



A new species and new records of harpacticoids (Crustacea: Copepoda: Harpacticoida) from North-Eastern Borneo

Новый вид и новые находки гарпактикоид (Crustacea: Copepoda: Harpacticoida) из Северо-Восточного Борнео

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Abstract. Zooplankton samples from inland water bodies in the north-eastern part of Borneo were collected in rivers, ponds, roadside ditches, irrigation canals, rice fields, and temporary water bodies. The harpacticoid copepods (Harpacticoida) were found only in three surveyed locations. Seven species of four genera from the families Canthocamptidae and Phyllognathopodidae were identified. Four of harpacticoid species found belong to the genus *Elaphoidella*. A new species, *Elaphoidella fatimae* sp. nov., is described. It differs from all known species of the genus by combination of the following characters: posterior margins of body somites serrate at dorsal side; anal operculum rounded, with spinules; caudal rami conical; exopod of leg 5 about three times as long as wide. Six species were reported for Borneo for the first time.

Резюме. Для исследований зоопланктона континентальных водоемов северо-восточной части Борнео были отобраны пробы из рек, прудов, придорожных канав и оросительных каналов, рисовых полей и временных водоемов. Гарпактикоиды (Harpacticoida) найдены лишь в трех из обследованных станций. Идентифицировано семь видов из четырех родов семейств Canthocamptidae и Phyllognathopodidae. Четыре из обнаруженных гарпактикоид относятся к роду *Elaphoidella*. Описан новый для науки вид – *Elaphoidella fatimae* sp. nov. От всех известных видов этого рода он отличается сочетанием следующих признаков: задние края сегментов тела зазубрены на спинной стороне, анальная пластинка округлая, с зубчиками, каудальные ветви конические, экзоподит ноги пятой пары в три раза длиннее своей ширины. Шесть видов указаны впервые для Борнео.

Key words: tropical fauna, harpacticoid copepods, *Elaphoidella*, new species

Ключевые слова: тропическая фауна, гарпактикоиды, *Elaphoidella*, новый вид

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Introduction

The island of Borneo is one of the largest tropical islands in the world. In spite of the hot and humid climate, high diversity of aquatic biotopes,

including humid ones, such as moist soils and leaf litter, the diversity of aquatic fauna of the island is rather low (Alekseev et al., 2016). Data on Harpacticoida of Borneo are scarce. We know only three early publications on these copepods, which

had appeared in the 20th century. In the first two of them (Spandl, 1924; Brehm, 1953), the harpacticoid species *Canthocamptus staphylinus* (Jurine, 1820) and *Elaphoidella bidens* (Schmeil, 1893) were reported. In the third early publication (Löffler, 1973), the list of species was expanded to four names, three of which were new to science, and they were described from Sabah in the vicinity of Mount Kinabalu: *Maraenobiotus kinabaluensis* Löffler, 1973, *Elaphoidella labani* Löffler, 1973 and *Attheyella (Canthosella) silvicola* Löffler, 1973.

In this article, the morphology of harpacticoid species, most of which are found in Borneo for the first time, is described and illustrated. Also a new species, *Elaphoidella fatimae* sp. nov., is described.

Material and methods

The material for our examination was samples of zooplankton and a terrestrial sample, which were collected in the north-east of Borneo from 8 to 15 June 2011 by Viktor R. Alekseev. For sampling, he used a manual net of triangular shape with mesh size about 100 µm and plankton net with mesh size 60 µm. Harpacticoids were found in three locations (Table 1). Together with the zooplankton sampling, some basic environmental parameters were determined using a water-quality multiprobe (Hydrolab Surveyor Data Sonde 4) which included, if possible, the measurement of depth, temperature, pH, conductivity and dissolved oxygen.

For the preparation of harpacticoid specimens and drawings, a microscope Leica DM 4000 B equipped with a drawing tube was used. Type material (glycerol preparations) is deposited in the

Type collection of freshwater invertebrates of the Zoological Institute of the Russian Academy of Sciences, St Petersburg, Russia (ZIN).

Results

During the investigation of the copepod diversity in the north-eastern Borneo, we found seven species belonging to four genera and two families. The genus *Elaphoidella* Chappuis, 1929 from the family Canthocamptidae was the most numerous; it includes four species in our samples. Here we provide a short description of the rare species found and a detailed description of a new species.

Oder Harpacticoida

Family Canthocamptidae

Subfamily Canthocamptinae

Genus *Attheyella* Brady, 1880

Subgenus *Chappuisiella* Brehm, 1926

Attheyella (Chappuisiella) prope *inopinata* Chappuis, 1931 (Figs 1a–h, 2)

Material examined. Male, **Malaysia, Sabah**, Papar Riv., shallow river bank, 9 June 2011 (ZIN, 55180).

