Taxonomic characters of the male endosomal structure in the genus *Rheumatogonus* Kirkaldy (Hemiptera: Gerridae), with descriptions of four new species from Borneo and Sri Lanka

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Chen, P.-p. & N. Nieser. Taxonomic characters of the male endosomal structure in the genus *Rheumatogonus* Kirkaldy (Hemiptera: Gerridae), with descriptions of four new species from Borneo and Sri Lanka. Zool Med. Leiden 76 (21), 27.xii.2002: 371-409, figs. 1-68.— ISSN 0024-0672.
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Key words: Gerridae; *Rheumatogonus*; new species; key; male genitalia; SE Asia.
The species of *Rheumatogonus* (Gerridae: Ptilomerinae) from Thailand, Borneo, Mindanao and Sri Lanka are revised. Four new species, collected from northern Borneo and Sri Lanka, are described: *R. esakii* spec. nov. from Brunei, *R. vantoli* spec. nov. and *R. inusitatus* spec. nov., both from Sabah, and *R. cheliforus* spec. nov. from Sri Lanka. Redescriptions of the genus and the four known species assigned to this paper are provided. A key to species with diagnostic illustrations is presented. The male genital structures are illustrated in detail, as they provide the most reliable specific characters. The pilosity on the connexival segment VI is used for identifying the females.

Introduction

Species of the genus *Rheumatogonus* Kirkaldy are inhabitants of mountainous streams, creeks and waterfalls in tropical rain forests of the Oriental region. In the same environment several other rheophilous species can be found, e.g., members of the genera *Limnometra* Mayr, 1865, *Pleciobates* Esaki, 1930, *Andersenius* Zettel & Chen, 1996, *Rhyacobates* Esaki, 1930, *Metrocoris* Mayr, 1865, and *Rhagovelia* Mayr, 1865, etc. The distributional range of *Rheumatogonus* is from the Philippines, across Borneo, Indo-China, the Malay Peninsula reaching Sri Lanka. Five species have been recognized so far: *R. luzonicus* (Kirkaldy, 1909) (Luzon), *R. borneensis* Esaki, 1927 (Borneo), *R. intermedius* Hungerford, 1933 (Sumatra), *R. seyferti* Zettel, 1994 (Negros), and *R. vietnamensis* Zettel & Chen, 1996 (S. Viet Nam).

The genus *Rheumatogonus* was established as a subgenus of *Ptilomera* Amyot & Serville by Kirkaldy in 1909, with the description of *R. luzonicus* from Manila, Philippines (Andersen, 1967). Esaki (1927) raised *Rheumatogonus* to genus level, and described *R. borneensis* from Pontianak, Kalimantan, Borneo, and redescribed *R. luzonicus*. In addition, he synonymized the genus *Jucundus* Distant, 1910, with *Rheumatogonus*, which has been accepted for many years (Hungerford, 1933; Matsuda, 1960, Cheng & Fernando, 1969; Polhemus, 1979; Andersen, 1982). Only recently the genus *Jucundus* has been re-established as a valid genus by Zettel & Thirumalai (2001) including *J. vittatus* (Esaki, 1928) from Sri Lanka. Hungerford (1933) described *R. intermedius* from the East coast of Sumatra. Matsuda (1960) redescribed the genus, based on three species: *R. intermedius* Hungerford, "*R. burmanus* (Distant)", and *R. custodiendus* (Distant, 1910), the latter is the type species of the genus *Jucundus*, whereas

the "*R. burmanus*" of Matsuda (1960) was an misidentification. The real *Jucundus burmanus* Distant (1910) is based on larvae of a *Ptilomera* species (Zettel & Thirumalai, 2001). Based on *R. intermedius*, Matsuda (1960) gave the first illustrations of the male and female genital structures, paying more attention to the endosomal structure than to the paramere. Andersen (1967) gave an excellent description and illustrations of *R. borneensis*(?) and *R. luzonicus*, based on material collected from Palawan, and compared his specimens with type material of both species. In the same year, Miyamoto (1967) reported a wider distribution for *R. borneensis*(?) in northern Borneo (Brunei and Sarawak), and noted a single female specimen of *Rheumatogonus* spec. from Ping Kong, N. Thailand. Cheng & Fernando (1969) reported a wide distribution of *R. intermedius* in the Malay Peninsula, providing an illustrated redescription of this species. In the present paper *R. intermedius* is reported from southern Thailand (Songkhla) for the first time. Zettel (1994) described *R. seyferti* from Negros, Philippines, and presented distributional data for the Philippines and illustrations of the male vesical structure for the three species occurring there, viz. *R. luzonicus*, *R. borneensis*(?) and *R. seyferti*. He indicated that the hairs on sternite VIII of the male have specific significance for separating the species from the Philippines, but further study is needed. Recently, Zettel & Chen (1996) described *R. vietnamensis* from S Viet Nam, and later (Chen & Zettel, 1998) listed species of *Rheumatogonus* from Thailand as "sp.". In the present paper it is confirmed that *R. vietnamensis* is widely distributed in N Thailand. Therefore, there are altogether five described species in the genus *Rheumatogonus*.

Discussion

Summarizing the studies mentioned above, most of the descriptions are based on external structures of body and appendages, including measurements, except the works by Matsuda (1960), Andersen (1967), Zettel (1994), and Zettel & Chen (1996). The endosomal structures were limited to lateral view. Therefore, basic knowledge of the male genital structures of *Rheumatogonus* remains little known, although it turns out to provide the most reliable characters for separating the species.

The status of *R. luzonicus*, *R. seyferti*, *R. intermedius*, and *R. vietnamensis* is clear. The status of *R. borneensis* from Palawan is questionable, as Andersen also pointed out several characteristic modifications in the species found in Palawan, e.g., the structure of female hind legs and paramere (Andersen, 1967: figs 12-14 & 16). However, regardless the status of *R. borneensis* from Palawan, there are three species known from Philippines. The unfortunate situation is that Esaki (1927) described *R. borneensis* from a single apterous female. Later on, more material of *Rheumatogonus* has been collected from Borneo, mostly from Sabah, Brunei, and Sarawak. The authors have seen specimens collected from Borneo identified as *R. borneensis*, but they all belong to undescribed species. Therefore, *R. borneensis* is the most problematic species in the genus. For a more detailed discussion see under that species below. Finally, the species occurring in Borneo need more study to have a better understanding of its faunistic composition and distributional pattern. These will be treated by other authors in a separate paper (Zettel, personal communication).

The genus is small compared to many other genera of Gerridae, but due to their very similar appearance, or, in other words, lacking clear external features to separate

them, the identification to species of *Rheumatogonus* in several museums is confused. Early descriptions of the species emphasized the body colour, but this varies within species. We have noticed variation in pattern of light and dark markings within the same samples. Even with the help of secondary sexual characters, such as the shape of male fore leg and pygophore, pilosity on the eighth sternite, etc. is still not sufficient to separate the species. After checking through the material at hand, we conclude that although the dimensions of the species show some differences, the most reliable characteristics for specific identification are male genital structures, namely the parameres and vesical sclerites. The paramere is the first stable characteristic for identification. In addition, the vesical sclerites, especially the shape of lateral sclerites and ventral sclerite, are of importance. It is recommended to check these structures carefully for a reliable identification. Special attention has been given to it in this work. To identify female specimens of *Rheumatogonus*, especially when no males from the same sample are available, is always uncertain as in many taxa of gerrids, thus the part of the identification key applicable to females must be considered preliminary. However, the pilosity of connexiva VI shows some stable characteristics which can be employed for specific identification by combining with other characteristics. Our intention is to give a reasonable and clear description to the species of *Rheumatogonus* we have seen, in order to offer a better understanding to taxonomy and systematics of this genus, which is certainly required for further phylogenetic analysis, and for application of certain modern techniques as well.

Phylogeny

"The taxonomy and relationships of the ptilomerine genera are not quite settled" (Andersen, 1982). One of the recent approaches to the phylogeny of Gerroidea was made by Muraji & Tachikawa (2000) on molecular level, and presented the cladograms which based on portions of the mitochondrial 16S rRNA gene (16S rDNA) and nuclear 28S ribosomal RNA (28S rDNA) sequencing. 30 gerrids were consulted in their study including *R. luzonicus*. The genus *Rheumatogonus* seemed closely to be related to *Jucundus* Distant by colour and size, although the latter is larger. The detailed comparative characters of separating these two genera were given by Zettel & Thirumalai (2001).

Within the genus of *Rheumatogonus*, a stringent cladistic analysis will have to wait for description of the male of *R. borneensis* based on material from the type area (Pontianak), and elucidation of the status of the species occurring in Palawan (Zettel, personal communication). There is a tendency of reduction in size and pilosity from the Philippines westward through Borneo and continental SE Asia to Sri Lanka. The larger size, the stronger development of the pilosity on male segment VIII, and the structure of the vesical sclerites bring the Philippine species *R. luzonicus* and *R. seyferti* together in a group. The apomorphy of clearly sclerotized vesical sclerites seem to link *R. intermedius* and *R. inusitatus* spec. nov. into one branch. The other two species, *R. vietnamensis* and *R. cheliforus* share the characteristics of having a shorter segment VIII with a softly concave ventral side in males. In addition, these two species seem close to each other also by the similarity of the paramere and the ventral sclerite. All the species from Borneo have certain modifications on the proctiger, e.g., the lateral setae

near the anterior margin are thicker or even modified as pegs (fig. 24), which brings *R. esakii* spec. nov. and *R. vantoli* spec. nov. together. Whether *R. inusitatus* will group with the continental species or the Bornean species has to await for a further analysis.

Material and methods

Four among the five described species, plus four new species (from Borneo and Sri Lanka) of the genus *Rheumatogonus* are treated in this paper. The descriptions and redescriptions refer to male specimens unless otherwise specified. All measurements are in millimetres. The measurements for appendages are given as the mean, the remaining measurements are given as the range. In apterous specimens the body length is measured from apex of head to apex of abdomen, in both cases along the median line in dorsal view with the body axis horizontal. Length and width of body parts refer to the maximum value with the specified body part horizontally. The names for genital structures follow the concepts established by Andersen (1975, 1982). The description of the male vesical sclerites is based on their resting or deflated position in the insects, so with the vesica folded back. In this position, it lies upside down, and with the true apical end situated basally. Therefore, the meaning of "apical" and "basal" when describing vesical sclerites are contrary with their orientation when inflated or expanded. As a complex of certain function, the sclerites of the phallus are connected or wrapped in by membranous tissues, which are divided into several lobes which are correlated to certain plates or sclerites. Some membranous connections are not easy to be observed in the deflated position. Therefore, "apart" or "fused" in describing phallic structures refers to the visible ones in a resting position. The uniform characters discussed in the generic description in all *Rheumatogonus* species, will not be repeated in the descriptions to each species. For the other four treated species only the data of measurements and the detailed male genital characters are given. The illustrations are made by Leitz optics including a camera lucida.

Abbreviations

Abbreviations of depositories:

BCBT = Department of Biology, Chulalongkorn University, Bangkok, Thailand.
CMUC = Dept. Of Biology, Chiang Mai University, Chiang Mai, Thailand;
PCBC = P.-p. Chen Collection, Beijing, China.
NCTN = Nieser Collection, Tiel, The Netherlands.
MNHN = Museum National d'Histoire Naturelle, Paris, France.
RMNH = National Museum of Natural History, Leiden, The Netherlands.
SEMC = Snow Entomological Museum, University of Kansas, Lawrence, KS, U.S.A.
ZMAN = Department of Entomology, Zoological Museum, University of Amsterdam, Amsterdam, The Netherlands.

Abbreviations of morphological structures:

ap = apical piece of dorsal sclerite;
apt = apterous form;
ba = basal apparatus of phallus;

bl = basal lobe;
dp = dorsal plate of vesica;
ds = dorsal sclerite of vesica;
cj = conjunctivum;
macr. = macropterous form;
lvV = fifth instar larva;
ls = lateral sclerite of vesica;
pa = paramere;
pr = proctiger;
pt = phallotheca;
py = pygophore;
sd = seminal duct;
sl = secondary lateral sclerite;
tarsal-I, tarsal-II = first and second tarsal segment, respectively;
vl = ventral lobe of vesica.

Systematics

Genus *Rheumatogonus* Kirkaldy, 1909

Rheumatogonus Kirkaldy, 1909: 390 (as subgenus of *Ptilomera*); Esaki, 1927: 265; Matsuda, 1960: 283.
Rheumatogonus; Andersen, 1982: 413; Esaki, 1927: 265; Hungerford, 1933: 4, Matsuda, 1960: 283; Cheng & Fernando, 1969: 118; Polhemus, 1979: 93. These authors follow Esaki (1927) by considering *Jucundus* a synonym of *Rheumatogonus*.

Type species: *Ptilomera luzonica* Kirkaldy, 1909: 389, by monotypy.

Redescription. Dimensions.— Small to medium sized elongate gerrids, females (body length 5-6, width about 1.7) distinctly larger than males (body length about 4 mm, width about 1.2 mm). Apterous form with body parallel sided in males, shuttle-shaped in females. Body furnished with golden and dark pubescence, ventral side of body with sparse dark short setae, and at certain parts with longer hairs and spinules.

Colour (figs 2, 4, 5, 7-19, 67).— Ground colour of body in living specimens greenish, becoming yellowish to yellowish brown after death, with extensive black markings dorsally, appendages mostly blackish. Head yellowish brown, interoculus with a median, caudally bifid, arrowhead-shaped black marking, poorly visible in some specimens. Eyes, anterior margin of antenniferous tubercles, anteclypeus and labrum blackish; rostral segments yellowish except basal 1/3 of third and fourth segments blackish; all four antennal segments blackish except basal 1/3 of first segment yellowish. Thoracic segments yellowish with extensive black markings. Anterior margin of pronotum blackish, broadened into a pair of blackish markings behind eyes. Anterior margin of mesonotum with a pair of small dark markings; the median line of mesonotum darkened, the length of this dark stripe varied within most species.

Suture between meso- and metanotum blackish, varied according to species. Metanotum yellowish, with median line and posterior margin darkened. Thoracic venter yellowish. Pleura, pro- and mesoacetabula yellowish to brownish, metacetabula with black marking. Legs dark brown to black except coxae, trochanters, and base

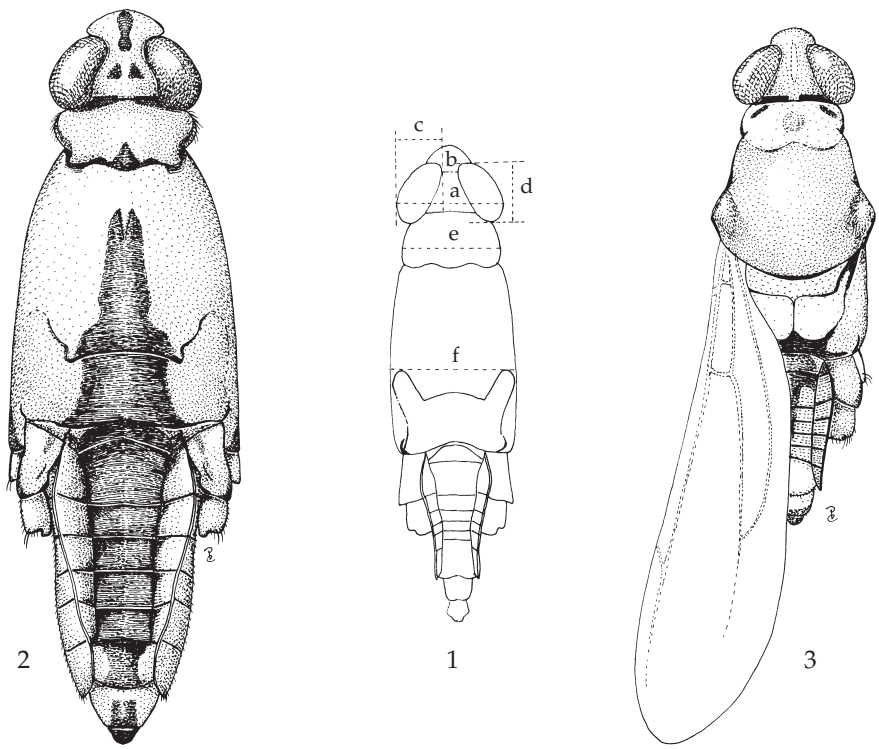
of femora yellowish to brownish. Fore femur yellowish with a dorsolateral black stripe in apical four fifth; in males the black markings more extensive, covering most of the lateral faces of fore femur. Abdominal tergites blackish with pale markings, abdominal tergites dull in males, strongly shining in females; connexiva mostly yellowish to brownish with basal margins darker. Tergite of first genital segment (segment VIII) yellowish with a variable blackish marking; proctiger (segment X) and anal cone (segment XI) dark brown to blackish. Pygophore (segment IX) yellowish in ventral view.

