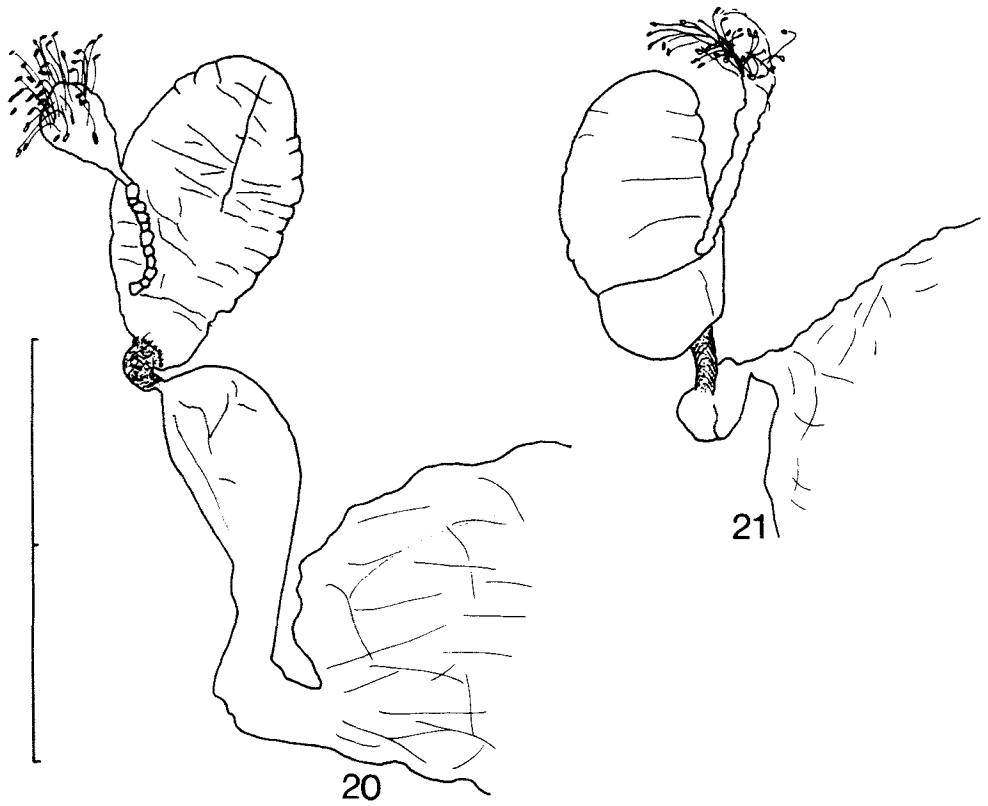
Holotype, ♂, INDIA: Kerala, Cardamom Hills, Valara Fall, 46 km south-west of. Munnar, 450–500 m, by sieving in the forest near the river, 25.xi.1972 (*Besuchet & Löbl*) (MHNG).

Paratypes, 18 ex., same data as holotype; 5 ex., Kerala, Cardamom Hills, between Pambanar and Peermade, 950 m, by sieving in forest near a river, 9.xi.1972 (*Besuchet & Löbl*) (MHNG; FB).

Discussion: the elytral colour pattern of *P.decoratus* is variable (Fig. 28). Form '*d*' is more commonly observed while *f* is a form with a colour pattern similar to *P.coccinelloides*.



Figs 13–19. *Psalitrus* spp., ♀ ectodermal genitalia. 13, *P.besucheti* sp.n.; 14, *P.loebli* sp.n.; 15, *P.silvestris* sp.n.; 16, *P.fallax* J. Balfour-Browne; div, diverticulum of the spermatheca. 17, *P.mahanuwara* sp.n.; 18, *P.championi* d'Orchymont; 19, *P.veddha* sp.n. Scale 0.2 mm.



Figs 20–21. *Psalitrus* spp., ♀ ectodermal genitalia. 20, *P.coccinelloides* sp.n.; 21, *P.decoratus* sp.n.; Scale 0.2 mm.

Psalitrus coccinelloides sp.n.

Length: 1.475 min; width: 0.900 mm. Oval, regularly convex, dark brown to black (Fig. 1), shining, very finely and sparsely micropunctate.

Head black. Labrum large, yellow to testaceous, with anterior margin slightly emarginate. Clypeus emarginate, nearly vertical, rufotestaceous, very finely and sparsely micropunctate, sides with rectangular lateral prominences under the antennal bases, finely margined in front and laterally. Fronto-clypeal suture obsolete. Frons finely micropunctate. Maxillary palpi testaceous. Antennae testaceous with darker club, second segment rounded, third segment longer than fourth and fifth.

Pronotum ferrugineous, margins testaceous, shining, very convex, transverse, very finely and sparsely micropunctate; sides very finely margined and regularly rounded; anterior angles obtuse, rounded, hind angles nearly 90°. Scutellum ferrugineous, small, forming an equilateral triangle.

Elytra convex, their widest point near base, rufous, with 3 testaceous maculae, one oval on disc, in first third near suture, extending between first and fifth rows of punctures, second in apical region in the last third, extending between second and eleventh rows, third macula triangular along the apical margin, often united with second maculae; margins testaceous. Main punctation formed by about 20 rows of points quite close to each other; punctation finer in scutellar and humeral regions but still clearly visible, not obsolete. Sutural stria very obsolete, visible only in apical quarter. Background very finely and sparsely micropunctate. Interstriae flat.

Underside ferrugineous, dull, microreticulate. Prosternum distinctly margined; antennal cavities barely defined, consisting of an oval depression, not reaching lateral margins of pronotum, delimited by an oblique posterior ridge. Mesosternal elevation distinctly margined. Metasternum dull at centre, shining in lateral areas, microreticulate; central pentagonal area distinctly elevated; lines and ridges absent; with sparse yellow setae. Abdomen covered with dense short yellow setae, first sternite without longitudinal carina, last sternite without apical emargination in both sexes.

Legs ferrugineous; femora dilated anterolaterally, covered with short dense yellow setae; tibiae cylindrical, with 3 rows of spines, spines at apex as long as first tarsomere; tarsi covered by short yellow setae beneath. Claws yellow, short. Wings present.

No visible secondary sexual dimorphism.

Aedeagus (Fig. 10) with median lobe longer than parameres, acuminate at tip, with subparallel sides; parameres subparallel, truncated at apex, as long as basal piece.