Description. Body length 0.5 mm, excluding caudal setae. Antennules (A1) short, geniculate with strongly reinforced middle segment. Sensory cylinder extending apex of terminal segment (Fig. 1a). Antennal (A2) exopod one-segmented, with four setae (Fig. 1b). Endopods of legs 1–4 (P1–P4) three-segmented (Fig. 1c–e). At least P1 endopod two-segmented, as long as P1 exopod

Table 1. Places and conditions of harpacticoids findings, Sabah, Malaysia, June 2011.

Dates	Coordinates	Type / name of water body, nearest locality	Environmental conditions: water temperature, depth, pH, conductivity, dissolved oxygen
9 June	5°43'N, 115°56'E	Papar River, shallow river bank	30°C, depth 115 cm, pH 7.6, conductivity 35 µS cm ⁻¹ , dissolved oxygen 6.78 mg L ⁻¹
12 June	5°42.811'N, 116°24.096'E	rice field, Lumando village, Tambunan District	31.5°C, depth 10 cm, pH 5.3, conductivity 36 µS cm ⁻¹
13 June	5°31.385'N, 118°12.437'E	wet leaf litter collected in Kinabatangan virgin forest	not in water

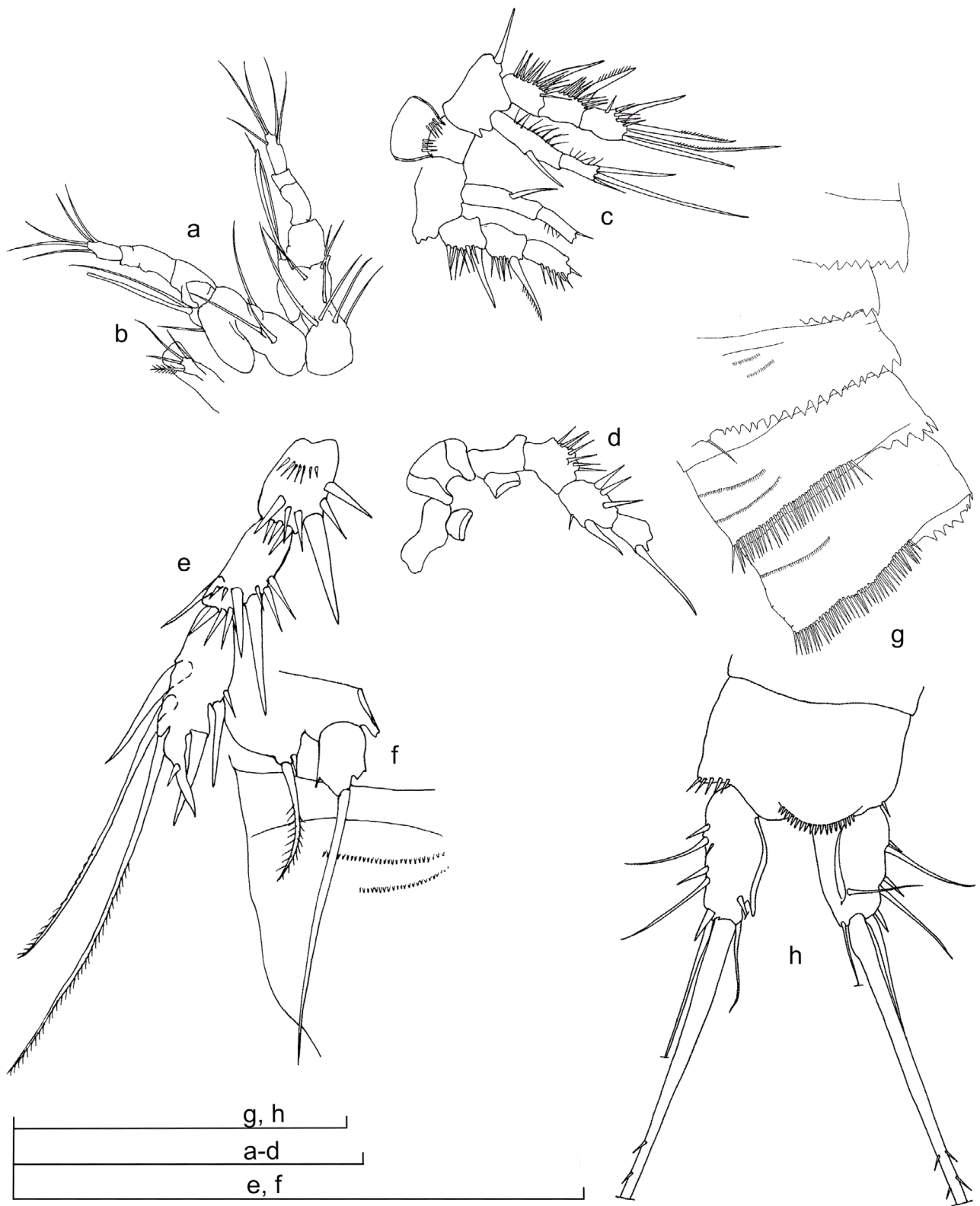


Fig. 1. *Attheyella (Chappuisiella) prope inopinata*, male. **a**, antennules; **b**, exopod of antenna; **c**, **d**, **f**, legs 1, 2, 5, partly; **e**, exopod of leg 4; **g**, two preanal abdominal somites; **h**, caudal rami and anal operculum, dorsal view. Scale bars: 0.1 mm (a–h).