Structural characteristics (unless specified referring to male).— Head, vertex with inner margins of eyes convergent anteriorly, front part of interoculus distinctly narrower. Vertex with the usual four pairs of trichobothria, and a row of about 9 bristles along inner margin of eye, which is more distinct in nymphs. Eyes globular and large, with two long hairs, one dorsoposteriorly, the other one lateroposteriorly. Antennae thin and long, segment I the longest, shorter than the length of segments II and III combined; segment II and III about same length in males, segment II slightly shorter than III in females; segment IV shortest, with an elongate ventroapical sulcus. All the antennal segments clothed with dark pubescence, ventral side of segment I with 4 thin and long hairs, segment III and IV each bearing 4 short setae. Rostrum short, just reaching anterior margin of mesosternum, segment III the longest, about two times the length of segment I, five times the length of segment II, and two and half times the length of segment IV. Rostrum densely covered with golden setae except the last segment, segment III with a pair of long hairs anteroapically. Thorax almost parallel in males, and diverging posteriorly in females. Mesonotum the longest, two to nearly three times as long as pronotum, and more than one and half times as long as metanotum. Pronotum subquadrangular, slightly narrower than head, its posterior margin slightly trilobate. Primary intersegmental suture (Andersen 1982: 204) between meso- and metanotum distinct, (figs 1-2, 7-19). Metacetabular groove transverse, and connected with very short longitudinal ridge in dorsal view. Scent orifice (omphalium) brownish, situated near posterior margin of metasternum, not on a tubercle or an elevation. Metathoracic spiracle located at lateral margin of metanotum, and next to the border of metacetabula (fig. 6). Apical margins of acetabula fringed with black bristles. Legs. Fore leg: femur longer than tibia, moderately incrassate in males, slightly tapering apically, about 5-7 times as long as wide in male; apical margin of coxae surrounded by bristles and with 3-4 long ventral hairs; trochanter with 6 long black ventral bristles; femur with 7-8 (♀) or 8-9 (♂) black bristles ventrally which are closer to each other at basal two thirds, and apical margin surrounded by bristles; fore tibia somewhat dorsoventrally flattened, its external and internal margin straight, inner margin with a short apical process bearing two long setae, inner margin of tibia with a fringe of fine hairs which is curved upwards, in addition, with a comb of bristles apically; tarsus cylindrical, tarsal-I about 0.8 times as long as tarsal-II, broadened apically, with two long hairs basally, pubescence curved upward at inner margin, downward at external margin; a pair of blade-like claws (about 0.1 mm long) situated at apical one third the length of second tarsal segment, ventral arolium leaf-like and membranous, dorsal arolium bristle-like. Middle leg: distinctly longer than hind leg, trochanter situated under the metacoxa, hidden from dorsal view, tibia three fifth the length of femur, 25 times that of tarsal-I, tarsal-I about twice length of tarsal-II; femur

clothed with fine setae, apical two third length of tibia with distinct ventral long hair fringe; claws thin and blade-like, arising from one fifth length of second tarsus, arolia bristle-like. Hind leg: femur thinner than mesofemur, as long as or very slightly longer than mesofemur, and about 3.5 times length of tibia; tarsal-I very short, tarsal-II 1.3 times longer than the first; claws not observed, arolium bristle-like.

Abdomen in dorsal view about 0.8 times the length of thorax in males, or subequal to thorax in females; sutures between abdominal tergites I-VII distinct; abdominal tergite I short, tergite II distinctly longer, about 2.2 times length of tergite I; tergite III as long as I; tergites IV-VI subequal in length, slightly shorter than tergite III; tergite VII as long as tergite II. Abdominal sternite I fused with metasternum, sternite VII about half the length of preceding abdominal sternites. Connexiva raised subvertically. Tergite of first genital segment in male shorter than tergite VII, its hind margin very slightly incised medially. The pilosity of abdominal venter more developed than on dorsum, each sternite fringed with longer setae at posterior margin.

Male genitalia.— Length of genital segments in ventral view slightly longer than preceding abdominal sternites. Abdominal segment VIII with longer setae, their den-



Figs 1-3, *Rheumatogonus* species with appendages being removed. 1, diagram of *R.* spec. apt., ♀, with lines indicating measurements: a = head width including eyes, b = narrowest with between eyes, c = eye width, d = eye length, e = pronotum width, f = thoracic width; 2, *R. vietnamensis*, apterous ♀, body length 5.7 mm, (N. Thailand); 3, *R. esakii*, macropterous ♂, right wings removed, body length 4.2 mm.

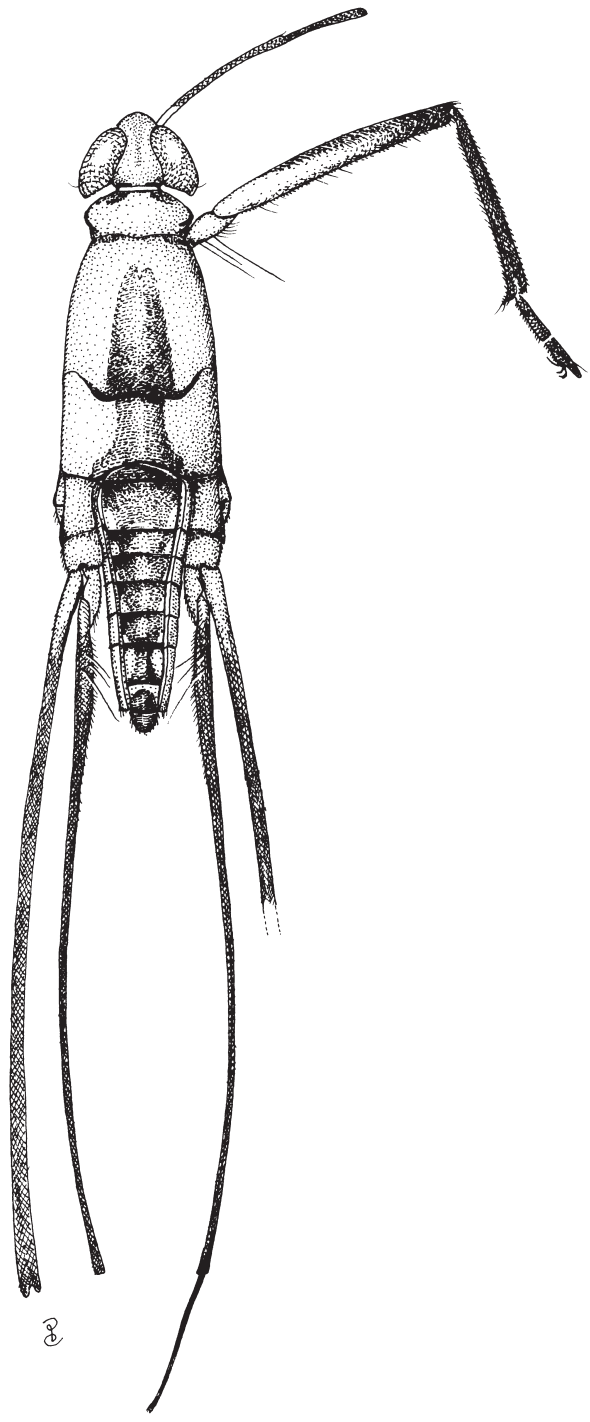


Fig. 4, *Rheumatogonus borneensis* Esaki, holotype, apterous female, body length 5.9 mm.

sity varied according to species. Pygophore subtriangular in lateral view, with a short basal bridge (tergite IX) dorsally (figs 23, 37), widely opened, bearing longer setae at caudal margin. Proctiger (fig. 24) about 1.3 times longer than wide, with a short broader posterior lobe, each side with a group of thicker setae dorsally (which can be modified into sclerotized spinules in certain species), central part with pilosity thinner and shorter, and longer toward caudal margin. Parameres (figs 39-47) darkened, symmetrical, just extending out of phygophore, falciform, shaft broad and almost parallel-sided, curved upwards and slightly tapering apically, bearing moderately long setae; apices transparent. Phallus: basal apparatus prolonged with apical part strengthened. Dorsal side of phallotheca with a broad opening dorsoapically, its ventral side with a deep U-shaped opening apically. Vesica (figs 48-55): dorsal plate indistinct apically, visible basally, and its apicolateral margins folded interad (fig. 51); dorsal sclerites asymmetrical, curved baselly, fused along its middle part, separate at both ends, apical piece almost membranous, bifid into two broad leaf-like pieces in dorsal view (eventually connected ventrally), which in inflated position form a flat connecting piece (fig. 38); ventral sclerite fused, composed of a thin twisted sclerite and a broad membranous tube, the thin sclerite supporting the membraneous tube, in the inflated position this spiral-thickening along the wall of the membranous tube is more clear (fig. 38), the sclerotization and number of twisting points of ventral sclerite varied according to species; a pair of subtriangular-shaped lateral sclerites distinctly broadened at basal half, where they cooperate with posterior part of dorsal plate and secondary lateral sclerites; basal lobe with secondary lateral sclerites, but usually weak and need a careful preparation for a better observation, however, in some species easily visible.

Female. Generally corresponding with the structure of male, with the following exceptions. Body larger and broader. Ventral side of body except the general fine pale hairs, also with short sparse dark setae, which are scattered all over the thorax and abdomen, more conspicuous in some species. Anteroventral margin mesothorax with a patch of longer setae, which is visible in dorsal view in some species. Fore femur slender, about nine to ten times as long as wide; first tarsal segment as long as the second. Middle and hind legs clothed with dark pubescence and short spines, also a number of very long setae and trichobothria. About basal one third length of hind femur dilated and flattened, except the hairs mentioned above, internal side also with golden or dark longer hairs, which varied in length according to species. Abdomen about as long as thorax. Longitudinal ridge longer than in males and connected with the transverse metacetabula groove in dorsal view; first abdominal spiracle more distinct than in male. Tergites strongly shining, with lateral pubescence. Each connexival segment with a long hair dorsally; connexival segment VII ending up with longer hairs; in some species connexival segment VI also with dark longer hairs. Sternite VII with a well developed median caudal lobe (fig. 25). Genital segments moderately large, ending in a pair of posterolateral subtriangular lobes. Proctiger bending ventrad. Therefore, in the normal resting position, the genital segments covered by a combination of segment VII ventrally, proctiger dorsally, and segment VIII laterally. Genital segments shorter than abdominal segment VII in dorsal view. Female ovipositor. Inner margin of median slit of gonocoxae with a group of long hairs at each side. Gonapophyses not serrate, with blunt membranous apices. The first pair of

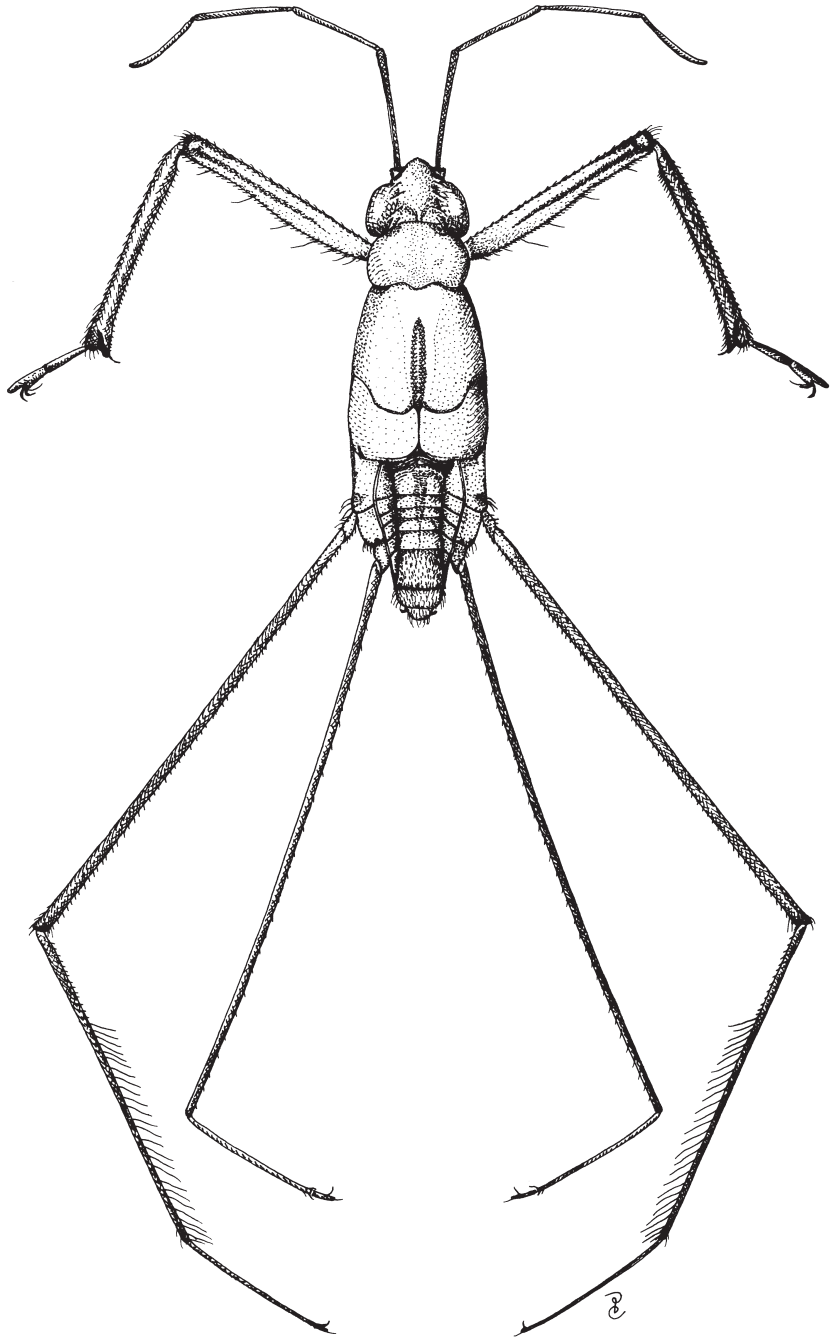


Fig. 5, *Rheumatogonus esakii* spec. nov., holotype, apterous male, body length 4.2 mm, Brunei.

gonapophyses slightly sclerotized basally, membranous apically, apices with a few apical long setae, second pair of gonapophyses moderately sclerotized, apices whitish and without hairs.

Macropterous male.— Generally in accord with apterous form with the following exceptions: pronotum divided in an anterior subrectangular part and a broad posterior lobe, posterior lobe three times as long as anterior lobe; posterior lobe expanded posteriorly with posterior margin arched (fig. 3); length of pronotum about 1.1 times its maximum width across humeri; wing distinctly longer than body length. Colour: anterior angle, ventral margin of humeri, and middle part of posterior margin darkened.

Cheng & Fernando (1969) mentioned for *R. intermedius* in the Malay Peninsula: "Winged forms are extremely rare, only one female has been collected so far". Our observation is in agreement with their statement, as usually most of the specimens in the samples are apterous. However, the two samples (N9517, N9518) from Phrae Province, northern Thailand contain only dealate macropterous specimens, but all are males. The other macropterous specimens in several other samples consist also only of dealate males. A dealate macropterous female was illustrated by Andersen (1982: 302).

Key to species of the genus *Rheumatogonus* Kirkaldy

1. Body almost parallel-sided, length 3.8-5.2 mm, thorax longer than abdomen; fore leg with tarsal-I shorter than tarsal-II; male (males of *R. borneensis* not known) 2
- Body spindle-shaped, length 5.5-6.9 mm, thorax about as long as abdomen; fore leg with tarsal-I slightly longer than tarsal-II; female 9
2. Abdominal segment VIII of male with a pair of ventrolateral hair tufts [Philippines: Negros] ..... ***R. seyferti*** Zettel
- Abdominal segment VIII of male not modified as above 3
3. Abdominal segment VIII of male laterally with about 0.075 mm long hairs (best visible in ventral view), body length 4.8-5.2 mm [Philippines] ..... ***R. luzonicus*** (Kirkaldy)
- Abdominal segment VIII of male laterally without or with only a few hairs longer than 0.05 mm, body length 3.8-4.5 mm 4
4. Ventral sclerite of vesica strongly or moderately sclerotized, twisted at least two times (figs 52-54) 5
- Ventral sclerite of vesica much less sclerotized, apparently not twisted or only twisted once at its base (figs 49, 50) 8
5. Dark markings of body conspicuous (figs 11, 17); vesica (fig. 52) with ventral sclerite strongly sclerotized and twisted four times; lateral sclerite with apical half narrow, about one fifth its width at base; paramere see figs 43-44; proctiger with basolateral spinules [Borneo: Sabah] ..... ***R. inusitatus*** spec. nov.
- Dark markings of body not conspicuous; apical half of lateral sclerite one third or more its width at base (figs 53, 54) 6
6. Vesica (fig. 53) with ventral sclerite moderately sclerotized and twisted three times; lateral sclerite with apical half about one third the width as base; paramere semicircular, basal part distinctly converging apically, apical part with a broadly rounded tip (figs 45-46); dark markings of body usually with vague margins

[Sumatra, W. Malaysia, Singapore, S. Thailand] ..... ***R. intermedius*** Hungerford

- Ventral sclerite of vesica twisted twice (figs 54, 65), lateral sclerite with apical half about half as wide as the width at base; paramere with basal part only slightly converging apically, apical part with a narrowly rounded tip (fig. 47, 66) 7

7. Dorsal sclerite ventroapically not strongly thickened, its connection with the ventral sclerite not resembling a pincer as in crabs (fig. 54); apical part of paramere relatively long about half as long as basal part (fig. 47) [S. Viet Nam, Thailand] ..... ***R. vietnamensis*** Zettel & Chen

- Dosral sclerite ventroapically strongly thickened, its connection with the ventral sclerite resembling a pincer as in crabs (fig. 65); apical part of paramere relatively short, about one third as long as basal part (fig. 66) [Sri Lanka] ..... ***R. cheliferus*** spec. nov.