Female genitalia (Fig. 20) with large oval spermatheca (L = 160 µm, l = 88 µm), short infundibulum (L = 24 µm),

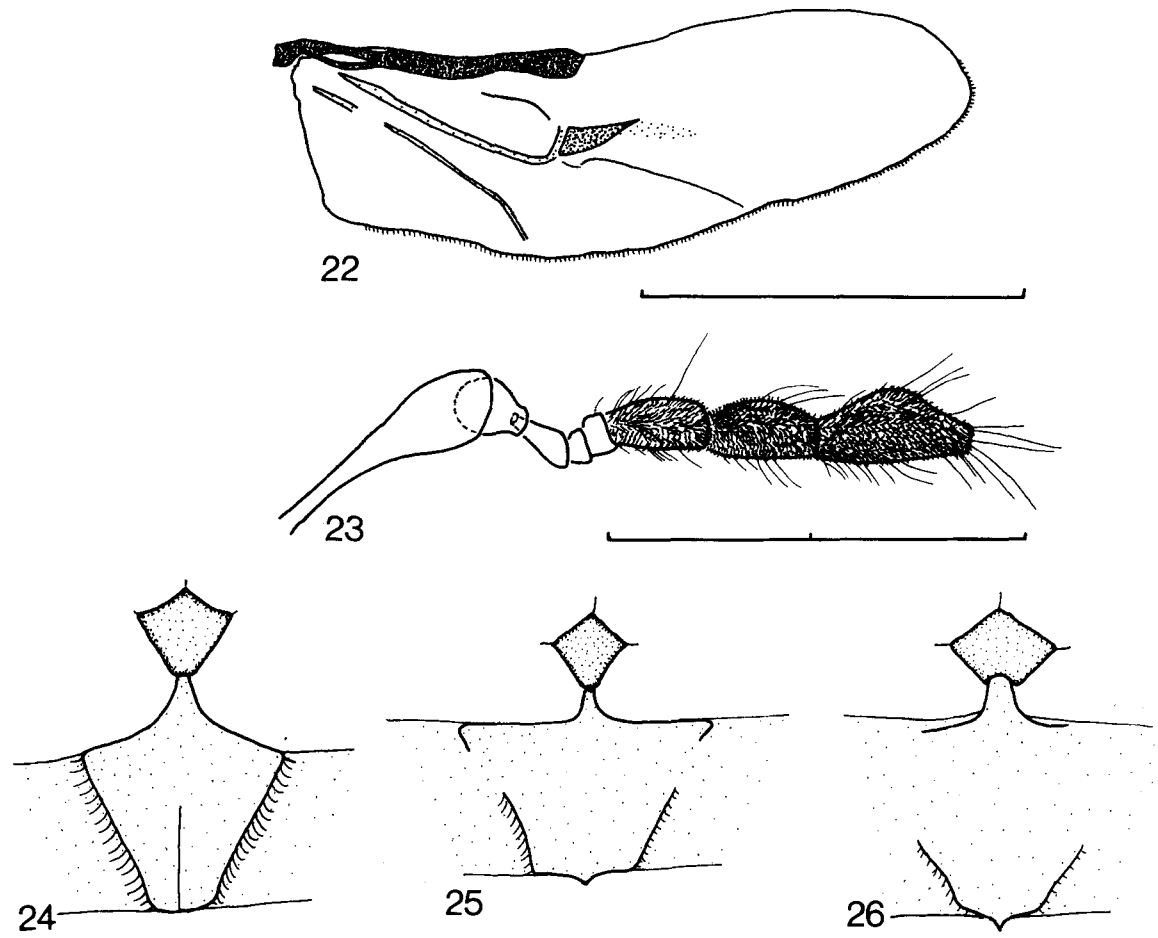


Fig. 22–26. 22, *Psalitrus decoratus* sp.n., wing. Scale 1 mm. 23, *Psalitrus* sp., antenna. Scale 0.2 mm. 24–26, *Psalitrus* spp., mesosternal apophysis and metasternal pentagonal plate. 24, *P.championi* d'Orchymont; 25, *P.besucheti* sp.n.; 26, *P.fallax* Balfour-Browne.

spermathecal duct rather long and large (L = 176 μm), spermathecal gland pyriform, duct of the spermathecal gland: L = 56 μm.

Etymology: named after the peculiar elytral pattern resembling that of some Coccinellidae, e.g. *Nephus*.

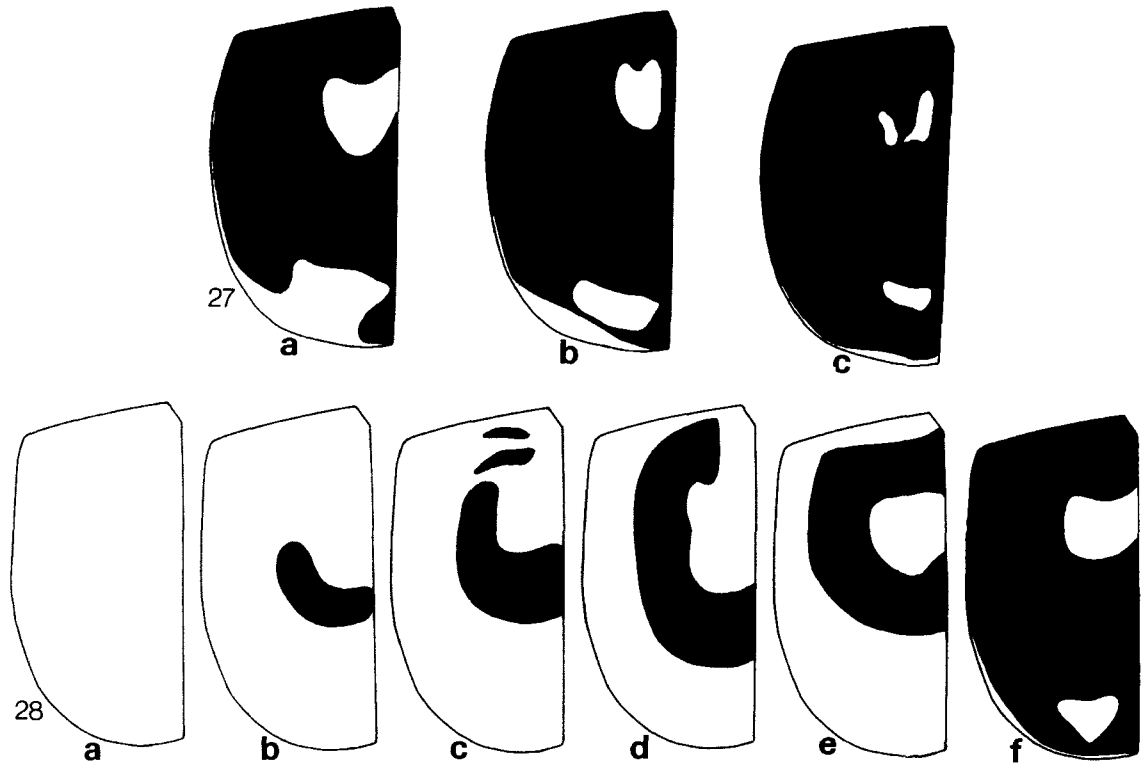
Holotype, ♂, INDIA: Tamil Nadu, Anaimalai Hills, 18 km north of Valparai, 1250 m, by sieving in forest, 18.xi.1972 (*Besuchet & Löbl*) (MHNG).