Fig. 2. *Attheyella (Chappuisiella) prope inopinata*, male caudal rami, photo. Scale bar: 0.1 mm.

(Fig. 1c). Distal segment of P4 exopod with five spines and setae, with apex extended in long curve triangular appendix (Fig. 1e). Dorsal margins of body somites roughly serrate; ventral margins of abdominal somites smooth. Two preanal somites spinose at ventral side (Fig. 1g). Anal operculum rounded, with about 20 small denticles (Fig. 1h). Caudal rami conical, quite large (as long as anal segment), with crest at dorsal side (Figs. 1h; 2). Baseoendopod of leg 5 (P5) bearing one seta and very small spine; exopodite distinct, roundish, bearing three setae (Fig. 1f).

Remarks. The described specimen is very close to *A. (Ch.) inopinata* from Sumatra (Chappuis, 1931). It differs from other Indonesian species of *Attheyella (Chappuisiella)*: *A. (Ch.) ruttneri* Chappuis, 1931, *A. (Ch.) minuta minuta* Chappuis, 1931, and *A. (Ch.) minuta incerta* Chappuis, 1931 in having denticles on anal operculum and long curve triangular appendix on P4.

Genus *Elaphoidella* Chappuis, 1929

Elaphoidella bidens (Schmeil, 1893)

(Fig. 3a–k)

Material examined. Four females, **Malaysia, Sabah**, Tambunan Distr., Lumando vill., rice field ponds, 12 June 2011.

Description. Body length 0.7 mm, excluding caudal setae. Antennules (A1) eight-segmented, sensory cylinder protruding just beyond terminal segment (Fig. 3a). Antennal (A2) exopod one-segmented, with four setae (Fig. 3b). Mandibular palp two-segmented, with five setae (Fig. 3c). Dorsal margins of segments serrate; ventral margins of abdominal segments spinose (Fig. 3h, i, k). Anal operculum small, rounded, with about twelve denticles (Fig. 3k). Caudal rami subquadrate, with crest at dorsal side (Fig. 3j, k). Legs 1–4 (P1–P4) with three-segmented exopods, terminal segments of P3–P4 bearing total six spines and setae. Legs 2–4 with two-segmented endopods (Fig. 3d–f). Baseoendopod of leg 5 (P5) with four plumose setae. Exopod segment of P5 oval, elongate, spinose on inner and outer margins, about 2.6 times as long as broad, bearing four or five setae (Fig. 3h, i).

Remarks. Previously, females and males of *E. bidens* were found in groundwater of the mountainous region of Borneo (Löffler, 1973). Analysis of the main characters of its subspecies (*E. b. coronata* (G.O. Sars, 1904), *E. b. decorata* (Day, 1901), and *E. b. subtropica* Kiefer, 1929) by Apostolov (2007) showed that the most variable characters of *E. bidens* are the structure of body somites, endopods of P1–P4 and caudal rami. According to this author, the above-mentioned subspecies are not real taxa, but represent forms of variability of the species. By the morphology of exopod of A2 and the structure of mandible palp, our specimens are close to a form from Northern Vietnam (Apostolov, 2007), and differ from a form from Romania (Damian-Georgescu, 1970) and Moscow Province of Russia (Fefilova, 2017).

Elaphoidella grandidieri

(Guerne et Richard, 1893)

Material examined. Female, **Malaysia, Sabah**, Tambunan Distr., Lumando village, rice field ponds, 12 June 2011.