8. Vesica with lateral sclerite L-shaped (fig. 50), distinct twist of ventral sclerite not observed; paramere curved about 90°, with apical part longer than that in other species (fig. 42) [Borneo: Sabah] ..... ***R. vantoli*** spec. nov.

- Vesica with lateral sclerite tapering apically, not L-shaped (fig. 49), ventral sclerite twisted once at its base; paramere (fig. 41) with curve over 90°, with apical part comparatively shorter than in preceding species [Borneo: Brunei] ..... ***R. esakii*** spec. nov.

9. Body length over 6.5 mm, Philippine species 10

- Body length less than 6.5 mm SE Asia and Borneo 11

10. Hind femur on inner surface with comparatively short (about 0.11 mm) hairs; median length of hind lobe of sternite VII 0.64 times the median length of the preceding part (see fig. 4 in Zettel, 1994) ..... ***R. luzonicus*** (Kirkaldy)

- Hind femur on inner surface with about 0.16 mm long hairs; median length of hind lobe of sternite VII 0.70 times the median length of the preceding part (see fig. 3 in Zettel, 1994) ..... ***R. seyferti*** Zettel

11. Caudal margin of connexival segment VI with longer and thicker setae than caudal margin of connexival segment VII (figs 59, 62) 12

- Caudal margin of connexival segment VI without longer and thicker setae than caudal margin of connexival segment VII 13

12. In lateral view, the caudal margin of abdominal segment VII sinusoid, convex in ventral half, concave in dorsal half ..... ***R. inusitatus*** spec. nov.

- In lateral view, the caudal margin of segment VII virtually straight to slightly concave in dorsal half ..... ***R. esakii*** spec. nov.

13. Dark marking on abdominal tergite VII with concave lateral margins (fig. 2) 14

- Dark marking on abdominal tergite VII with lateral margins almost parallel 16

14. Hairs on inner side of base of hind femur about 0.06 mm long; body length 5.9 mm [Borneo: Kalimantan Barat] ..... ***R. borneensis*** Esaki

- Hairs on inner side of base of hind femur 0.04-0.05 mm long 15

15. Body length 5.5-5.6 mm ..... ***R. intermedius*** Hungerford

- Body length 5.8-6.4 mm ..... ***R. cheliferus*** spec. nov.

16. Mesosternum anterolaterally with a distinct patch of black setae ..... ***R. vietnamensis*** Zettel & Chen

- Mesosternum anterolaterally with some scattered black setae not forming a patch .. ***R. vantoli*** spec. nov.

Rheumatogonus luzonicus (Kirkaldy) 1909
(figs 7, 14, 26, 32, 39, 40, 48, 57, 67).

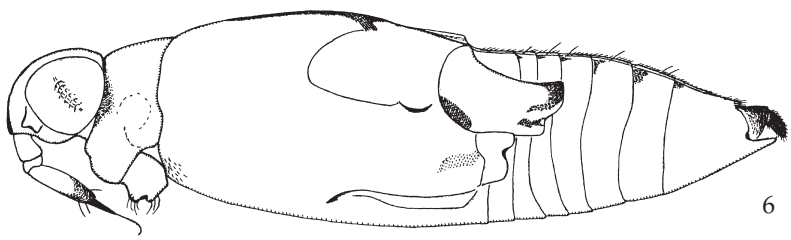
Ptilomera (Rheumatogonus) luzonica Kirkaldy, 1909: 389-390 (description, apt. ♀ - no locality).
Rheumatogonus luzonicus; Esaki, 1927: 265-267 (redescription); Andersen, 1967: 270-272 (discussion & comparative notes, holotype in NHRS); Zettel, 1994: 80-82 (distributional data).

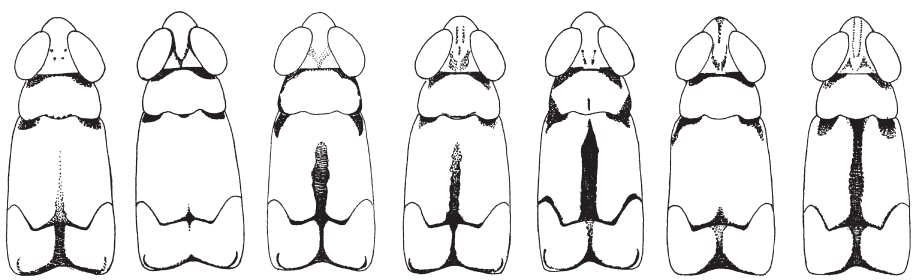
Material.— **Philippines**: Mindanao, Saringani Prov., Lake Sebu area: Bakdolong village, stream in valley with agricultural fields, mountain stream aspect, bottom in centre with stones, water somewhat whitish turbid, 3.xii.1993, N. Nieser, N9366, 2 ♂ 2 ♀ apt.; Bakdolong village, upstream part of stream (same stream as N9366) flowing into Lake Sebu at Bakdolong village, in hilly area, 10.xii.1993, N. Nieser, N9379, 5 ♂ 5 ♀ apt.; Just downstream of second waterfall, at edge of spray zone, sheltered bay behind boulders, 7.xii.1993, N9373, 1 ♂, macr. dealated (all in NCTN).

Type locality.— Luzon, Philippines.

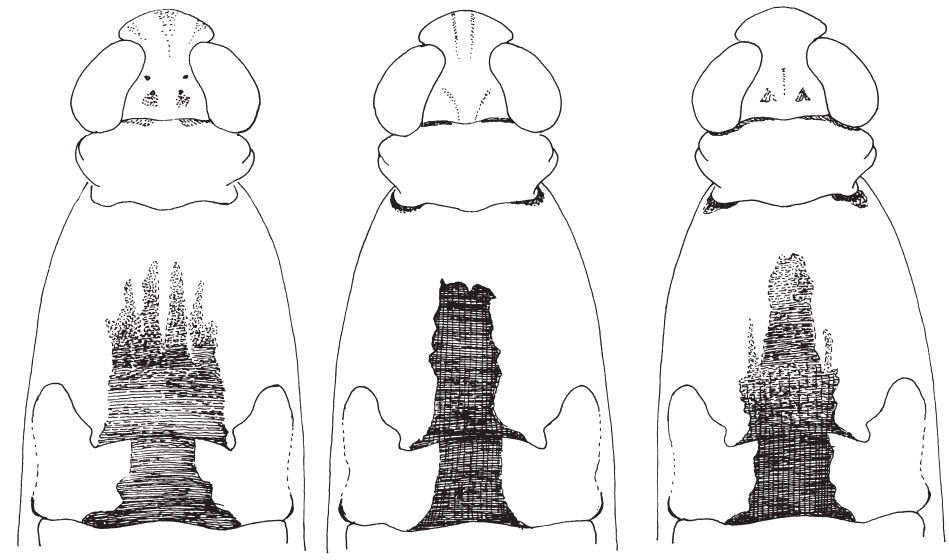
Redescription, apterous form.— Dimensions. Females distinctly larger than males; body length 4.80 - 5.20 (♂), 6.65 - 6.80 (♀); maximum width across suture between metanotum and abdomen 1.38 - 1.41 (♂), 1.99-2.00 (♀), thoracic height in lateral view 1.30 - 1.32 (♂), 1.85 - 1.91 (♀).

Colour.— Generally corresponding with the description of the coloration under the genus, but the ground colour of female body rather pale yellowish; in males yellowish brown dorsally, and yellowish ventrally; the dark markings on head and





Figs 6-13, *Rheumatogonus* species. 6, *R. borneensis*, holotype, apterous female, lateral view, appendages removed, body length 5.90 mm. 7-13, dorsal view of head and thoracic segments of apterous males, showing the pigmentation: 7, *R. luzonicus*; 8-9, *R. esakii*; 10, *R. vantoli*; 11, *R. inusitatus*; 12, *R. intermedius*, 13, *R. vietnamensis*.



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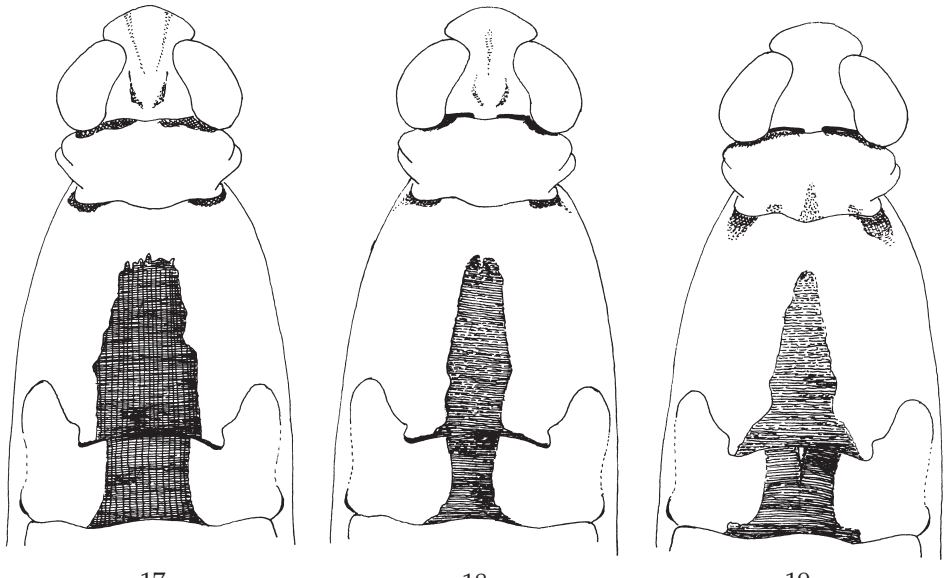


17 18 19

Figs 14-19, *Rheumatogonus* species. Dorsal view of thoracic segments of apterous female: 14, *R. luzonicus*; 15, *R. esakii*; 16, *R. vantoli*; 17, *R. inusitatus*; 18, *R. intermedius*; 19, *R. vietnamensis*.

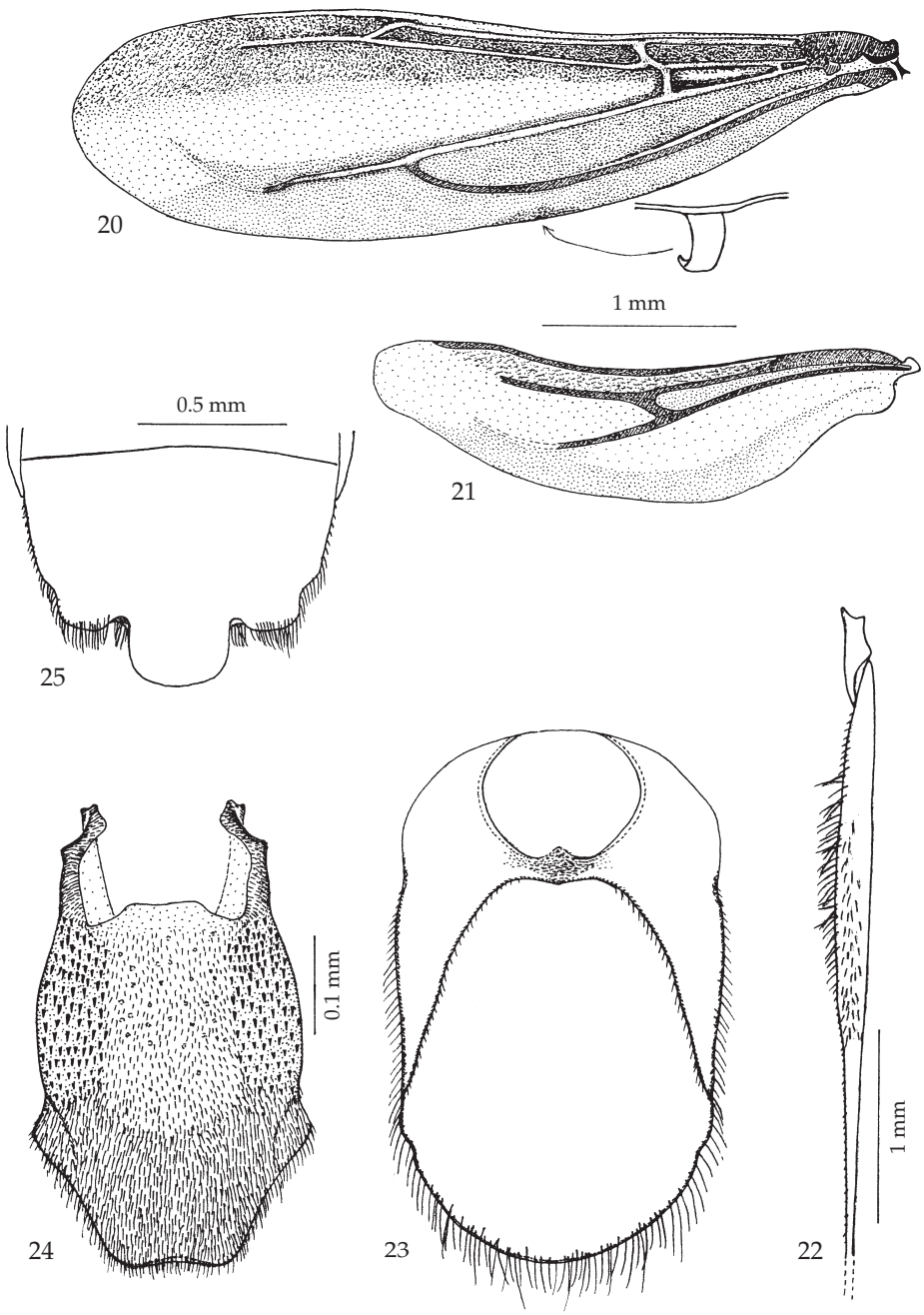
pronotum weak and small (figs 7, 14); basal half of middle leg with internal and external sides yellowish in both sexes; tergite II of female with a pair of large and clear yellowish markings laterally.

Structural characteristics.— Head length in dorsal view 0.96 - 0.98 (♂) and 1.17 - 1.19 (♀), its narrowest width between eyes 0.29 - 0.30 (♂) and 0.36 - 0.39 (♀). Eye length 0.50 - 0.51 (♂), 0.58 - 0.59 (♀), width 0.39 - 0.40 (♂), 0.40 - 0.43 (♀). Length of antennal segments I-IV: 1.48: 0.88: 0.80: 0.65 (♂, N = 7), 1.81: 1.00: 0.89: 0.73 (♀, N = 5). Length of rostral segments I-IV: 0.17: 1.00: 0.52: 0.18 (♂),0.20: 0.11: 0.56: 0.27 (♀). Pronotum short 0.59-0.60 (♂), 0.62 - 0.69 (♀), about as wide as head (0.97 - 0.98) in male, slightly narrower (1.15 - 1.19) than head (1.16 - 1.20) in female. Length of mesonotum 1.20-1.29 (♂), 1.60 - 1.62 (♀). Length of metanotum 0.51 - 0.57 (♂), 0.69 - 0.72 (♀). Fore leg: Measurements of legs see table. Fore femur about 8 times as long as wide basally in male, 10 times as long as wide in female; tarsal-I 0.85 times as long as second in male, 1.16 times as long as second in female. Male abdomen including genital segments (1.92-2.10) in dorsal view shorter than thorax (2.40 - 2.42), about the same length in females (2.80 - 3.00 : 3.00-3.10). Length of tergite VII 0.35 - 0.39 in ♂, 0.50 - 0.51 in ♀. Male abdominal sternite VII (0.25) about 3/5 length of preceding abdominal sternites (0.42), with longer pilosity laterally.

Male genitalia.— Tergite of first genital segment (0.25) about same length as seventh (0.25). Length of genital segments (0.70) in ventral view about as long as preceding abdominal sternites combined (0.69). Ventral margin of abdominal segment VIII in lateral view (fig. 26) more or less straight, with denser longer setae (fig. 32), but not forming a distinct hair tuft. The hairs on ventral side of abdomen are more conspicuous on each segment. Proctiger longer than wide, with a short broad posterior lobe, each side with longer spine-like setae dorsally, central pilosity shorter and gradually longer toward caudal margin. Parameres (figs 39-40) darkened, symmetrical, just extending out of phygophore, falciform, shaft broad and almost parallel, curved upwards at about 2/5 of its apical length, and tapering apically, with transparent apex, bearing moderately long setae. Phallus and phallotheca as in generic description. Vesica (fig. 48): dorsal plate with its apical margin slightly folded interad, its posterior margin distinct; dorsal sclerites as in generic description with apical membranous piece more sclerotized; ventral sclerite fused into a broad membranous tube, which is curved but not twisted; a pair of subtriangular lateral sclerites distinctly broadened at basal half, and narrower at apical half; the secondary lateral sclerite of basal lobe distinct.