Paratypes, 56 ex., same data as holotype (MHNG; FB).

Discussion: *P.coccinelloides* and the related species *P.decoratus* have an elytral colour pattern that seems to be unique within the Omicrini. It is extremely variable in both species between two extremes (Figs 27, 28). This variation in elytral pattern may be an example of the diffusing-morphogen-gene-activation model mechanism proposed by Murray (1981) for the formation of colour patterns on animals.

Character assessment

Although it is easy to identify male specimens of *Psalitrus* by their aedeagi, it is useful to include external characters in identification keys whenever possible. However, the ten known species of Indian and Sri Lankan *Psalitrus* are extremely similar; the only available good external characters are the elytral colour pattern (*P.decoratus* and *P.coccinelloides*), the non-obsolete punctation in the scutellar and discal regions (*P.silvestris*, *P.veddha* and *P.serendibensis*) and the shape of the metasternal pentagonal plate. Since *Psalitrus* exhibit differences in size it was natural to search for morphometric characters to be used in a key to species. Six measurements were made on 246 specimens (Fig. 35) and three dimensional ratios were calculated; the results are shown in Table 1. The nine biometric parameters were computed by multiple-discriminant analysis (MDA). This multivariate analysis technique is useful to examine and enhance the properties distinguishing different groups (i.e. the species). It can be used to study geographical variations within a species (Zimmerman & Ludwig, 1975), and it is particularly powerful in search of distinguishing characters of two or more very close taxa (Zimmerman, 1980; Wiley, 1981; Foucart, 1985; Verschuren, 1989). MDA is not able to



Figs 27–28. *Psalitrus* spp., elytral colour variation. 27, *P.coccinelloides* sp.n.; 28, *P.decoratus* sp.n.

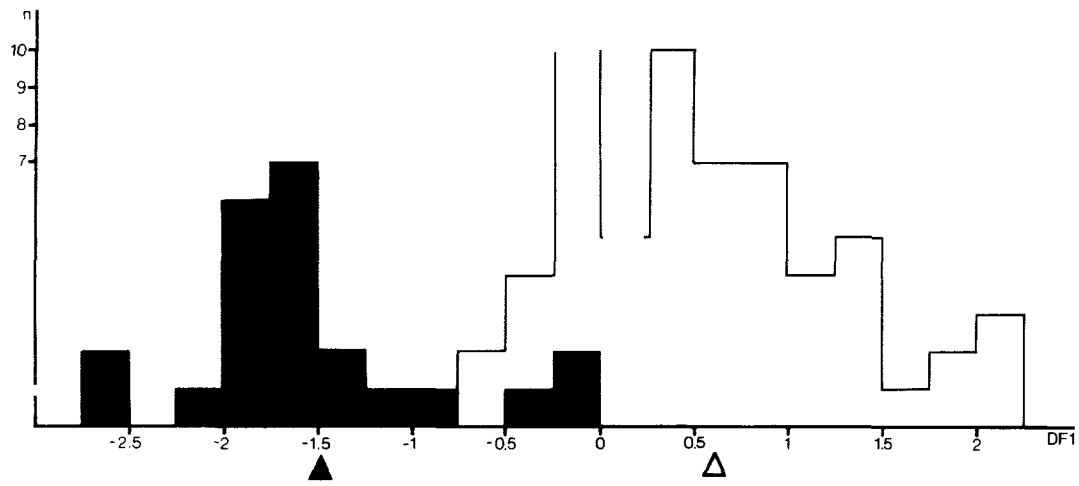


Fig. 29. Frequency distribution of *Psalitrus decoratus* sp.n. (■) and *P.coccinelloides* sp.n. (□) on the axis of discriminant function. Triangles indicate the group means.

show phylogenetic relationships between taxa and with the present level of knowledge of *Psalitrus* a cladistic analysis is not possible.

The species were initially placed in three groups. The first group analysed comprised *P.decoratus* and *P.coccinelloides*, which are easy to separate from the other species by their elytral colour pattern. The result is shown in Fig. 29. There is only one discriminating axis and the width of specimens (TW) is the variable best correlated with this (coefficient of correlation (CC) = 0.99). However, the discriminant coefficient (DC) of this variable is only 0.55. The scores of the species overlap in the diagram, so the analysis is not entirely discriminant (only 0.75). This is a consequence of an overlapping of TW values between

Table 1. Biometric data (in mm). BL, body length. EL, elytral length. HW, head width. MH, maximum height. MH/BL, convexity ratio. PL, pronotum length. PW, pronotum width. PW/TW, parallelism ratio. TW, width. TW/BL, circularity ratio. min, minimum value. max, maximal value. $\bar{x}$, mean. s, standard deviation.