Female.— Generally corresponding with the structure of the male with the following exceptions. Basal golden hairs of hind femur moderately long. Length of tergite VII 0.46, its sternite with a well developed median caudal lobe (0.50). Connexival segment VI caudally with a tuft of distinct dark setae (fig. 57), more conspicuous than those of connexival segment VII. Genital segments (0.58) in dorsal view longer than abdominal segment VII (0.52). Abdominal tergites I-VI strongly shining along median line, pubescence at lateral side striking, the strongly shining median stripe broad basally and tapering caudally, tergite V-VII and genital segments are almost covered by pubescence, giving a dull appearance.

Macropterous form.— We have seen a single dealate macropterous male. Pronotum: total median length 1.61 (anterior part 0.42, pronotal lobe 1.19), width of anterior



Figs 20-25, *Rheumatogonus* species. 20-21, *R. esakii*, 20, fore wing of male; 21, hind wing of male; 22, *R. vantoli*, dorsal view of basal part of femur of female hind leg; 23-24, *R. inusitatus*, 23, dorsal view of pygophore; 24, dorsal view of proctiger; 25, *R. vietnamensis*, ventral view of segment VII of female.

part of pronotum 1.00, width between humeri 1.50, length from anterior angle to humeri 1.00, length between humeri to median point of posterior margin 0.66.

Distribution (fig. 67).— Philippines: Luzon, Mindoro, Panay, Negros, Mindanao. We have seen specimens collected from the same general area of Mindanao as the specimens cited by Andersen (1967). In addition, we have seen an apterous female (MNHN) identified by Esaki as *R. luzonicus*, unfortunately without locality label. Esaki (1927: 267) mentioned: "I have seen many specimens from this island (= Luzon), but no detailed locality is known to me". We suppose this female is one of the many seen by Esaki. The other distributional records are collected from references mentioned above.

Comparative notes.— There is a tendency among the species found in the Philippines so far, to have the pilosity on the genital segments more developed than in species of other areas. *R. luzonensis* males can be separated from *R. seyferti* by lacking a pair of distinct long hair tufts ventrally on segment VIII of male, as illustrated by Zettel (1994). This characteristic separates *R. seyferti* from all other species of *Rheumatogonus*. Apart from its larger size, *R. luzonicus* apparently has longer hairs on segment VIII of the male than species found in Borneo and continental Asia. The paramere of *R. luzonicus* is characterized by having a very incrassate shaft which is almost parallel-sided and after curving upwards, the short apical part tapering strongly (fig. 40). The endosomal sclerites (fig. 48) are different from other species by the shape of its lateral and ventral sclerites. No conspicuous differences were found in the female identified by Esaki from MNHN cited above after comparing it with the specimens from Mindanao, except for its smaller size (length 6.65, width 1.91) and darker colour.

Rheumatogonus borneensis Esaki, 1927
(figs 4, 6, 58, 67)

Rheumatogonus borneensis Esaki, 1927: 267-268 (description apt. ♀ - W Borneo).
? *Rheumatogonus borneensis*; Andersen, 1967: 267-272 (Palawan & Calamianes Islands); Zettel, 1994: 82 (Palawan).

Material.— Holotype, apt. ♀, "**Borneo** Sept., Pontianak, R. Oberthur 1897" (MNHN).

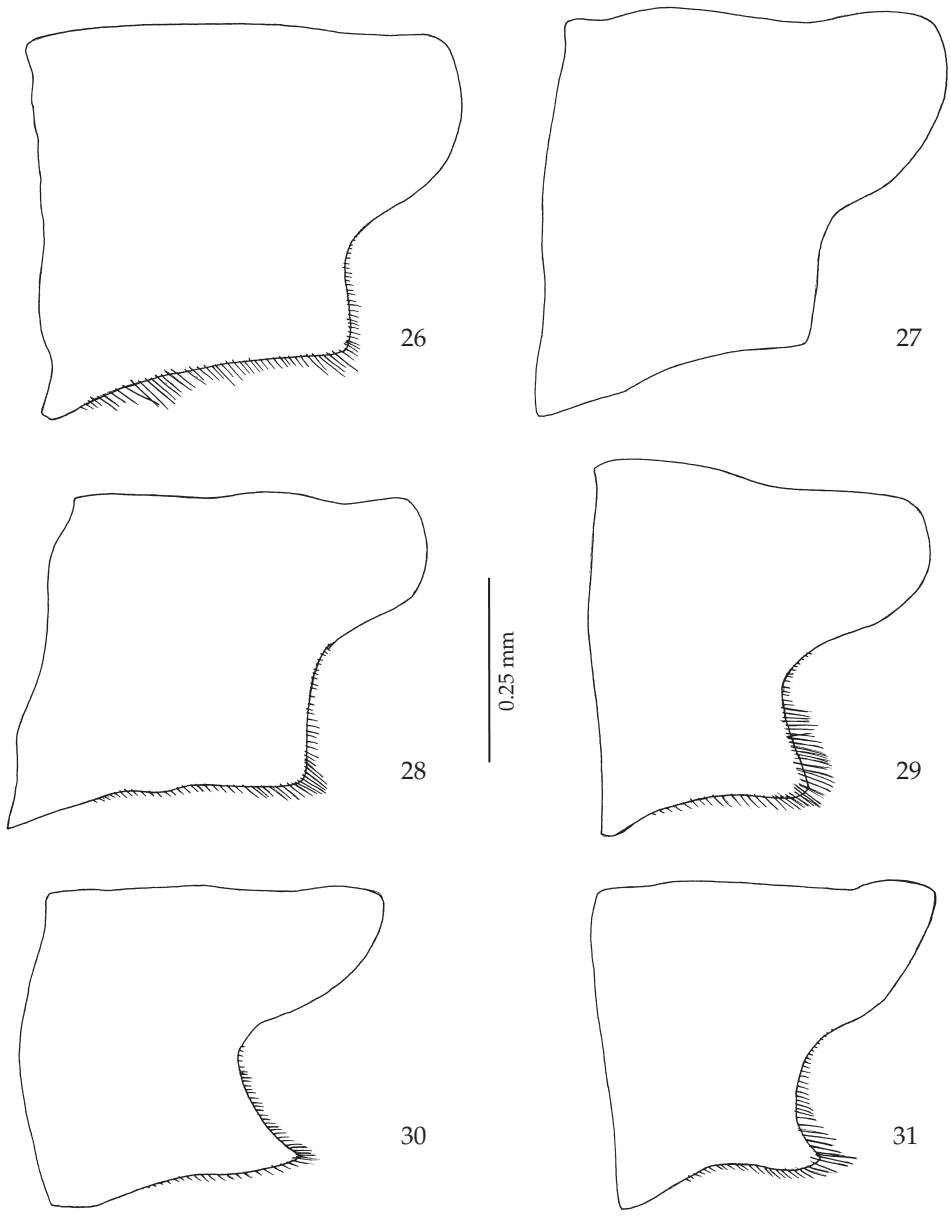
Type locality.— Borneo [Kalimantan]: Pontianak.

We give only the redescription of the female holotype for further study.

Dimensions.— Female. Body length 5.90; width across meso- and metathoracic suture 1.50, width across suture between metanotum and abdomen 1.52. Thoracic height in lateral view 1.61.

Colour.— Generally corresponding with the description of the coloration under the genus, but the ground colour of body rather brown, and yellowish brown ventrally; the dark markings on head and pronotum weak and small (fig. 4); basal part of middle leg with internal and external sides brownish. The darker coloration might be due to the age of the specimen. Abdominal tergite II with a pair of small and vague yellowish markings laterally.

Structural characteristics.— Head length in dorsal view 0.81; its narrowest width between eyes 0.27. Eye length 0.67, width 0.50. Length of antennal segments I-II: 1.51: 0.80 (III-IV missing). Length rostral segments I-IV: 0.20: 0.11: 0.51: 0.21. Pronotum



Figs 26-31, lateral view of eight abdominal segment of male *Rheumatogonus* species. 26, *R. luzonicus*; 27, *R. esakii*; 28, *R. vantoli*; 29, *R. inusitatus*; 30, *R. intermedius*; 31, *R. vietnamensis*.

short (0.52), narrower (1.08) than head (1.16). Length of mesonotum 1.42. Length of metanotum 0.70.

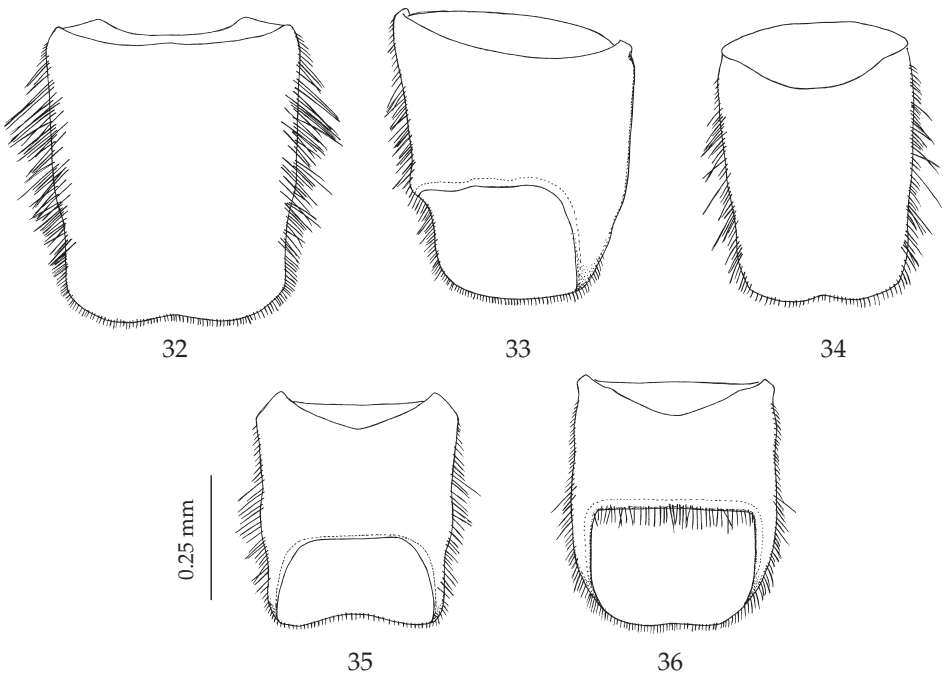
Fore leg: Measurements of legs see table. Fore femur about 10.9 times as long as wide basally; tarsal-I 1.17 times as long as tarsal-II. Basal golden hairs of hind femur moderately long (0.10). Abdomen including genital segments (2.40) in dorsal view shorter than thorax (2.64). Length of tergite VII 0.40, sternite VII with a well developed median caudal lobe (0.31). Connexival segment VI caudally with sparse longer setae (fig. 58). Genital segments (0.36) in dorsal view, shorter than abdominal segment VII (0.52). Abdominal tergite I-VI strongly shining, lateral pubescence denser than along median line. Connexival segment VII caudally with dark longer setae; connexival segment VI without distinct longer setae as in segment VII.

Distribution (fig. 67).— Indonesia: (Borneo) Kalimantan, Pontianak.

Comparative notes.— See under *R. esakii* spec. nov.

Discussion.— Esaki described this species from a single apterous female, this unfortunate situation has resulted in a confusion due to the similar appearances of other species (see below). Our measurements of the holotype are different from those given by Esaki. Our scale was checked with a 0.01 mm micrometer F (Shimadzu, Kyoto, Japan). The holotype is more brownish than any *Rheumatogonus* species we have seen, which is probably caused by long time of deposition (collected in 1879). Part of the appendages are missing. The remaining appendages are: segments I & II of right antenna, right fore leg, tibia and tarsus-I & II of left fore leg, middle and hind femora (right femur only with basal half), part of tibia of right hind leg (see table).

Several authors after Esaki either did not or insufficiently study the male genital characteristics. Although the female holotype has been consulted for comparison by several authors, due to lacking a male type, all the *Rheumatogonus* specimens from Borneo were wrongly considered to be *R. borneensis*. The species was described from Pontianak, Borneo (Kalimantan, Indonesia). According to the literature records, its distribution ranges from western Borneo (Esaki, 1927), through Sarawak and Brunei (Miyamoto, 1967) to Palawan (Andersen, 1967; Zettel, 1994). However, all the specimens we have seen from northern Borneo (Brunei and Sabah) identified as *R. borneensis* belong to the three new species described in this paper. Moreover, Andersen (1967: 271, figs 16-17) also noticed differences of female legs between the holotype and specimens from Palawan. He also presented parameres for *R. luzonicus* and *R. borneensis* from Calamianes Islands, and showed distinct differences between these two. However, his figure of the paramere (fig. 14) matches with *R. vantoli* spec. nov. from Sabah. Therefore, we consider that the species from the Palawan area which has been identified as *R. borneensis* is probably either *R. vantoli* spec. nov. or another species. Further, Zettel (1994) also reported distributional data of *R. borneensis* from Palawan, and illustrated the vesical sclerites based on the material from Palawan, which is different from *R. vantoli*, but more or less matching *R. esakii* from Brunei. Unfortunately, the paramere was not figured in his paper. After all, the status of *R. borneensis* will have to wait until males from the Pontianak area become available. The distributional pattern of *R. borneensis* given in the literature is wrong, so far the only verified record is the holotype from northwestern Borneo.



Figs 32-36, Abdominal segment VIII of male *Rheumatogonus* species. 32, *R. luzonicus*; 33, *R. esakii*; 34, *R. vantoli*; 35, *R. intermedius*; 36, *R. vietnamensis*; 32, 34, dorsal view; 35-36, ventral view; 33, ventrolateral view.

Rheumatogonus esakii spec. nov.
(figs 3, 5, 8-9, 15, 20-21, 27, 33, 37, 41, 49, 59, 67).

Rheumatogonus borneensis; Nieser, 1994: 322 (misidentification).

Material.— Holotype apterous ♂, allotype apterous ♀, **Brunei**: Dessa Temburong, Kuala Belalong Field Study Centre, Sungai Belalong, 16-17.iv.1993, N. Nieser, N9344 (RMNH). Paratypes 8 ♂ 3 ♀ apt., 1 ♂ macr., same data as holotype (RMNH, ZMAN, NCTN).

Type locality: Brunei, N. Borneo.

Description of apterous form.— Dimensions. Females distinctly larger than males; body length 4.12 - 4.46 (♂), 5.50 - 6.08 (♀); maximum width across suture between meso- and metanotum 1.12 - 1.14 (♂), 1.52 - 1.60 (♀), thoracic height in lateral view 1.20 - 1.24 (♂), 1.61-1.62 (♀). Body furnished with dark pubescence, additional hairs and spinules will be described under each detailed structure.

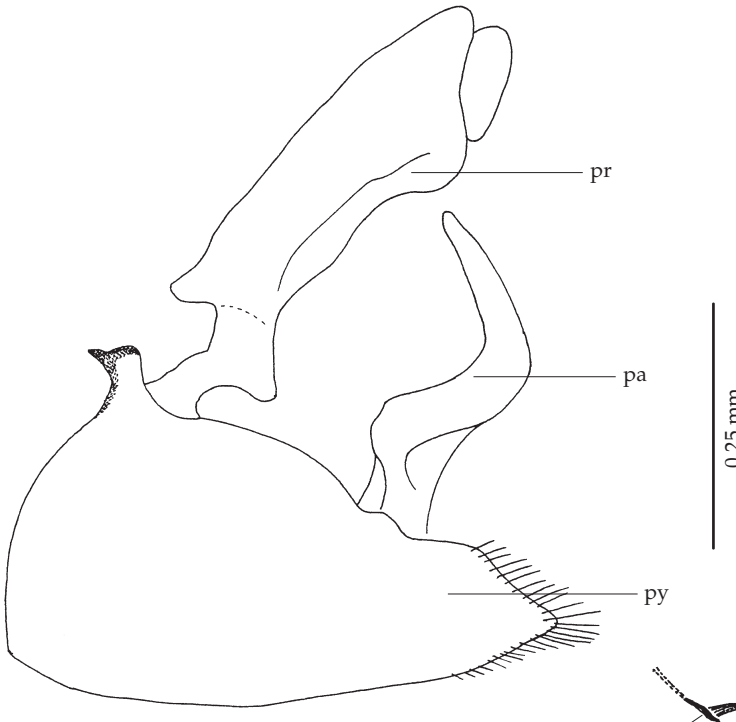
Colour.— See the description of genus. In some specimens the dark markings of the thorax nearly absent; tergite II of female with a pair of yellowish markings laterally.