		PL	EL	TW	PW	HW	MH	TW/BL	PW/TW	MH/BL
P.besucheti	min	0.25	0.68	0.70	0.68	0.40	0.41	0.62	0.81	0.37
($n = 29$)	max	0.31	0.90	0.95	0.82	0.45	0.63	0.89	1.11	0.53
	$\bar{x}$	0.28	0.79	0.83	0.75	0.43	0.53	0.78	0.91	0.41
	s	0.02	0.05	0.06	0.03	0.01	0.05	0.06	0.08	0.03
P.loebli	min	0.29	0.75	0.80	0.31	0.41	0.47	0.71	0.31	0.35
($n = 19$)	max	0.36	0.93	1.05	0.85	0.49	0.63	0.95	0.94	0.41
	$\bar{x}$	0.31	0.83	0.89	0.74	0.44	0.54	0.78	0.84	0.39
	s	0.02	0.05	0.06	0.11	0.02	0.04	0.04	0.13	0.02
P.decoratus	min	0.25	0.75	0.76	0.70	0.40	0.42	0.58	0.75	0.35
($n = 23$)	max	0.35	1.00	1.05	0.90	0.50	0.68	0.89	1.06	0.43
	$\bar{x}$	0.31	0.88	0.88	0.78	0.45	0.54	0.75	0.89	0.38
	s	0.03	0.07	0.07	0.05	0.03	0.06	0.07	0.08	0.02
P.fallax	min	0.33	0.97	1.00	0.85	0.45	0.50	0.73	0.85	0.33
($n = 2$)	max	0.33	1.05	1.00	0.85	0.45	0.53	0.77	0.85	0.35
	$\bar{x}$	0.33	1.01	1.00	0.85	0.45	0.51	0.75	0.85	0.34
	s	0.00	0.04	0.00	—	0.00	0.01	0.02	—	0.01
P.championi	min	0.33	0.93	0.97	0.82	0.45	0.57	0.71	0.75	0.34
($n = 6$)	max	0.38	1.07	1.10	0.93	0.53	0.65	0.85	0.90	0.40
	$\bar{x}$	0.35	0.99	1.02	0.88	0.50	0.61	0.76	0.86	0.37
	s	0.02	0.05	0.04	0.03	0.03	0.03	0.04	0.05	0.02
P.silvestris	min	0.25	0.85	0.93	0.78	0.45	0.57	0.75	0.81	0.34
($n = 4$)	max	0.40	1.20	1.20	0.97	0.55	0.72	0.84	0.89	0.41
	$\bar{x}$	0.31	1.03	1.03	0.87	0.50	0.67	0.77	0.84	0.37
	s	0.05	0.13	0.11	0.07	0.04	0.06	0.04	0.03	0.02
P.veddha	min	0.30	0.95	0.93	0.82	0.47	0.55	0.70	0.83	0.36
($n = 5$)	max	0.38	1.02	1.10	0.93	0.53	0.68	0.81	0.92	0.51
	$\bar{x}$	0.34	0.99	1.00	0.88	0.49	0.64	0.75	0.88	0.40
	s	0.02	0.03	0.06	0.04	0.02	0.04	0.04	0.03	0.05
P.coccinelloides	min	0.31	0.88	0.95	0.80	0.45	0.45	0.67	0.72	0.34
($n = 57$)	max	0.40	1.11	1.20	0.99	0.55	0.90	0.92	0.95	0.40
	$\bar{x}$	0.35	0.96	1.06	0.89	0.50	0.62	0.81	0.84	0.38
	s	0.02	0.06	0.06	0.04	0.02	0.08	0.05	0.06	0.01
P.mahanuwara	min	0.30	0.82	0.88	0.80	0.42	0.53	0.68	0.77	0.33
($n = 67$)	max	0.42	1.13	1.20	1.02	0.53	0.97	0.92	0.97	0.40
	$\bar{x}$	0.36	1.00	1.06	0.91	0.48	0.67	0.79	0.86	0.36
	s	0.03	0.06	0.08	0.05	0.02	0.07	0.05	0.04	0.02
P.serendibensis	min	0.35	0.95	1.07	0.97	0.53	0.70	0.71	0.73	0.33
($n = 34$)	max	0.50	1.38	1.50	1.15	0.60	0.97	0.95	0.95	0.41
	$\bar{x}$	0.40	1.17	1.28	1.06	0.56	0.84	0.81	0.83	0.36
	s	0.03	0.10	0.09	0.05	0.03	0.07	0.06	0.05	0.02

P.decoratus and *P.coccinelloides*, as shown by a Dice-Leraas diagram (Fig. 30). However, the means of the TW differ in the two species and the confidence limits of the means do not overlap. As the means occur in the confidence limits with very high probability ($P = 0.99$) I believe that the use of the values of TW within these limits helps to distinguish *P.decoratus* and *P.coccinelloides*.

The second analysis was on the three species with similar scutellar and discal punctation: *P.silvestris*, *P.veddha* and *P.serendibensis*. The first axis of the scatter-diagram (Fig. 31) is the most discriminant with a high 0.997 value, with only 0.206 for the second axis. The first axis is strongly

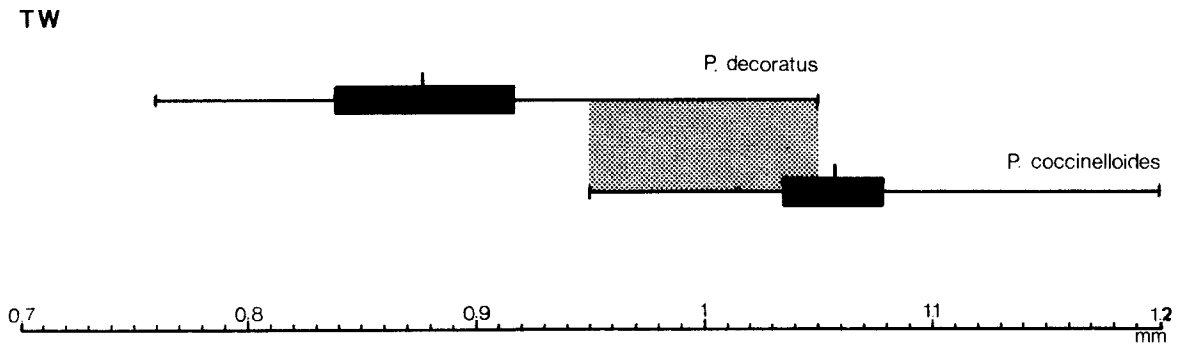


Fig. 30. Dice-Leraas diagram of total width of the body of *P.decoratus* sp.n. and *P.coccinelloides* sp.n. Horizontal lines, range. Black bars, confidence limits of the mean. Vertical lines, means. Grey interval, overlapping.

correlated with the ratio maximum height/body length (CC = 0.98), head width (CC = 0.97), elytral length (CC = −0.96) and pronotum width (CC = 0.85). Unfortunately, all these variables are poorly discriminant: they have low DCs, with the best on the first axis being DC = 0.59 (for the ratio pronotum width/total width). However, this character proved to be unsatisfactory. The number of measured specimens of *P.silvestris* and *P.veddha* is too low for a confidence limits calculation and the ratio is too variable in *P.serendibensis* (s = 0.05). So, in spite of an excellent graphic result it is impossible to select useful discriminant variables for the identification of the three species, since no particular variable is discriminant but the combination of almost all variables is responsible for the discrimination.