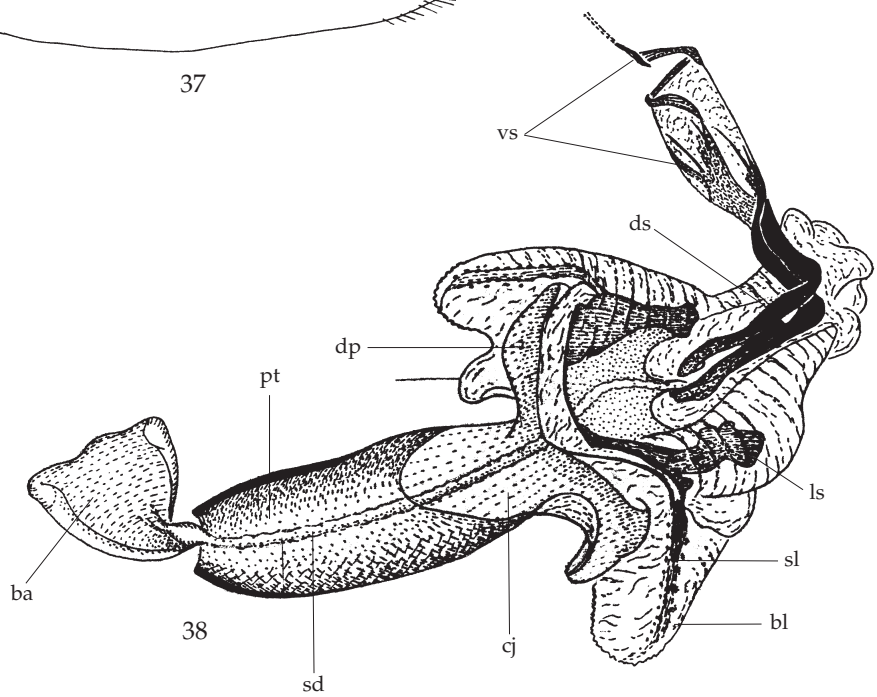
Structural characteristics. Head length in dorsal view 0.61 -0.63 (♂) and 0.81 - 0.94 (♀), its narrowest width between eyes 0.21 - 0.22 (♂) and 0.28 - 0.30 (♀). Vertex with a row of 7-8 bristles along inner margin of eye. Eye globular and large, its

length 0.50 - 0.55 (♂), 0.61 - 0.62 (♀), width 0.33 - 0.34 (♂), 0.42 - 0.45 (♀). Length of antennal segments I-IV: 1.23: 0.81: 0.82: 0.65 (♂, N = 5), 1.53: 0.94: 0.98: 0.75 (♀, N = 4). Length of rostral segments I-IV: 0.18: 0.09: 0.41: 0.22 (♂), 0.20: 0.10: 0.61: 0.22 (♀). Pronotum short (0.45 - 0.50 in ♂, 0.52 - 0.58 in ♀), its width (0.80 - 0.82 in ♂, 1.00 - 1.10 in ♀) slightly narrower than head (0.89 - 0.95 in ♂, 1.02 - 1.18 ♀), subquadrangular with lateral margins subparalleled in males, and converging posteriorly in females. Mesonotum (1.08 - 1.15 in ♂, 1.31 - 1.52 in ♀) somewhat over two times as long as pronotum in males to slightly less than three times as long as pronotum in females; sides subparallel in males, diverging posteriorly in females. Primary intersegmental suture between meso- and metanotum distinct (figs 9, 15). Length of metanotum 0.42 - 0.45 in males, 0.67 - 0.69 in females. Legs. Fore leg: femur moderately incrassate, tapering apically, about 7 times as long as wide in male; femur with about 7-8 black bristles ventrally which are set closer to each other at basal two thirds; tarsus cylindrical, tarsal-I about 0.71 times as long as tarsal-II, a pair of blade-like claws (0.12 in ♂, 0.14 in ♀) situated at apical one third the length of second tarsal segment. Middle leg: tarsal-I about 6.5 times the length of tarsal-II. Abdomen of male in dorsal view shorter (1.49 - 1.76) than thorax (2.00 - 2.05); sutures between abdominal tergites I-VII distinct, abdominal tergite I short, tergite II distinctly longer, about three times length of the third, tergites III-VI subequal in length, tergite VII longer (0.32 - 0.33). Abdominal sternite VII (0.22 - 0.23) about half the length of preceding abdominal sternites combined. The pilosity of abdominal venter more developed than on dorsum, each sternite fringed with longer setae at posterior margin.

Male genitalia.— Tergite of first genital segment (0.28) shorter than seventh (0.32-0.33), its hind margin very slightly incised medially. Length of genital segments in ventral view slightly shorter than preceding abdominal sternites (0.42: 0.55). Ventral margin of abdominal segment VIII in lateral view (fig. 27) not concave, with longer setae ventrolaterally, but not forming a distinct hair tuft. Proctiger longer than wide, with a short broad posterior lobe and near the base of proctiger with a group of 40 spinule-like setae laterally; central pilosity shorter, and gradually longer toward caudal margin. Parameres (fig. 41) darkened, symmetrical, just extending out of pygophore, semioval, shaft broad, curved upwards at 2/3 of its length, and slightly tapering apically, with transparent apex, bearing moderately long setae. Phallus and phallotheca as in generic description. Vesica (fig. 49): its apical margin rolled up interad and fused with phallotheca, basal part of dorsal plate visible; dorsal sclerites as in generic description; two thin weakly sclerotized ventral sclerites supporting a broad membranous tube; a pair of lateral sclerites distinctly broadened at basal half; the secondary lateral sclerite of basal lobe distinct.

Female.— Generally corresponding with the structure of male with the following exceptions. Legs, fore femur slender, 9.2 times as long as wide; tarsal-I about as long as tarsal-II. Anteroventral hair patch not conspicuous, invisible in dorsal view; ventral sparse dark setae very short, not conspicuous. Abdomen about as long as thorax (2.50:2.60). Interocaudal margin of connexival segment VI with dark longer setae, longer and thicker than the ones on connexival segment VII (fig. 59). Seventh sternite with a well developed median caudal lobe (0.31); length of posterolaterally subtriangular lobes of segment VIII (0.24 - 0.27). Genital segments (0.38 - 0.40) shorter than





Figs 37-38, *Rheumatogonus* species. 37, *R. esakii*, lateral view of pygophore and proctiger; 38, *R. intermedius*: dorsolateral view of inflated male phallus.

abdominal segment VII (0.42 - 0.47) in dorsal view. Otherwise apex of abdomen and genital segments as in generic description.

Macropterous form (fig. 3).— We have seen one macropterous male. Pronotum broadened: median length 1.48, pronotal lobe (1.10) 2.75 times longer than anterior part of pronotum (0.40); maximum width between humeri 1.30; length from anterior margin to humeri 0.90, from humeri to apex 0.60. Wings dark brown, impressively large compared to the size of body, and distinctly surpassing abdominal end, the length of wings from humeri to apex 4.25 in fore wing, and 2.80 in hind wing.

Distribution (fig. 67).— (Borneo) Brunei.

Biological notes.— The specimens were collected on a quiet edge of the main stream at the Kuala Belalong Field Study Centre, downstream of the boat jetty. This is a small open river in a gorge in primary rain forest.

Etymology.— This species is named in honour of Dr T. Esaki, for his contributions to the knowledge of this interesting genus and other semiaquatic bugs.

Comparative notes.— This species is very similar to *R. borneensis*. Unfortunately, as there is no male of *R. borneensis* available for our study, the differences in males of these two species cannot be discussed. Regarding the females, *R. esakii* spec. nov. can be separated from *R. borneensis* by lighter body colour, larger size, wider distance between eyes, longer legs, connexival segment VI of female with distinct and longer setae than on connexival segment VII. The male paramere and endosomal structures separate *R. esakii* spec. nov. from the remaining species.

Rheumatogonus vantoli spec. nov.
(figs 10, 16, 22, 28, 34, 42, 50-51, 61, 67)

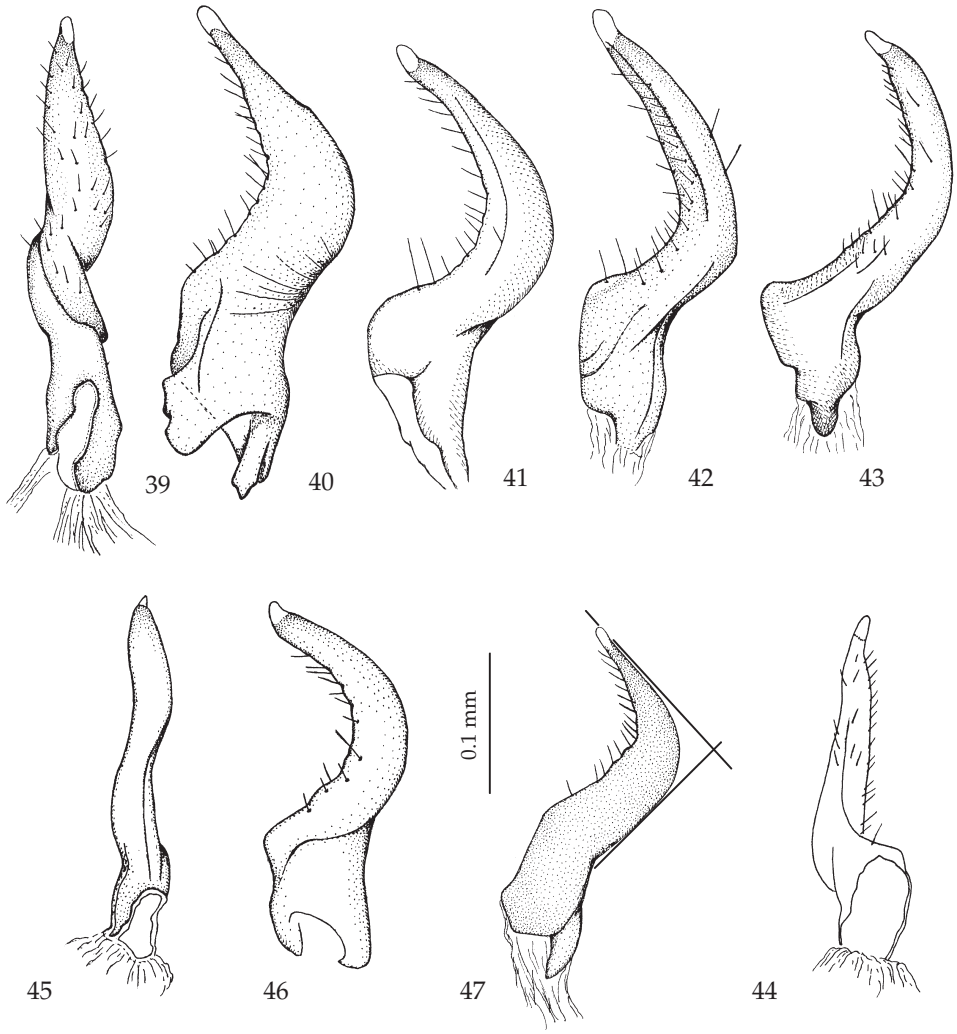
Material.— Holotype: ♂, apterous, **E Malaysia**: E **Sabah**, 60 km W of Lahad Datu, Danum Valley Field Centre at junction Sungai Segama and Sungai Talum Tambun, 150 m, 4º58′N, 117º48″E, 24.iii.1987, van Tol & Huisman (RMNH). Allotype: 1♀, apterous and paratype: 1♂ apterous, same data as holotype (RMNH).

Type locality: Sabah, E. Malaysia, N. Borneo.

Description, apterous form.— Dimensions. Females distinctly larger than males; body length 3.85 - 4.20 (♂), 6.05 (♀); maximum width across suture between meso- and metanotum 1.09 - 1.12 (♂), 1.70 (♀), thoracic height in lateral view 1.10 (♂), 1.50 (♀). Body furnished with dark pubescence, additional hairs and spinules will be described in more detail under each structure.

Colour.— See the description to genus; tergite II of female with a pair of small and vague yellowish markings laterally.

Structural characteristics.— Head length in dorsal view 0.69 (♂) and 0.73 (♀), its narrowest width between eyes 0.23 (♂) and 0.25 (♀). Vertex with a row of 7-8 bristles along inner margin of eye. Eye globular and large, its length 0.50 (♂), 0.60 (♀), width 0.32 (♂), 0.40 (♀). Length of antennal segments I-IV: 1.20: 0.71: 0.71: 0.58 (♂, N = 2), 1.50: 0.82: 0.80: 0.67 (♀, N = 1). Length of rostral segments I-IV: 0.11: 0.08: 0.40: 0.17. Pronotum short (length 0.40 in ♂, 0.50 in ♀); width 0.81-0.82 in ♂, 0.95 in ♀ slightly narrower than head (0.90 in ♂, 1.10 ♀), subquadrangular with lateral margins subparalleled in males, and converging posteriorly in females. Mesonotum (1.10 in ♂, 1.40 in ♀) slightly less than three times as long as pronotum, lateral margins subparallel in males, diverging



Figs 39-47, *Rheumatogonus* species, left parameres. 39-40, *R. luzonicus*; 41, *R. esakii*; 42, *R. vantoli*; 43-44, *R. inusitatus*, 45-46, *R. intermedius*, 47, *R. vietnamensis*. 39, 44, anterior view; 45, posterior view; 40-43, 46-47, external view.

posteriorly in females. Primary intersegmental suture between meso- and metanotum distinct, (figs 10, 16). Length of metanotum 0.48 in males, 0.59 in females. Legs. Fore leg: femur moderately incrassate, tapering apically, about 4.7 times as long as wide in male, tarsal-I about 0.63 times as long as tarsal-II, a pair of blade-like claws (0.1 mm long) situated at apical one third the length of tarsal-II. Middle leg: tarsal-I about 2.5 times the length of tarsal-II. Abdomen of male in dorsal view shorter (1.41) than thorax (1.98); tergite II distinctly longer than tergite I, about three times length of the third, tergites III-VI subequal in length, tergite VII longer (0.30). Abdominal sternite I fused with metasternum, sternite VII (0.20) about half the length of preceding abdominal sternites.

Male genitalia.— Tergite of first genital segment (0.22) shorter then seventh (0.30), its shape (fig. 34) slender compared with other species of the genus, its hind margin very slightly incised medially. Length of genital segments in ventral view slightly longer than preceding abdominal sternites combined (0.65: 0.52). Ventral margin of eighth abdominal segment in lateral view (fig. 28) not concave, with longer setae ventrolaterally, but not forming a distinct hair tuft. Proctiger longer than wide, with a short broad posterior lobe and long spine-like setae dorsobasally, central pilosity shorter, and gradually longer toward caudal margin. Parameres as in fig. 42. Phallus and phallotheca as in generic description. Vesica (figs 50-51): its apical margin rolled up interad and fused with phalotheca (fig. 51), basal part of dorsal plate visible; dorsal sclerites as in generic description; ventral sclerite fused into a broad tube, which is strengthened by thin and twisted sclerites which are poorly sclerotized; a pair of lateral sclerites distinctly broadened at basal half, more or less L-shaped; the secondary lateral sclerite of basal lobe distinct.

Female.— Generally corresponding with the structure of male, with the following exceptions. Fore femur slender, 9.2 times as long as wide; first tarsal segment about as long as the second. Abdomen about as long as thorax (2.60:2.60). Interocaudal margin of connexivum VI without dark longer setae, connexivum VII with spare longer setae (fig. 61). Sternite VII with a well developed median caudal lobe (0.29) covering genital segments. Genital segments (0.35) shorter than abdominal segment VII (0.50) in dorsal view. Otherwise female apex of abdomen, genital segments and ovipositor as in description of genus.

Macropterous form.— unknown.

Distribution (fig. 67).— (Borneo) East Malaysia, Sabah.

Biological notes.— The specimens carried labels with notes: "Stream at junction Sungai Segama and Sungai Talum Tambun, 150 m, at light, 10:30-21:00, disturbed evergreen lowland rainforest". J. van Tol (in litt.) comments that the collectors were standing in the river with lamps and that the specimens were lured to the light.

Etymology.— This species is named in honour of Jan van Tol (head of Department of Entomology, National Museum of Natural History, Leiden, The Netherlands), for his excellent contributions to the knowledge of aquatic insects.

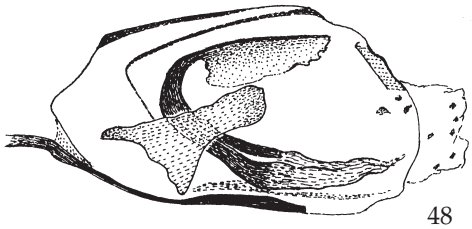
Comparative notes.— See under *R. inusitatus* spec. nov.

Rheumatogonus inusitatus spec. nov.
(figs 11, 17, 23-24, 29, 43-44, 52, 62, 67)

Material.— Holotype: apterous ♂, **E Malaysia**: Borneo, **Sabah**, Danum Valley, 70 km W of Lahad Datu, Main Trail West 12, 180 m, narrow creek, 2.xii.1989, M.J. & J.P. Duffels, Sample Sab. 52 (ZMAN). Allotype: apterous ♀, and paratypes: 8 ♂ apt., same data as holotype; 1 ♂ 1♀, apt., E Malaysia: Borneo, Sabah, Danum Valley, 70 km W of Lahad Datu, Main Trail West 5, 150 m, South 3, middle-sized stream and waterfall, 3.xii.1989, leg. M.J. & J.P. Duffels, Sample Sab. 54; 5 ♂ 6 ♀, apt., Borneo, Sabah, Danum Valley, 70 km W of Lahad Datu, Main Trail West 5, 150 m, South 3, narrow creeks in rainforest, 16.xii.1989, M.J. & J.P. Duffels, Sample Sab. 70. (ZMAN, RMNH, NCTN, CCBC).

Type locality: Sabah, E. Malaysia, Borneo.

Description of apterous form.— Dimensions. Females distinctly larger than males; body length 3.80 - 4.20 (♂), 5.50 - 6.00 (♀); maximum width across suture between



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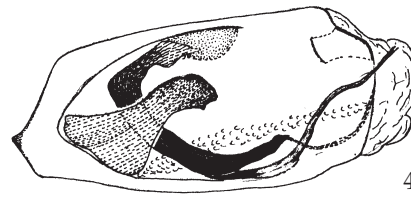

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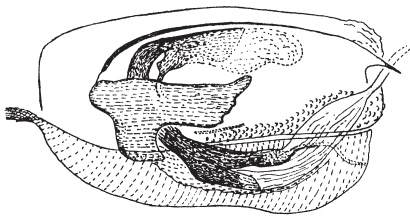

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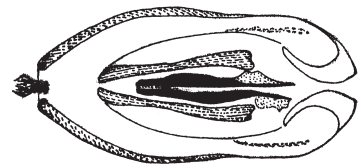

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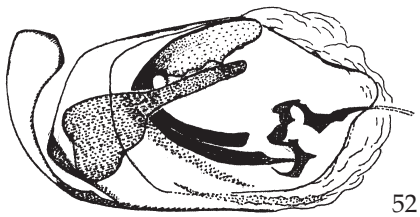

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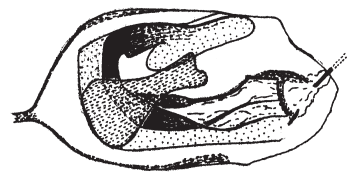

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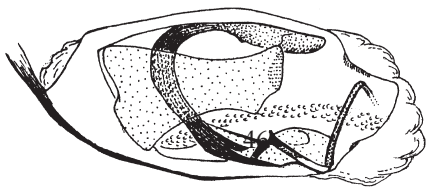

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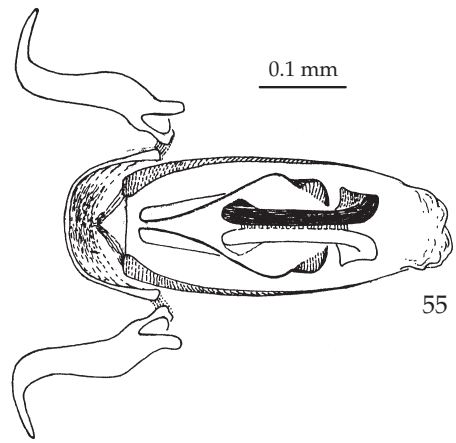

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Figs 48-55, vesica. 48, *R. luzonicus*; 49, *R. esakii*; 50-51, *R. vantoli*; 52, *R. inusitatus*; 53, *R. intermedius*; 54-55, *R. vietnamensis*. 48-50, 52-54, lateral view; 51, dorsal view; 55, ventral view.

meso- and metanotum 1.10 - 1.13 (♀), 1.60-1.70 (♀), thoracic height in lateral view 1.10 - 1.20 (♂), 1.60 - 1.70 (♀). Body furnished with dark pubescence, additional hairs and spinules will be described under each detailed structure.

Colour.— Generally corresponding with the description of the coloration under the genus. However, the dark markings rather conspicuous (figs 11, 17), rarely weakened as in other species. Tergite II of female with a pair of large yellowish markings laterally.

Structural characteristics.— Head length in dorsal view 0.62-0.68 (♂) and 0.80-0.90 (♀), its narrowest width between eyes 0.21-0.24 (♂) and 0.30-0.32 (♀). Vertex with a row of 7-8 bristles along inner margin of eye. Eye globular and large, its length 0.49-0.50 (♂), 0.58-0.60 (♀), width 0.39-0.40 (♂), 0.40-0.43 (♀). Length of antennal segments I-IV: 1.20: 0.78: 0.80: 0.65 (♂, N = 5), 1.52: 0.82: 0.89: 0.70 (♀, N = 5). Length of rostral segments I-IV: 0.11: 0.08: 0.40: 0.17 (♂), 0.18: 0.12: 0.50: 0.25 (♀). Pronotum short (length 0.50 in ♂, 0.51 in ♀), slightly narrower (0.81 in ♂, 1.05 in ♀) than head (0.94 in ♂, 1.15 in ♀), subquadrangular with lateral margins subparallel in males, and converging posteriorly in females. Mesonotum (1.02 ♂, 1.36 ♀) slightly less than three times as long as pronotum, subparallel in males, diverging posteriorly in females. Primary intersegmental suture between meso- and metanotum distinct, (figs 11, 17). Length of metanotum 0.40-0.45 in males, 0.60 - in females. Legs. Fore leg: femur moderately incrassate, tapering apically, about 6.7 times as long as wide in male; trochanter (0.50) with 5-6 long black bristles ventrally; claws 0.09 mm long. Middle leg: tarsal-I about 2.5 times the length of tarsal-II. Abdomen of male in dorsal view shorter (1.05-1.10) than thorax (1.92-1.98); abdominal tergite I short, tergite II distinctly longer, about three times length of tergite III, tergites III-VI subequal in length, tergite VII longer (0.30). Abdominal sternite VII (0.20) about half the length of preceding abdominal sternites.

Male genitalia.— Tergite of first genital segment (0.29) about same length as abdominal tergite VII (0.30), its hind margin very slightly incised medially. Length of genital segments in ventral view slightly longer than preceding abdominal sternites (0.65:0.52). Ventral margin of abdominal segment VIII in lateral view (fig. 29) somewhat concave, with longer setae, but not forming a distinct hair tuft. Pygophore as in fig. 23. Proctiger (fig. 24) longer than wide, with a short broad posterior lobe, each side with a group of about 50 sclerotized spinules dorsally, central pilosity shorter and gradually longer toward caudal margin. Parameres (figs 43-44) darkened, symmetrical, just extending out of phygophore, falciform, shaft broad and almost parallel, curved upwards at about 2/5 of its apical length, and slightly tapering apically, with transparent apices, bearing moderately long setae. Vesica (fig. 52): dorsal plate and sclerites as in generic description; ventral sclerite fused into a broad tube, strengthened by a thin and four-times twisted sclerite; a pair of lateral sclerites distinctly broadened at basal half, and slender at apical half; the secondary lateral sclerite of basal lobe less visible.

Female.— Generally corresponding with the structure of male with the following exceptions: fore femur slender, 8.3 times as long as wide; first tarsal segment about as long as the second. Abdomen including genital segments about as long as thorax (2.60:2.70). Interocaudal margin of each connexival segment with dark longer setae (fig. 62). Sternite VII with a well developed median caudal lobe (0.30). Genital seg-

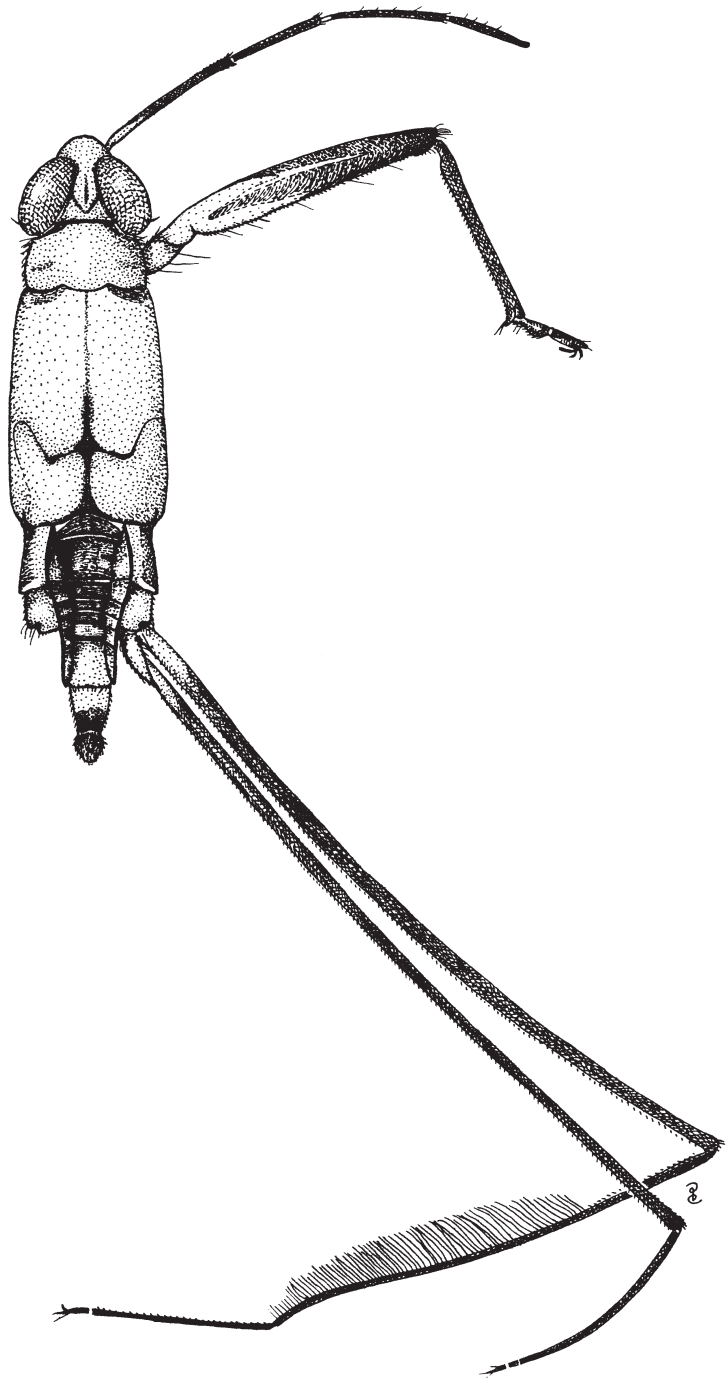


Fig. 56, *R. vietnamensis* Zettel & Chen, apterous ♂, body length 4.1 mm (N. Thailand).

ments covered as in generic description. Genital segments (0.38) shorter than abdominal segment VII (0.50) in dorsal view. Female ovipositor and gonapophyses as in generic description, first gonapophyses with 3 long setae apically.

Macropterous form.— unknown.

Distribution (fig. 67).— (Borneo) Sabah, East Malaysia.

Biological notes.— The specimens were collected from narrow creeks, a middle-sized stream and a waterfall in tropical rainforest between 150-180 m above sea level.

Etymology.— *inusitatus* (Latin, adj.) means unusual, referring to the strongly modified, and very characteristic ventral sclerites of the vesica of this species.

Comparative notes.— Among the three species found in Borneo, this species can be recognized in the first place by its strong contrast of coloration, e.g., the dark markings of body with clear border (figs 11, 17), not as in other species somewhat running or vague (figs 9, 10, 15, 16). Secondly, the ventral margin of abdominal segment VIII of the male in lateral view is slightly concave, and marginal pilosity is longer (fig. 29). In addition, the proctiger (fig. 24) of this species has well sclerotized spinules laterally near its basal margin, and the paramere is curved softly upwards, not more sharply curved as in *R. vantoli*; the apical part is shorter than in *R. borneensis* and *R. vantoli*. Especially the strongly sclerotized and twisted ventral sclerite of the vesica (fig. 52) is the most striking characteristic to separate it from the other species of the genus. Although *R. intermedius* shares this character, its ventral sclerite is less sclerotized, and its does not occur in Borneo, but in the Malay Peninsula. In *R. esakii* and *R. vantoli*, the thin piece of the ventral sclerite at apical half are much less sclerotized and less twisted (figs 49, 50). Finally, in the female of *R. inusitatus*, each abdominal tergite provided with a patch of longer dark setae at the interocaudal corner (fig. 62), but not in *R. esakii* (fig. 59) and *R. vantoli* (fig. 61).

Rheumatogonus intermedius Hungerford, 1933
(figs 12, 18, 30, 35, 38, 45-46, 53, 60, 67)

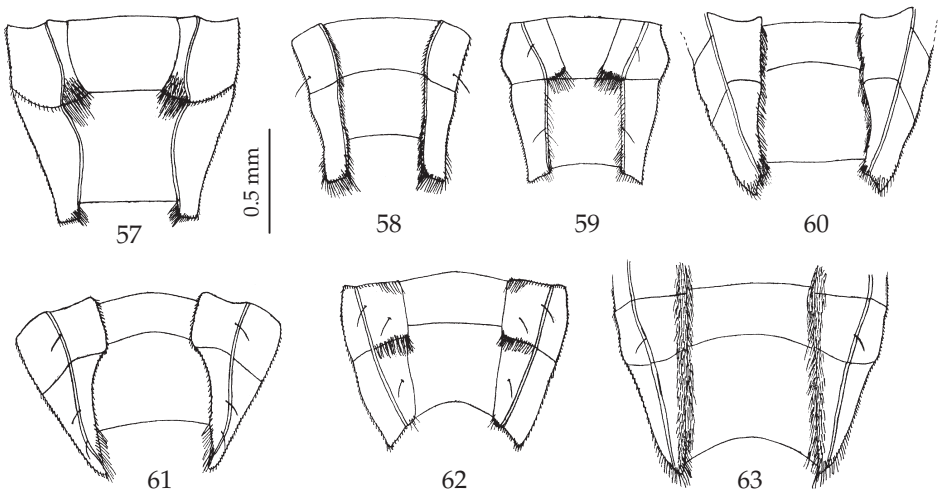
Rheumatogonus intermedius Hungerford, 1933: 3-4, (description apt. & macr. ♂, ♀, Sumatra); Matsuda, 1960: 283 (figs); Cheng & Fernando, 1969: 118 (redescription, Malay Peninsula); Yang et al., 1999: 284 (checklist from Pulau Tioman).

Material.— 2 ♀ apt. types, [**Indonesia**], Baboera River, East Coast of **Sumatra**, 24.ix.1931, J.C. van der Meer Mohr (SEMC). Additional specimens: 11 ♂, 4 ♀, apt. **Thailand**: Songkhla Prov., stream of Ton Nga Chang waterfall (outside of the park), 27.xi.1995, N. Nieser, N9533 (NCTN). First record for Thailand.

Redescription of apterous form.— Dimensions. Comparatively small species; body length 3.92 - 4.05 (♂), 5.55-5.60 (♀); maximum width across suture between metanotum and abdomen 1.09 - 1.10 (♂), 1.60 - 1.69 (♀), thoracic height in lateral view 1.09 - 1.10 (♂), 1.65 - 1.70 (♀).

Colour.— Generally corresponding with the description to the coloration under the genus, the dark markings on head and pronotum weak and small (figs 12, 18); tergite II of female dark, without a pair of large yellowish markings laterally.

Structural characteristics.— Head length in dorsal view 0.54 - 0.60 (♂) and 0.68 - 0.80 (♀), its narrowest width between eyes 0.18 - 0.19 (♂) and 0.26 - 0.28 (♀). Eye



Figs 57-62, Dorsal view of female abdominal segment VI and VII, width and position of connexiva depending on stage of development of eggs; only longer setae are drawn. 57, *R. luzonicus*; 58, *R. borneensis* (holotype); 59, *R. esakii*; 60, *R. intermedius*; 61, *R. vantoli*; 62, *R. inusitatus*; 63, *R. vietnamensis*.

length 0.50 - 0.52 (♂), 0.60 - 0.62 (♀), width 0.36 (♂), 0.46 (♀). Length of antennal segments I-IV: 1.10: 0.63: 0.69: 0.53 (♂, N = 5), 1.40: 0.71: 0.70: 0.60 (♀, N = 4). Length of rostral segments I-IV: 0.09: 0.10: 0.39: 0.15 (♂), 0.20: 0.16: 0.50: 0.15 (♀). Pronotum short (0.40 - 0.41 in ♂, 0.51 - 0.52 in ♀), about as wide as head (0.89: 0.82) in male, slightly narrower than head in female (1.05: 1.13). Length of mesonotum 1.00 -1.02 in ♂, 1.35 - 1.40 in ♀. Length of metanotum 0.39 - 0.40 in ♂, 0.57 - 0.61 in ♀. Fore leg: femur about 7 times as long as wide basally in male, 11 times as long as wide in female; tarsal-I 0.77 times as long as second in male, 1.16 times as long as second in female. Measurements of legs see table. Male abdomen including genital segments (1.48 - 1.52) in dorsal view shorter than thorax (1.79 - 1.83), about the same length with thorax in females (2.48 : 2.45). Length of tergite VII 0.28 - 0.30 in ♂, 0.42 - 0.50 in ♀. Male abdominal sternite VII (0.19) about as long as preceding abdominal sternites (0.20), with longer pilosity laterally.