The species with elytral punctation more or less obsolete in the scutellar region were the subject of the third MDA: *P.besucheti*, *P.loebli*, *P.fallax*, *P.championi* and *P.mahanuwara*. On the scatter-diagram (Fig. 32), the first axis is most discriminant (0.82). Two characters correlated with the first axis are good discriminants: elytral length (CC = −0.96, DC = −0.66) and pronotum length (CC = −0.86, DC = −0.64). Pronotum width is discriminant and correlated with the second axis (CC = −0.96, DC = −0.758). However, there are strong overlaps between character scores, as shown by Dice-Leraas diagrams (Figs 33, 34). In species from which a low number of measurements were made the confidence limits are larger than the range (i.e. *P.championi*). In this third MDA only *P.besucheti* and *P.mahanuwara* could be separated by morphometric characters, the most discriminant being the pronotum length and pronotum width.

On female genitalia in Hydrophilidae

Female genitalia of Hydrophilidae are very poorly known and no complete study of their morphology is available. The spermatheca and associated gland and ducts seems to be of a 'classical' saccular type as seen in many families of Coleoptera (see Iablokoff-Khnzorian (1974) for a general survey and references). There are no sclerotized plates or differentiated structures such as spines in the spermatheca and *bursa copulatrix* as there are in Elateridae (Dajoz, 1964).

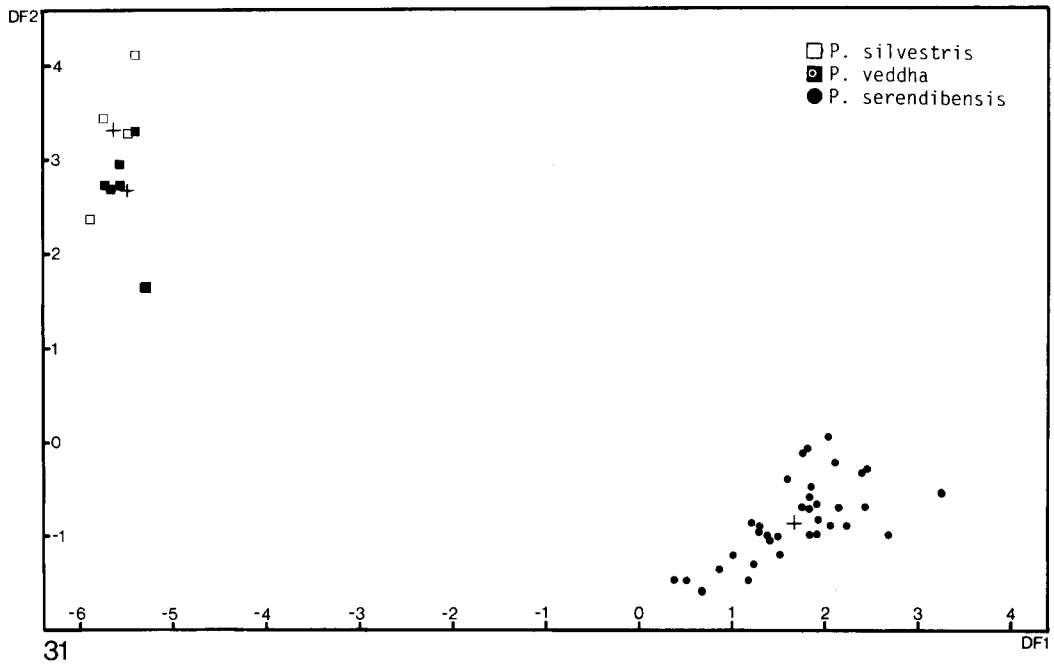
Until now, specific characters offered by the spermatheca and associated structures in Hydrophiloidea have been overlooked and not used for identification (see Smetana, 1974; Hansen, 1987). Only in Hydraenidae – a group which is included by modern authors in Staphylinoidea – have spermathecal characters been used (i.e. Ordish, 1984). However, use of the stain chlorazol black E (see 'Material and Methods') makes all ectodermal membranous structures dark blue, the dye thus showing structural differences which are normally transparent and invisible (Figs 12–21). The method proved to give reliable results and makes identification of females possible even in groups of very similar species.

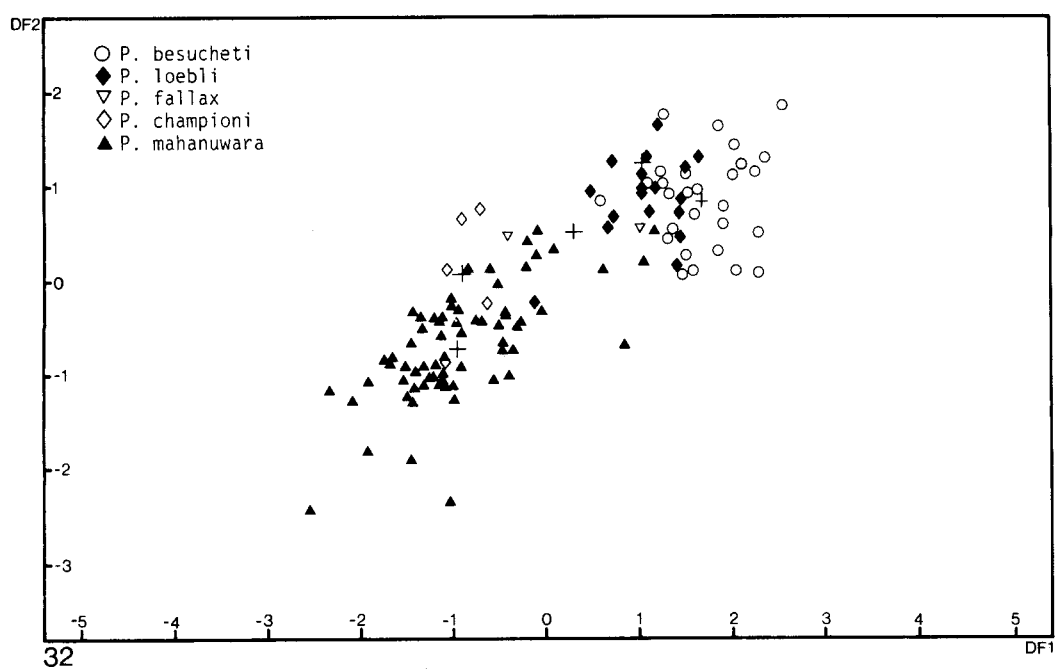
Female genitalia of *Psalitrus* (Fig. 12) are constituted by: (1) a sclerotized part: laterotergite VIII (formerly ninth tergite), mediotergite VIII (formerly 'valvifer'), coxostyle IX and gonostyle IX (formerly 'stylus') (terminology and definitions by Deuve, 1988) and (2) a membranous part: an associated gland – probably a silk gland – the *bursa copulatrix*, spermathecal duct, spermatheca with its *infundibulum*, *nodulus*, *ramus* and *cornu*, and the so-called spermathecal gland with its duct (terminology after Dobzhansky, 1926). It is notable that spermatozoa are also visible. Carayon (1969) has reported the affinity of chlorazol black for spermatozoa. However, in *Psalitrus* spermatozoa are always observed around the spermathecal gland lumen but not in the spermatheca. The spermatozoa seems to adhere together with the spermathecal gland lumen by their flagellum. The same have been observed in some African and Asiatic *Psalitrus* species (Bameul, 1991).