Male genitalia.— Tergite of first genital segment (0.18) about same length as abdominal tergite VII (0.19). Length of genital segments (0.60) in ventral view longer than preceding abdominal sternites (0.45). Ventral margin of abdominal segment VIII in lateral view (fig. 30) more or less straight, with denser longer setae (fig. 35), but not forming a distinct hair tuft. Proctiger longer than wide, with a short broad posterior lobe, each side with longer setae dorsally, central pilosity shorter and gradually longer toward caudal margin. Parameres (fig. 45-46) darkened, symmetrical, just extending out of phygophore, semicircular, shaft broad and almost parallel, curved upwards at about half of its length, and only tapering at apical transparent apices, bearing moderately long setae. Phallus and phallotheca as in generic description. Vesica (fig. 53) essentially as in generic description, dorsal plate with its apical margin slightly folded interad, its posterior

margin distinct; ventral sclerite fused into a broad tube, strengthened by a thin and three-times twisted sclerite; a pair of lateral sclerites distinctly broadened in basal half, and narrower in apical half; the secondary lateral sclerite of basal lobe visible.

Female.— Dark hairs in anteroventral patch of mesothorax short. Basal golden hairs of hind femur moderately long. Length of tergite VII 0.42, sternite VII with a well developed median caudal lobe (0.26 mm). Connexiva yellowish brown, along inner margin with slightly dark longer setae (fig. 60). Genital segments (0.38) in dorsal view, shorter than abdominal tergite VII (0.42). Abdominal tergites I-VI completely blackish and strongly shining, pubescence distribute evenly; tergite VII yellowish, with a large triangular dark marking. Genital segments covered by longer pubescence, giving a dull appearance.

Macropterous form.— We have not seen a macropterous specimen. Hungerford (1933) gave the width between humeri 1.2 mm for winged male, and 1.8 mm for winged female. Cheng & Fernando (1969) reported a single macropterous female, but the measurements of pronotum were not mentioned.

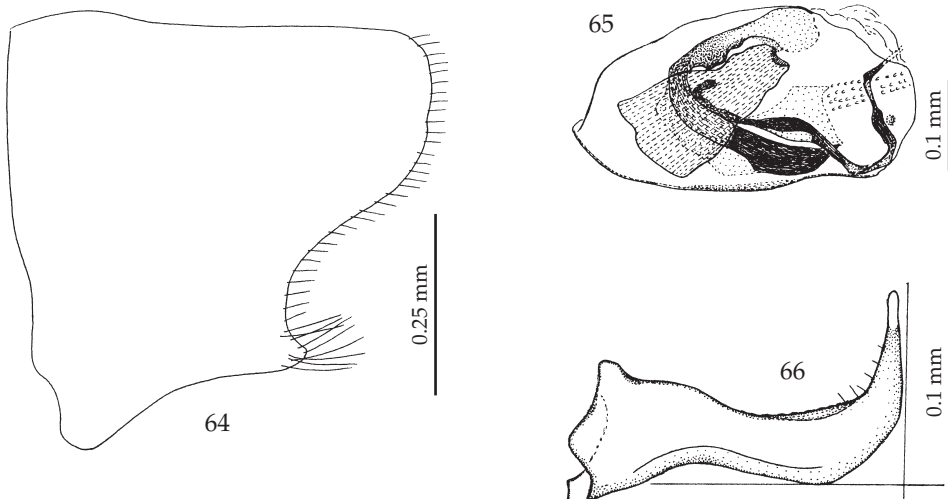
Distribution (fig. 67).— Indonesia: Sumatra; Singapore; W. Malaysia; Thailand (Songkhla).

Comparative notes.— *R. intermedius* is similar to *R. vietnamensis*, which is also close geographically, in its small size and dull coloration. It can easily be separated by its genital structure. *R. intermedius* has a typical semicircular paramere (fig. 45-46). Only *R. esakii* spec. nov. has a similar shape of paramere (fig. 41), but is a distinctly larger species. In *R. vietnamensis*, the paramere (fig. 47) has a longer parallel-sided shaft and its apical 1/3 length distinctly tapering towards apex. The shape of this paramere is somewhat similar to that of *R. luzonicus*, which again is distinctly larger. The lateral sclerite of the vesica in *R. intermedius* (fig. 53) is less broadened than in *R. vietnamensis* (fig. 54). The ventral vesical sclerite of *R. intermedius* (fig. 53) is twisted three times and in *R. vietnamensis* (fig. 54) twisted twice, and raised up in a resting position. The ventral side of the pygophore of the male in *R. intermedius* (fig. 30) is not as concave as in *R. vietnamensis* (fig. 31). The female mesothoracic dark hair patch is less striking and shorter in *R. intermedius*, and all females measured so far have a shorter body length than *R. vietnamensis*.

Rheumatogonus vietnamensis Zettel & Chen
(figs 2, 13, 19, 25, 31, 36, 47, 54-56, 63, 67)

Rheumatogonus vietnamensis Zettel & Chen, 1996: 171 (description apt. ♂, ♀ - S. Viet Nam).
Rheumatogonus sp. Miyamoto, 1967: 241 (distr. & notes); Chen & Zettel, 1998: 39 (list).

Material.—1 ♂, 1 ♀, apterous paratypes, S **Vietnam**, 40 km NW An Khe, Buon Luoi, 14º10′N, 108º30″E, 620-750 m, 28.iii.-12.iv.1995, Pacholátko & Dembiky. Additional specimens: **Thailand**: Chiang Mai Prov., Chiang Dao, village outside Chiang Dao Cave Chiang Dao, 26.iii.2001, P. Chen, B. Kavinseksan, S. Wongsiri, C0137, 1 ♂ apt.; Chiang Mai Prov., Mae Daeng Dist., Road 107 along Mae Ping River, 50 km N Chiang Mai City, Mae Ping River at Ban Mae Srac, Village, 28.iii.2001, C0143, P. Chen, Boomee Kavinseksan, S. Boonkorn, 32 ♂ 27 ♀ apt., 1 ♂ macr. (dealated); Chiang Mai Prov., Mae Daeng Dist., Road 107 along Mae Ping River, 40 km N Chiang Mai City, Mae Ping River at Royal Ping Garden & Resort, 28.iii.2001, P. Chen, B. Kavinseksan, S. Boonkorn, C0144, 8 ♂ 12 ♀, apt.; Chiang Mai Prov., Mae Wang Dist., Doi Hui Muang, Baan Hui Kho stream, 460 m, near Baan Hui Thong village, 18.ii.2002, P. Chen, C. Duangsupa, A. Thanyakam, 1 ♀, 5 larvae, C0206; Chiang Mai Prov., Doi Saket



Figs 64-66, *Rheumatogonus cheliforus*: 64, lateral view of VIIIth abdominal segment; 65, lateral view of vesical sclerites; 66, external view of left paramere.

Dist., Pa Meang Subdist., Baan Pong Ao, Kuang river, along road 118, 36 km NE Chiang Mai city, 30.i.2002, P. Chen, N. Nieser, C. Duangsupa, A. Thanyakam, C0219, 4 ♂ 2 ♀ apt.; Chiang Mai Prov., Chom Tong Dist., Doi Inthanon NP, Wang Khwaay waterfall, 72 km SW Chiang Mai city, 31.i.2002, N. Nieser, C. Duangsupa & A. Thanyakam, N0204/C0223, 1 ♂ 1 ♀ macr. (dealated); Chiang Mai Prov., Chom Tong Dist., Kwang Pao subdist., Baan Luang Chom Thong, 63 km SW Chiang Mai city, 31.i.2002, N. Nieser, C. Duangsupa & A. Thanyakam, C0224, 10 ♂ 7 ♀ apt.; Chiang Mai Prov., Hot Dist., Ob Luang NP, Mae Jam river, 108 km SW Chiang Mai city, 05.ii.2002, P. Chen, N. Nieser, C. Duangsupa & A. Thanyakam, C0226, 19 ♂ 25 ♀, apt., 1 ♂ macr. (dealated); Chiang Mai Prov., Chom Thong Dist., Baan Pae Subdist., Baan Mae Jam Fang Khaw, Mae Ping river, 82 km SW Chiang Mai city, 05.ii.2002, P. Chen, N. Nieser, C. Duangsupa & A. Thanyakam, C0227, 4 ♂ 5 ♀ apt.; Chiang Mai Prov., Fang Dist., Wiang Subdist., Baan Mae Chai, Mae Chai river, 20 km E Fang town, 24.ii.2002, P. Chen, N. Nieser, C. Duangsupa & A. Thanyakam, C0247, 5 ♂ 5 ♀ apt., 1 ♂ macr. (dealated); Chiang Mai Prov., Chai Prakan Dist., Pong Tong Subdist., Baan Hui Muang, Fang river, 3 km, N Chai Prakan town, 24.ii.2002, P. Chen, N. Nieser, C. Duangsupa & A. Thanyakam, C0248, 8 ♂ 5 ♀ apt.; Chiang Mai Prov., Chiang Dao Dist., Ping Khong Subdist., Baan Ping Khong, Mae Ping river, 10 km N Chiang Dao town, 24.ii.2002, P. Chen, N. Nieser, C. Duangsupa & A. Thanyakam, C0249, 10 ♂ 6 ♀ apt.; Chiang Rai Prov., Mae Suai Dist., Tha Koh Subdist., Baan Chai, mountaious stream, 73 km SW Chiang Rai city, 27.i.2002, P. Chen, C. Duangsupa, A. Thanyakam & W. Jaiyai, C0217, 42 ♂ 48 ♀; Chiang Rai Prov., Muang Dist., Mae Khon Subdist., nr. Baan Pang Rim Khon, 31 km SW Chiang Rai city, 23.ii.2002, P. Chen, N. Nieser, C. Duangsupa & A. Thanyakam, C0244, 4 ♂ 1 ♀ apt.; Mae Hong Son Prov., 17 km N Mae Hong Son town, stream along road to Pha Sua waterfall, 11.xi.1995, N. Nieser, N9510, 1 ♂ 1 ♀ apt., 1 ♂ macr. (dealated); Mae Hong Son Prov., Sop Moei Dist., Mae Khatuan Subdist., Baan Mae Khatuan, Mae Yuam river, 275 m, 5 km N Sop Moei town, 19.ii.2002, P. Chen, N. Nieser, C. Duangsupa, A. Thanyakam, C0240, 3 ♂ 2 ♀ apt.; Mae Hong Son Prov., Sop Moie Dist., Mae Ka Tuan Subdist., Baan Mai, Mae Paan stream, 13 km N Sop Moie town, ca.1000 m, 19.ii.2002, P. Chen, N. Nieser, C. Duangsupa, A. Thanyakam, C0241, 28 ♂ 20 ♀ apt.; Nan Prov., Pua District, Ban Gul Village, Hui Han stream, 6 km NE of Pua town, 19.xi.1994, P. Chen & S. Piyapichart, C9407, 2 ♀ apt.; Phrae Prov., narrow tributary to Mae Kam waterfall, somewhat downstream of fall, 16.xi.1995, N. Nieser, N9517, 5 ♂ macr. (dealated); Phrae Prov., stream at Ban Huay Kaet, along road 101 to Nan, 17.xi.1995, N. Nieser, N9518,

4 ♂ macr. (dealated); Phetchabun Prov., Khao Pueya, 148 km E of Phitsanulok, upper part of Khek (stream) river, subdivision of Tunsaleangluang NP, 24.xi.1994, P. Chen & S. Piyapichart, C9412, 1♂ macr. (dealated); Phitsanulok Prov. Thung Saleang Luang NP, 400 m, stream, 6.iii.2002, P. Chen, N. Nieser & D. Wattanachaiyingcharoen, C0252, 1 ♀ apt.; Uttaradit Prov., Lab Lae Dist., Mae Phuut Subdist., Baan Mae Phuut, Mae Phuut waterfall, 670 m., 24 km NW Uttaradit city, 09.ii.2002, P. Chen, N. Nieser, C. Duangsupa, A. Thantakam, W. Jaiyai, C0228, 1 ♀ apt., 1 ♂ macr.(dealated); Uttaradit Prov., Ban Khok Dist., Muangchedton Subdist., Baan Muagchedton, Hui Sai stream, 1061 m, 10 km W Ban Khok town, 10.ii.2002, P. Chen, N. Nieser, C. Duangsupa, A. Thanyakam & W. Jaiyai, C0230, 16 ♂ 16 ♀ apt.; (BCBT, CCBC, CMUC, NCTN, NHMV, RMNH, ZMUC). A first record for Thailand.

Redescription.— Dimensions. Comparatively small species. Body length 4.00 - 4.10 (♂), 5.65 - 6.40 (♀); maximum width across suture between metanotum and abdomen 0.98 - 1.01 (♂), 1.70 - 1.71 (♀), thoracic height in lateral view 1.00 - 1.08 (♂), 1.60 - 1.65 (♀).

Colour.— Generally corresponding with the description of the coloration under the genus, the dark markings on head and pronotum weak and small, the dark markings varied in a broad scale within species (fig. 13, 19); tergite II of female with a pair of small yellowish markings laterally.

Structural characteristics.— Head length in dorsal view 0.51 - 0.55 (♂) and 0.71 - 0.80 (♀), its narrowest width between eyes 0.20 - 0.22 (♂) and 0.28 - 0.29 (♀). Eye length 0.45 - 0.49 (♂), 0.57 - 0.63 (♀), width 0.35 - 0.38 (♂), 0.45 - 0.48 (♀). Length of antennal segments I-IV: 1.08: 0.67: 0.65: 0.56 (♂, N = 5), 1.43: 0.80: 0.73: 0.65 (♀, N = 5). Length of rostral segments I-IV: 0.13: 0.07: 0.37: 0.18 (♂), 0.20: 0.11: 0.44: 0.20 (♀). Pronotum short (0.42 - 0.43 in ♂, 0.51 - 0.52 in ♀), narrower than head in both sexes (0.80 : 0.88) in male, (1.14 : 1.17) in female. Length of mesonotum 1.08 - 1.14 in ♂, 1.52 - 1.53 in ♀. Length of metanotum 0.36 - 0.40 in males, 0.60 - 0.62 in females. Fore leg: femur about 5.90 times as long as wide basally in male, 11 times as long as wide in female; tarsal-I 0.86 times as long as second in male, 1.14 times as long as second in female. Measurements of legs see table. Male abdomen including genital segments (1.38 - 1.40) in dorsal view shorter than thorax (1.87 - 1.96), about (2.30 - 2.70) the same length with thorax (2.49 - 2.51) in females. Length of tergite VII 0.30 - 0.33 in ♂, 0.48 - 0.49 in ♀. Male abdominal sternite VII (0.20) shorter than preceding abdominal sternites (0.42), with longer pilosity laterally.

Male genitalia.— Tergite of first genital segment (0.21) about same length as abdominal tergite VII (0.30-0.33). Length of genital segments (0.41 - 0.45) in ventral view longer than preceding abdominal sternites (0.40 - 0.42). Ventral margin of abdominal segment VIII in lateral view (fig. 31) clearly concave, with denser longer setae (fig. 36), but not forming a distinct hair tuft. Proctiger longer than wide, with a short broad posterior lobe, each side with longer and thicker setae dorsally, central pilosity shorter and gradually longer toward caudal margin. Parameres (fig. 47) darkened, symmetrical, just extending out of phygophore, hooked, shaft broad and almost parallel-sided, curved upwards at one third of its length, and tapering towards apical transparent apices, apical part very slightly slanting backward, bearing moderately long setae. Phallus and phallotheca as in generic description. Vesica (fig. 54-55) essentially as in generic description, dorsal plate with its apical margin slightly fold interad, its posterior margin distinct; ventral sclerite fused into a broad tube, strengthened by a thin and twice twisted sclerite; a pair of lateral sclerites distinctly broadened in basal half, and

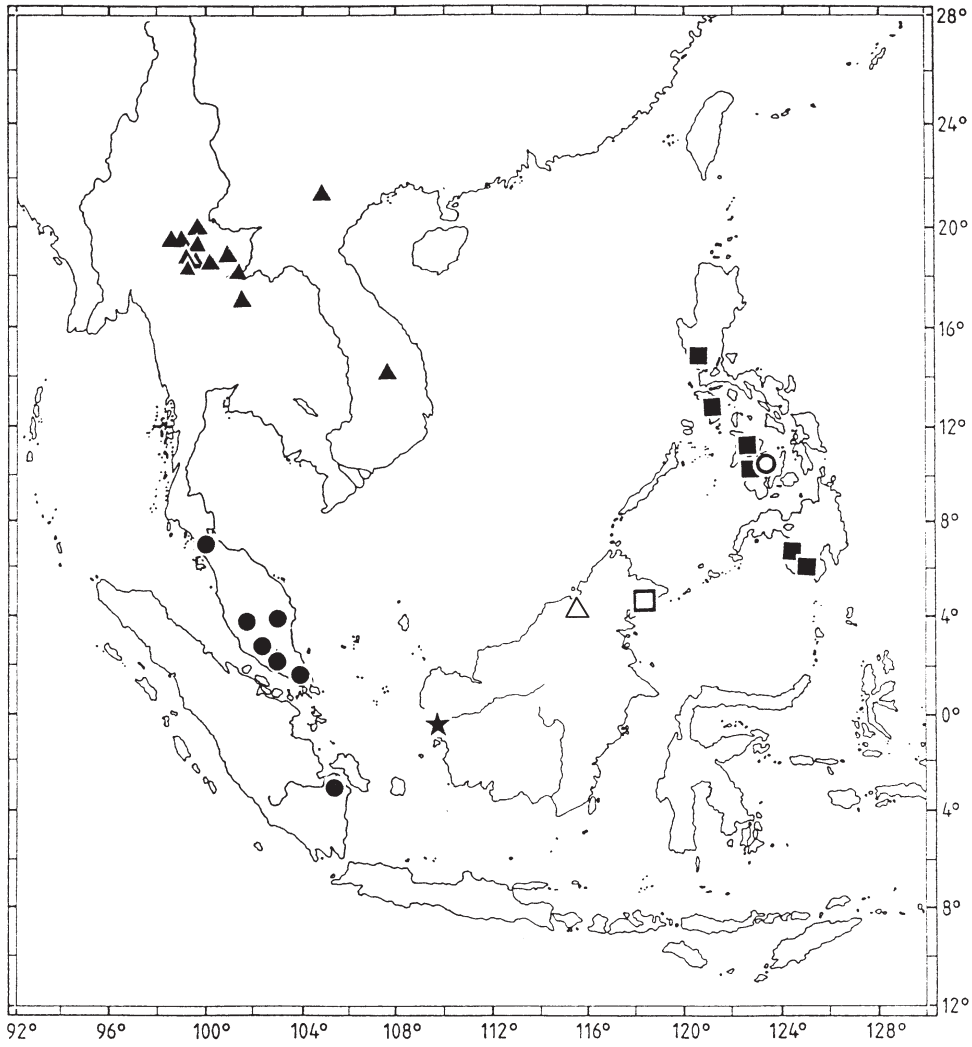


Fig. 67, Distribution of *Rheumatogonus* species. Square = *R. luzonicus*; open circle = *R. seyferti*; star = *R. borneensis*; open triangle = *R. esakii*; open square = *R. vantoli* and *R. inusitatus*; circle = *R. intermedius*; triangle = *R. vietnamensis*.

narrower in apical half; the secondary lateral sclerite of basal lobe visible.

Female.— Anteroventral dark hair patch of mesothorax conspicuous, visible in dorsal view. Dark short setae of ventral side of body conspicuous. Basal golden hairs of hind femur moderately long. Middle femur slightly longer than hind femur. Internal margin of each connexival segment with dark longer setae, when abdomen in an expanding position, a wide stripe of dark hairs can be clearly seen; connexivum VI with a few dark longer setae (fig. 63) caudally. Length of tergite VII 0.49, its sternite with a well developed median caudal lobe (0.28 - 0.29). Genital segments (0.41-0.50) in

dorsal view, shorter than abdominal tergite VII (0.49). Abdominal tergites I-VI blackish and strongly shining, with lateral yellowish markings, which only exist on tergite II in some specimens; pubescence distributed evenly; tergite VII yellowish, with a large triangular dark marking. Connexiva yellowish brown, along inner margin with longer setae; genital segments covered by longer pubescence, giving a dull appearance.

Macropterous form.— Two samples (N9517 and N9518) from Phrae Province, northern Thailand contain only dealate macropterous males. The measurements of pronotum: total median length 1.50 (anterior part 0.42, pronotal lobe 1.08), width of anterior part of pronotum 0.89, width between humeri 1.21, length from anterior angle to humeri 0.99, length between humeri to median point of posterior margin 0.75.

Distribution (fig. 67).—Widely distributed throughout continental SE Asia, from Viet Nam to northern Thailand. The first report of this species is by Miyamoto (1967) as "sp". He mentioned a single macropterous (dealate) female from "Ping Kong, Thailand". Through the help of Dr A. Lewvanich (Bangkok), we have been able to determine that Ping Khong (= Ping Kong) is a village in Chiang Dao District, Chiang Mai Province.

Biological notes.— In Thailand, species of *R. vietnamensis* were collected from deep or shallow mountainous streams, where it stayed at quiet edges. Ping River is a comparatively large river in Chiang Mai, rather sluggish and for the most part shallow during the dry season when the specimens were collected from both shaded and open river or stream sides.

Comparative notes.— See under *R. intermedius*.

Rheumatogonus cheliforus spec. nov.
(figs 64, 65, 66, 68)

Rheumatogonus custodiensis; Calabrese, 1980: 94 (misidentification).

Material.— Holotype: apterous male, allotype apterous female, **Sri Lanka** (= Ceylon on the label): Wallawaya, 8.vii.1961, K.L.A. Perera (SEMC). Paratypes: 29 ♂ 8 ♀ apt., 1 ♂ macr. (dealated), same as holotype (SEMC, NCTN, CCBC); 1 ♂ 3 ♀ apt., Ceylon, Giriulla, 13.x.1957, C.H. Fernando (SEMC); 1♂ apt., Ceylon, Polonnaruwa, 21.iii.1960, K.L.A. Perera; (SEMC).

Type localities: Sri Lanka: Wallawaya, Giriulla, Polonnaruwa.

Description.— Dimensions. Body length 4.41 - 4.58 (♂), 5.85 - 6.40 (♀); maximum width across suture between metanotum and abdomen 1.08 - 1.09 (♂), 1.72 - 1.75 (♀), thoracic height in lateral view 1.15 - 1.16 (♂), 1.62 - 1.77 (♀).

Colour.— Body dull yellowish, the dark markings of body much less developed as in other species; the dark markings on pro- and mesonotum hardly exist, and very vagure on metanotum; abdominal tergites dominantly dull yellowish, except along median line, anterior margin of tergite 1, posterior margin of tergites 1-6, 8, proctiger and anal lid, which dark brown to blackish.

Structural characteristics.— Head length in dorsal view 0.56 - 0.58 (♂) and 0.70 - 0.71 (♀), its narrowest width between eyes 0.23 - 0.24 (♂) and 0.31 - 0.32 (♀). Eye length 0.49 - 0.50 (♂), 0.56 - 0.57 (♀), width 0.31 - 0.35 (♂), 0.42 - 0.43 (♀). Length of antennal segments I-IV: 1.21: 0.79: 0.79: 0.61 (♂, N = 5), 1.66: 0.93: 0.82: 0.69 (♀, N = 5). Length of rostral segments I-IV: 0.15: 0.09: 0.56: 0.12 (♂), 0.23: 0.12: 0.69: 0.13 (♀).

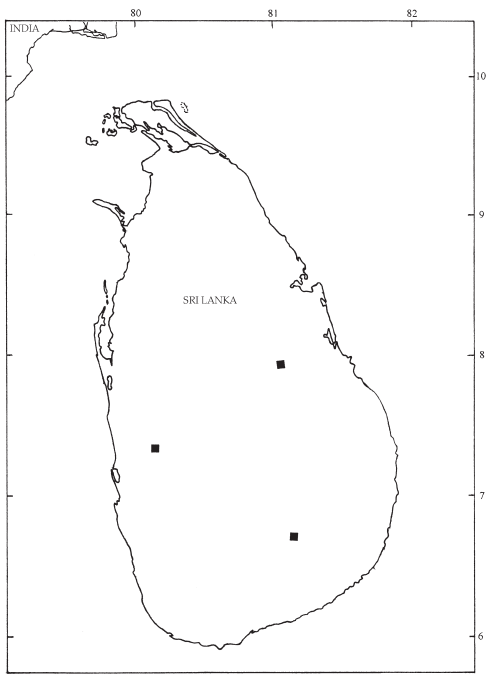


Fig. 68. Distribution of *Rheumatogonus cheliforus* spec. nov.

Pronotum short (0.48 - 0.50 in ♂, 0.54 - 0.60 in ♀), narrower than head in both sexes (0.76 : 0.88) in male, (1.07 : 1.16) in female. Length of mesonotum 1.23 - 1.26 in ♂, 1.57 - 1.66 in ♀. Length of metanotum 0.48 - 0.50 in males, 0.66 - 0.70 in females. Fore leg: femur about 6.5 times as long as wide basally in male, 8.5 times as long as wide in female; tarsal-I 0.76 times as long as second in male, 1.13 times as long as second in female. Measurements of legs see table. Male abdomen including genital segments (1.65 - 1.85) in dorsal view shorter than thorax (2.19 - 2.26), about the same length (2.62 - 2.90) with thorax (2.77 - 2.96) in females. Length of tergite VII 0.32 - 0.40 in ♂, 0.45 - 0.50 in ♀. Male abdominal sternite VII (0.22 - 0.24) shorter than preceding abdominal sternites (0.40 - 0.60), with longer pilosity laterally.

Male genitalia.— Tergite of first genital segment (0.40 - 0.48) slightly longer than abdominal tergite VII (0.32 - 0.40). Length of genital segments (0.50 - 0.53) in ventral view shorter than preceding abdominal sternites together (0.63 - 0.83). Ventral margin of abdominal segment VIII in lateral view (fig. 64) clearly concave, with denser longer setae, but not forming a distinct hair tuft. Proctiger longer than wide, with a short broad posterior lobe, each side with longer and thicker setae dorsally, central pilosity shorter and gradually longer toward caudal margin. Parameres (fig. 66) darkened, symmetrical, just extending out of phygophore, hooked, shaft broad and almost parallel-sided, curved upwards at about one third of its length, and tapering towards apical transparent apices, bearing moderately long setae, apical part very slightly slanting foreward. Phallus and phallotheca as in generic description. Vesica (fig. 65) essentially as in generic description, dorsal sclerite broadened apically, giving a cheliceral looking; ventral sclerite long and twisted twice; a pair of lateral sclerites distinctly broadened in basal half, and narrower in apical half; the secondary lateral sclerite of basal lobe visible.

Female.— Anteroventral dark hair patch of mesothorax inconspicuous, not visible in dorsal view. Dark short setae of ventral side of body inconspicuous. Basal golden hairs of hind femur moderately long. Middle femur about as long as hind femur. Internal margin of each connexival segment with brownish longer setae; connexivum VI without caudal longer setae. Length of tergite VII 0.45 - 0.50, sternite with a well developed median caudal lobe (0.25 - 0.35). Genital segments (0.41 - 0.50) in dorsal view about as long as abdominal tergite VII (0.48). Pronotum of female with posterior median dark stripe; abdominal tergites I-VI blackish and strongly shining, tergite II

with a pair of small and tergite VII with a pair of large yellowish markings laterally. Pubescence distributed evenly.

Macropterous form.— Pronotum: total median length 1.64 (anterior part 0.44, pronotal lobe 1.20), width of anterior part of pronotum 0.75, width between humeri 1.21, length from anterior angle to humeri 1.08, length between humeri to median point of posterior margin 0.77. Wings are broken.

Distribution (fig. 68).— It is probably endemic to Sri Lanka.

Etymology: cheliforus (latinization of Greek adjective "cheliphoros", meaning privided with a claw, referring to the cheliceral claw-like end of dorsal sclerite.

Comparative notes.— This species is very similar to *R. vietnamensis* by external characters, such as the male 8th abdominal sternite concave in lateral view (fig. 64), paramere hooked, with longer shaft and short apical curve, which almost straightly pointing up, and female connexival segments without modified hair tuft. *R. cheliforus* has its apical part of the paramere very slightly slanting forward (fig. 66), whereas in *R. vietnamensis* it is straight (fig. 47). The apical part of dorsal sclerite of *R. cheliforus* thickened and cheliceral. The ventral sclerite raised up and curved as in *R. vietnamensis*, but the middle part of ventral sclerite is distinctly broadened (fig. 65), whereas in *R. vietnamensis* the ventral sclerite has even thickness (fig. 54). All the specimens examined by us are in general with light colour, especially the blackish markings on thoracic tergites of males are poorly developed.

Remarks: In the loan from Snow Entomological Museum, we found four specimens, each carrying a label of "*Rheumatogonus custodiensis* Dist., det. D. Calabrese", which seemed to be used in her work of 1980. All four specimens are eventually *R. cheliforus* spec. nov.

Acknowledgements

The field trip to Thailand in 2002, during which considerable material was collected, was supported by two grants from the Uyttenboogaart-Eliasen Stichting to the authors for the promotion of entomological research (Amsterdam, The Netherlands). For collecting specimens, managing the loan of specimens and type series for this work, our sincere thanks are due to M.J. & J.P. Duffels (ZMAN), R. Brooks (SEMC), E. Gilbert (MNHN), W. Hogenes (ZMAN) and J. van Tol (RMNH). For extensive logistic help and warm hospitality during our excursions in Thailand, we are in debt to: S. Wongsiri, C. Lekprayoon, B. Kavinseksan, S. Leepitakrat, A. Chitiwong (Bangkok), S. Piyapichart, W. Wattanachaiyingcharoen, D. Wattanachaiyingcharoen, Chonphon (Phitsanulok), P. Leksawasdi, C. Duangsupa, A. Thanyakam, T. Yantarasri, J. Sornsrivichai, S. Boonkorn, S. Praiwan, Family Chandarapaoraya (Chiang Mai), and many others to whom we sincerely apologize for not being mentioned. In addition, our special thanks are due to Dr A. Lewvanich (Bangkok), for the discussion on many interesting topics on the insect fauna of Thailand, and her effort helping to figure out various locality names. Finally, we thank Dr H. Zettel (Vienna, Austria) and J. van Tol (Netherlands) for the exchange of valuable opinions during our work, and Prof. Dr N.M. Andersen for reviewing the manuscript.

Table 1. Measurements of legs (in mm) of *Rheumatogonus* species.

	femur	tibia	tar.I	tar.II
luzonicus				
fore leg (♂)	2.40	1.78	0.33	0.39
middle leg	6.60	4.40	1.68	0.25
hind leg	6.80	2.00	0.08	0.12
fore leg (♀)	3.10	2.25	0.60	0.52
middle leg	8.30	5.50	2.00	0.31
hind leg	8.60	3.35	0.09	0.13
seyferti (according to Zettel, 1994: 80)				
fore leg (♂)	1.85	1.21	0.20	0.33
middle leg	5.28	3.25	1.15	0.20
hind leg	5.20	1.21	0.07	0.10
borneensis (HT, ♀)				
fore leg	2.50	1.70	0.44	0.41
middle leg	6.80	incomplete	——	——
hind leg	6.75	incomplete	——	——
esakii spec. nov.				
fore leg (♂)	2.05	1.43	0.24	0.38
middle leg	6.25	4.09	1.70	0.27
hind leg	6.48	1.76	0.07	0.12
fore leg (♀)	2.72	1.98	0.45	0.42
middle leg	7.35	5.20	1.89	0.28
hind leg	7.45	2.40	0.08	0.16
vantoli spec. nov.				
fore leg (♂)	1.85	1.21	0.20	0.33
middle leg	5.28	3.25	1.15	0.20
hind leg	5.20	1.21	0.07	0.10
foreleg (♀)	2.40	1.72	0.46	0.40
middle leg	6.80	4.20	1.21	——
hind leg	6.55	2.20	0.08	0.12
inusitatus spec. nov.				
fore leg (♂)	2.05	1.47	0.26	0.29
middle leg	5.34	3.60	1.62	0.25
hind leg	5.56	1.33	0.08	0.14
foreleg (♀)	2.55	1.95	0.40	0.36
middle leg	7.00	4.50	0.18	0.24
hind leg	7.05	1.49	0.10	0.15
intermedius				
fore leg (♂)	1.78	1.20	0.20.	0.26
middle leg	5.00	3.20	1.06	0.21
hind leg	5.02	1.30	0.08	0.12
fore leg (♀)	2.45	1.70	0.43	0.37
middle leg	6.45	4.30	1.16	0.21
hind leg	6.62	2.58	0.07	0.12
vietnamensis				
fore leg (♂)	1.80	1.26	0.25	0.30
middle leg	5.10	3.10	1.00	0.19
hind leg	5.12	1.46	0.08	0.12
fore leg (♀)	2.45	1.85	0.47	0.41
middle leg	6.70	4.18	1.20	0.22♀
hind leg	6.62	2.40	0.09	0.12
cheliforus				
fore leg (♂)	2.03	1.44	0.27	0.36
middle leg	5.51	3.25	1.20	0.22
hind leg	5.53	1.55	0.08	0.13
fore leg (♀)	2.70	1.96	0.54	0.45
middle leg	7.33	5.15	1.65	0.28
hind leg	7.67	2.60	0.09	0.14
	femur	tibia	tar.I	tar.II

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Received: 25.i.2002 (revised: 8.v.2002)
Accepted: 30.ix.2002
Edited: J. van Tol