Key to the *Psalitrus* species from India and Sri Lanka

1 Elytra with a colour pattern, constituted by dark marking with clear background or clear markings with dark background (Figs 1, 27–28) 2

– Elytra without colour pattern, completely ferrugineous, rufous or dark brown 3





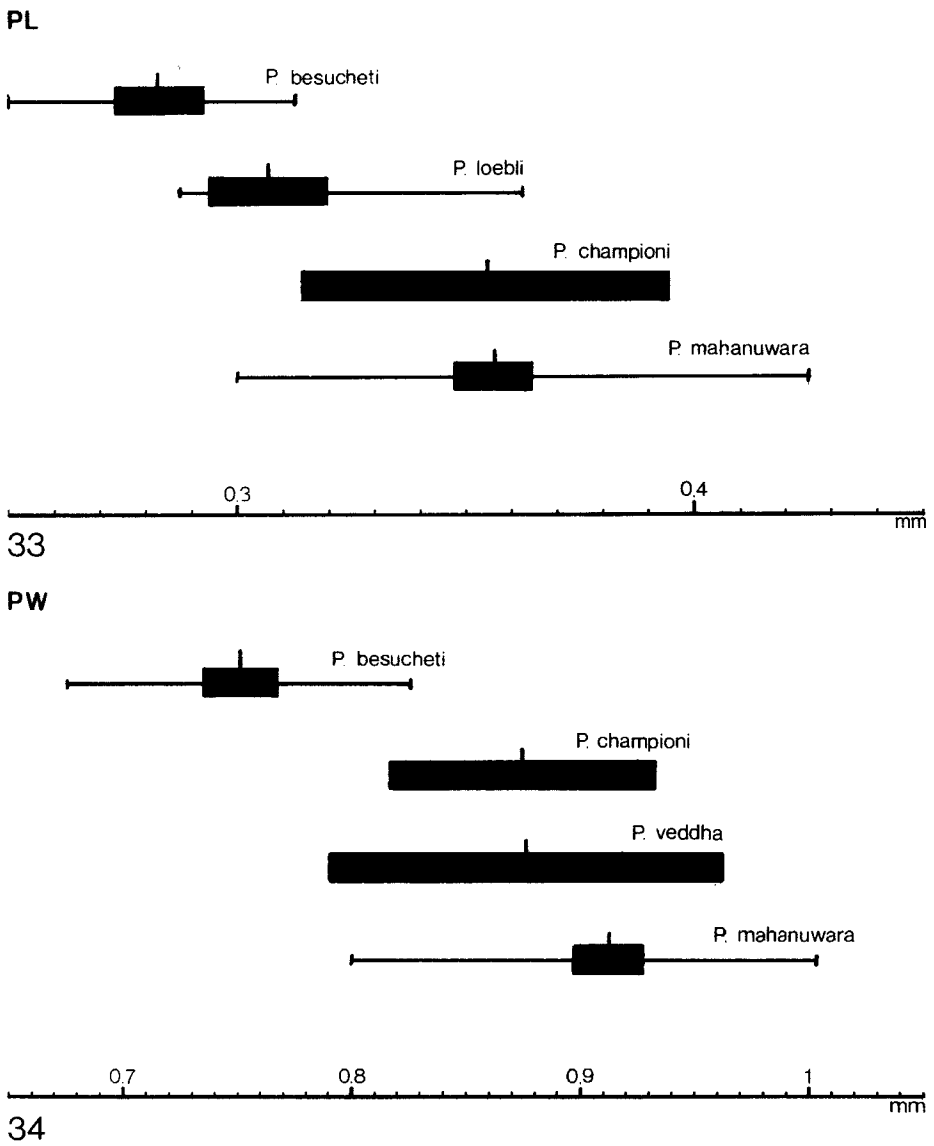
Figs 31–32. Scatter-diagrams of distribution of *Psalitrus* along their first two discriminant functions. Crosses indicate the group centroids positions.

2 Total width of body < 0.95 mm (Fig. 30), if between 0.95 and 1.05 mm check genitalia characters. Parameres bilobed at tip (Fig. 11). Nodulus of spermatheca present (Fig. 21). Spermathecal duct short: L < 100 µm. (India). *decoratus* sp.n.

– Total width of body > 1.05 mm (Fig. 30), if between 0.95 and 1.05 mm check genitalia characters. Parameres truncate at tip (Fig. 10). Nodulus of spermatheca not clearly visible (Fig. 20). Spermathecal duct long: L > 100 µm. (India) ..... *coccinelloides* sp.n.

3 Elytral punctation well-defined in scutellar region, with punctures as large as in discal region 4

– Elytral punctation obsolete in scutellar region, with punctures smaller than in discal region 7



Figs 33–34. Dice-Leraas diagrams of: 33, Pronotum length; 34, Pronotum width. Horizontal lines, range; black bars, confidence limits of the mean; vertical lines, means.

4 Metasternal pentagonal plate feebly elevated (Fig. 25). Aedeagus with median lobe enlarged at apex (Fig. 9). Cornu of spermatheca not present (Fig. 19). Spermathecal duct long: L ≈ 140 µm. Wings present. (Sri Lanka) ... *veddha* sp.n.

– Metasternal pentagonal plate distinctly elevated (Fig. 24). Aedeagus with median lobe not enlarged at apex (Figs 4, 6). Cornu of spermatheca visible (Figs 12, 15). Spermathecal duct shorter: L < 120 µm. Wingless species 5

5 Colour dark-brown to black. Pronotal width >0.97 mm. Aedeagus large, median lobe with a dilated apex and parameres curved inward at tip (Fig. 6). Spermathecal duct longer: L ≈ 105 µm (Fig. 12). (Sri Lanka) ..... *serendibensis* sp.n.

– Colour testaceous to brown. Pronotal width <0.97 mm. Aedeagus small, with median lobe pointed at apex and parameres bilobed at tip. Spermathecal duct shorter 6

6 Colour brown. Aedeagus as in Fig. 4. Spermatheca with a reduced ramus. Spermathecal duct: L ≈ 71 µm (Fig. 15) (India) ..... *silvestris* sp.n.

– Colour testaceous. Aedeagus as in Fig. 11. Spermatheca with a well-defined ramus. Spermathecal duct: L ≈ 50 µm (Fig. 21) (India) ..... *decoratus* sp.n. variety *a* (Fig. 28)

7 Metasternal pentagonal plate feebly elevated (Fig. 26) 8

– Metasternal pentagonal plate strongly elevated (Fig. 24)..... 9

8 Aedeagus with median lobe parallel-sided, pointed at apex (Fig. 2). Spermathecal duct very long and large (L = 160 µm) without spermathecal diverticulum (Fig. 13). (India) ..... *besucheti* sp.n.

– Aedeagus with median lobe concave at sides (Fig. 5). Spermathecal duct very short, practically not distinct (L ≈ 24 µm),

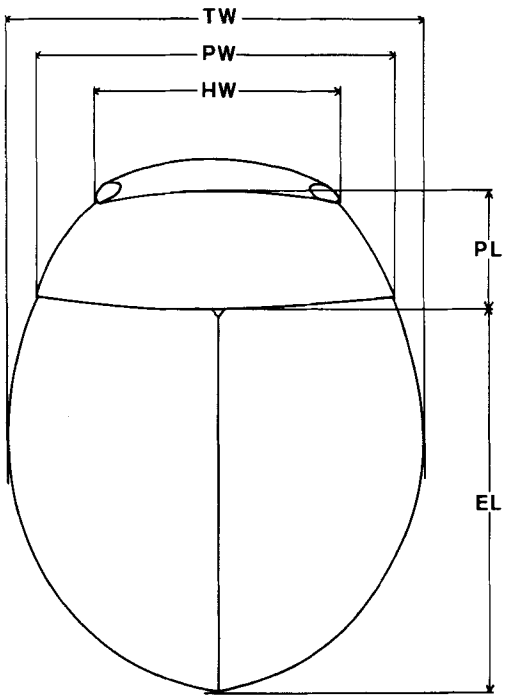


Fig. 35. Measurements used for morphometric analysis; see Table 1 for explanation of terms.

with a lateral diverticulum at base of the spermatheca (Fig. 16). (North India)..... *fallax* J. Balfour-Browne

9 Head width < 0.525 mm. Aedeagus with parameres less than 2 times longer than basal piece (Figs 3, 8). Maximal length of spermatheca < 120 µm (Figs 14, 18). Wings present.....10

– Head width > 0.525 mm. Aedeagus very long and slender, parameres 2 times longer than basal piece (Fig. 7). Maximum length of spermatheca > 120 µm (Fig. 17). Wingless. (Sri Lanka) ..... *mahanuwara* sp.n.

10 Colour black. Pronotum width < 0.825 mm. Head width < 0.45 mm. Aedeagus with median lobe parallel-sided, parameres longer than basal piece (Fig. 3). Duct of spermathecal gland short (L ≈ 37 µm) (Fig. 14). (Sri Lanka) ..... *loebli* sp.n.

– Colour orange to ferrugineous. Pronotum width > 0.825 mm. Head width > 0.45 mm. Aedeagus with median lobe large and spatuliform, parameres as long as basal piece (Fig. 8). Duct of spermathecal gland long (L = 85 µm) (Fig. 18). (India) ..... *championi* d'Orchymont

Catalogue of the World species of *Psalitrus* d'Orchymont

1. *P.balfouri* Bameul, 1991 — Southern Sudan
2. *P.besucheti* Bameul, 1992 — Southern India
3. *P.bryanti* J. Balfour-Browne, 1948 — Indonesia: Penang Is.
4. *P.championi* d'Orchymont, 1925 — Southern India
5. *P.coccinelloides* Bameul, 1992 — Southern India
6. *P.decoratus* Bameul, 1992 — Southern India
7. *P.dorchymonti* J. Balfour-Browne, 1948 — South Africa
8. *P.durisi* Bameul, 1991 — Nigeria
9. *P.fallax* J. Balfour-Browne, 1948 — North India
10. *P.loebli* Bameul, 1992 — Sri Lanka
11. *P.mahanuwara* Bameul, 1992 — Sri Lanka
12. *P.nigrorufus* d'Orchymont, 1932 — Bali
13. *P.saundersi* J. Balfour-Browne, 1948 — Singapore
14. *P.sauteri* d'Orchymont, 1929 — Taiwan
15. *P.serendibensis* Bameul, 1992 — Sri Lanka
16. *P.silvestris* Bameul, 1992 — Southern India
17. *P.vandenbosscheae* d'Orchymont, 1919 — Sumatra, Penang Is.
18. *P.veddha* Bameul, 1992 — Sri Lanka
19. *P.villiersi* J. Balfour-Browne, 1948 — Ivory Coast
20. *P.vinsoni* J. Balfour-Browne, 1958 — Mauritius
21. *P.waelbroecki* d'Orchymont, 1925 — Zaire

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References

Balfour-Browne, J. (1948) A revision of the genus *Psalitrus* d'Orchymont (Coleoptera: Palpicornia: Sphaeridiinae). *Annals and Magazine of Natural History*, **12**, 377–391.

Balfour-Browne, J. (1958) New Species of Malgassic Hydrophilidae (Col.). *Mauritius Institut Bulletin*, **5**, 134–147.

Bameul, F. (1986) Les Hydrophiloidea des îles Mascareignes (Coleoptera). *Revue Suisse de Zoologie*, **93**, 875–910.

Bameul, F. (1990a) Le DMHF, un excellent milieu de montage en entomologie. *L'Entomologiste*, **46**, 233–239.

Bameul, F. (1990b) Description of *Nannomicrus*, new genus of the tribe *Omicrini* Smetana from Sri Lanka (Coleoptera, Hydrophilidae, Sphaeridiinae). *Elytron*, **4**, 131–136.

Bameul, F. (1990c) Observations sur la biomécanique de l'édéage des *Psalitrus* D'ORCHYMONT (Col. Hydrophilidae). *Nouvelle Revue d'Entomologie* (N.S.), **7**, 302.

Bameul, F. (1991) On some new or little known *Psalitrus* d'Orchymont from Africa and Asia (Coleoptera, Hydrophilidae, Sphaeridiinae). *Bulletin et Annales de la Société Royale Belge d'Entomologie*, **127** (in press).

Besuchet, C., Burckhardt, D.H. & Löbl, I. (1987) The 'Winkler/Moczarski' eclector as an efficient extractor for fungus and litter Coleoptera. *Coleopterists Bulletin*, **41**, 392–394.

Carayon, J. (1969) Emploi du noir chlorazol en anatomie microscopique des insectes. *Annales de la Société Entomologique de France* (N.S.), **5**, 179–193.

Champion, G.C. (1925a) Some Indian (and Tibetan) Coleoptera (17). *The Entomologist's Monthly Magazine*, **61**, 169–181.

Champion, G.C. (1925b) Some Indian (and Tibetan) Coleoptera (18). *The Entomologist's Monthly Magazine*, **61**, 261–273.

Dajoz, R. (1964) Anatomie et importance taxinomique des voies génitales femelles d'origine ectodermique chez les Elateridae (Insectes, Coléoptères). *Cahiers des Naturalistes, Bulletin des Naturalistes Parisiens*, n.s. **20**, 55–72.

Deuve, T. (1988) Les sternites VIII et IX de l'abdomen sont-ils visibles chez les imagos de Coléoptères et des autres Insectes Holométaboles? *Nouvelle Revue d'Entomologie* (N.S.), **5**, 21–34.

Dobhzanski, T. (1926) Polovoï apparat bojikh korovok (Coccinellidae) kak vidovoï i grouppovoï priznak. Tchasie vtoraia. *Izvestya Akademia Nauk SSSR*, VI sér., **20**, 1555–1586, 2 pls. [in Russian].

Foucart, T. (1985) Analyse factorielle. Programmation sur microordinateurs. 2e édition révisée avec nouveaux programmes. Masson, Paris, 238 pp.

Hansen, M. (1987) The Hydrophiloidea (Coleoptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica*, Volume 18. E. J. Brill/Scandinavian Science Press Ltd, Leiden, 254 pp., 4 pls.

Hansen, M. (1990) Australian Sphaeridiinae (Coleoptera: Hydrophilidae): a taxonomic outline with descriptions of new genera and species. *Invertebrate Taxonomy*, **4**, 317–395.

Iablokoff-Khnzorian, S.M. (1974) Remarques sur les genitalia femelles des Coléoptères et leur armure. *Annales de la Société Entomologique de France* (N.S.), **10**, 467–486.

Malcolm, S.E. (1980) *Oreomicrus* new genus, and Elaboration of the Tribe Omicrini (Coleoptera: Hydrophilidae: Sphaeridiinae). *Annals of the Entomological Society of America*, **73**, 185–188.

Malcolm, S.E. (1981) A phylogeny and classification of the Sphaeridiinae (Coleoptera: Hydrophilidae). Ph.D. thesis, University of Connecticut, Storrs, xi + 220 pp., 8 pls.

Murray, J.D. (1981) On pattern formation mechanisms for lepidopteran wing patterns and mammalian coat markings. *Philosophical Transactions of the Royal Society*, B, **295**, 473–496.

Orchymont, A.d' (1919) Contribution à l'étude des sous-familles des *Sphaeridiinae* et des *Hydrophilinae* [Col. Hydrophilidae]. *Annales de la Société Entomologique de France*, **88**, 105–168.

Orchymont, A.d' (1925a) Contribution à l'étude des Hydrophilides II. *Bulletin et Annales de la Société Royale Entomologique de Belgique*, **65**, 139–169.

Orchymont, A.d' (1925b) Contribution à l'étude des Hydrophilides IV. *Bulletin et Annales de la Société Royale Entomologique de Belgique*, **65**, 298–305.

Orchymont, A.d' (1928) Catalogue of Indian Insects. Part 14. Palpicornia. Government of India, Central Publication Branch, Calcutta, ii + 146 pp.

Orchymont, A.d' (1929) Contribution à l'étude des *Palpicornia*. VII. *Bulletin et Annales de la Société Royale Entomologique de Belgique*, **69**, 79–96.

Orchymont, A.d' (1932) LIII. Zur Kenntnis der Kolbenwasserkäfer (Palpicornia) von Sumatra, Java und Bali. *Archiv für Hydrobiologie, Supplement-Band*, **9**, 623–714, tables 14–19.

Ordish, R.G. (1984) Hydraenidae (Insecta: Coleoptera). *Fauna of New Zealand*, Number 6. Science Information Publishing Centre, DSIR, 65 pp.

Smetana, A. (1974) Revision of the genus *Cymbiodyta* Bed. (Coleoptera: Hydrophilidae). *Memoirs of the Entomological Society of Canada*, **93**, iv + 113 pp.

Smetana, A. (1975) Revision of the New World Genera of the Tribe Omicrini trib. nov. of the Hydrophilid Subfamily Sphaeridiinae (Coleoptera). *Studies on the Neotropical Fauna*, **10**, 153–182.

Smetana, A. (1978) Revision of the subfamily Sphaeridiinae of America North of Mexico (Coleoptera: Hydrophilidae). *Memoirs of the Entomological Society of Canada*, **105**, 292 pp., 1 pl.

Verschuren, D. (1989) Revision of the larvae of West-Palaearctic *Cordulegaster* Leach, 1815 (Odonata, Cordulegastridae) with a key to the considered taxa and a discussion on their affinity. *Bulletin et Annales de la Société Royale Belge d'Entomologie*, **125**, 5–35.

Wiley, E.O. (1981) *Phylogenetics. The Theory and Practice of Phylogenetic Systematics*. John Wiley & Sons, New York, xvi + 439 pp.

Zimmerman, J.R. (1980) Use of multivariant procedures in studies of species problems in the *sculptilis* group of North American *Colymbetes* (Coleoptera: Dytiscidae). *Coleopterists Bulletin*, **34**, 213–226.

Zimmerman, J.R. & Ludwig, J.A. (1975) Multiple-discriminant analysis of geographical variation in the aquatic beetle, *Rhantus gutticolis* (Say) (Dytiscidae). *Systematic Zoology*, **24**, 63–71.

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