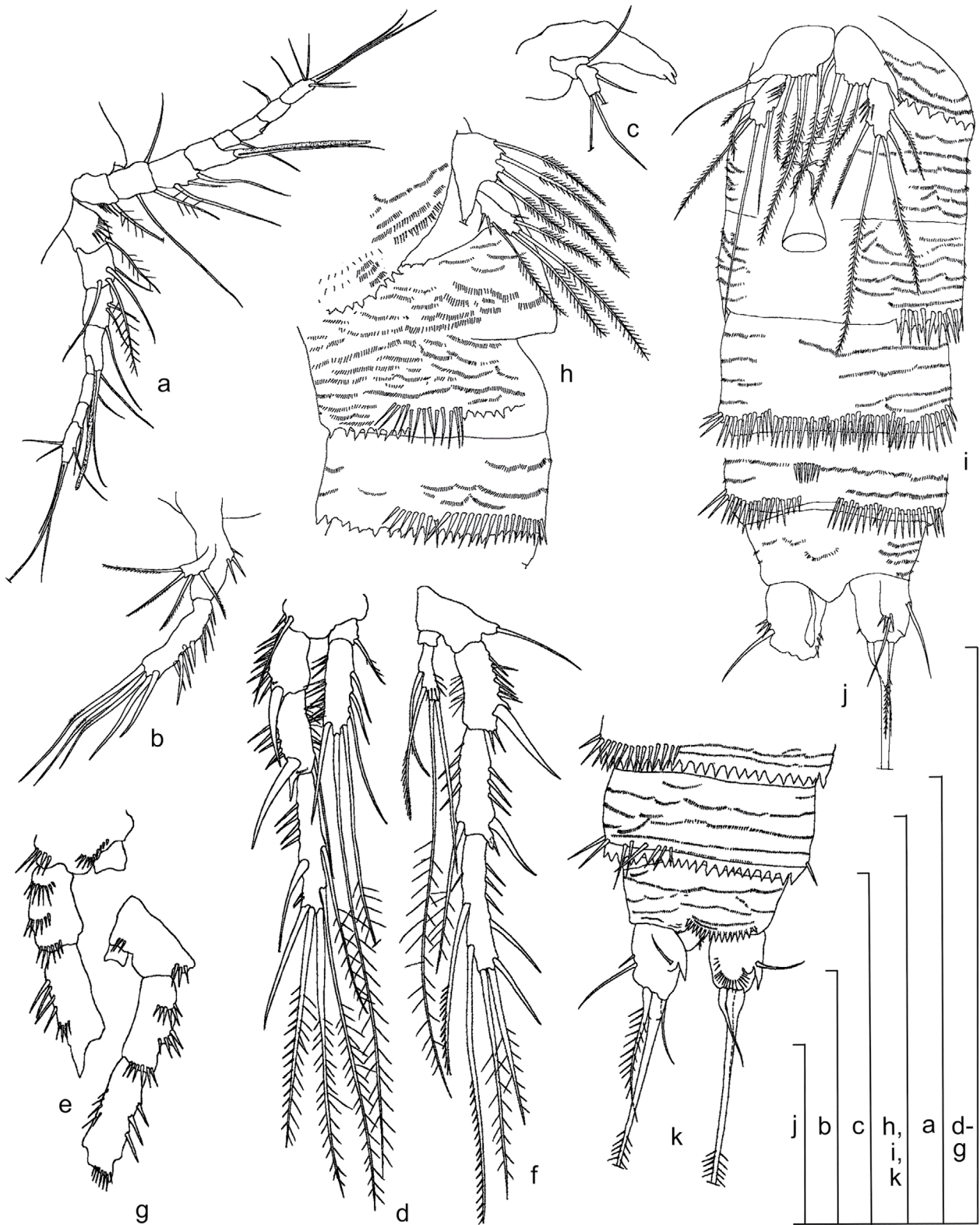


Fig. 3. *Elaphoidella bidens*, female. **a**, antennules; **b**, antenna; **c**, mandible; **d**, leg 3; **e**, first of two exopod segments of leg 3 (partly); **f**, leg 4; **g**, first of two exopod segments of leg 4 (partly); **h**, abdominal somites with leg 5; **i**, abdominal somites with legs 5, ventral view; **j**, caudal rami, ventral view; **k**, caudal rami and anal operculum, dorsal view. Scale bars: 0.1 mm (b, c, j); 0.2 mm (a, d–g, h, i, k).

Remarks. Body length 0.7 mm, excluding caudal setae. The specimen found in Borneo is completely appropriate the original description of the species (Guerne & Richard, 1893).

***Elaphoidella fatimae* Fefilova sp. nov.**

(Figs 4a–c, 5a–e, 6a, b)

Holotype. Female, **Malaysia, Sabah**, collected within wet leaf litter from Kinabatangan virgin forest in a laboratory at room temperature, 13 June 2011 (ZIN, 55178).

Description. Body length from apex of rostrum to apices of caudal rami 0.6 mm.

Length of apical caudal setae 0.23 mm. Body cylindrical, slightly narrowed towards abdomen. Antennules (A1) eight-segmented; segment 4 with long esthetasc, reaching posterior margin terminal segment (Fig. 4a). Exopod of antenna (A2) one-segmented, with four setae (Fig. 4b). Mandibular palp two-segmented, with five setae (Fig. 4c). Exopods of legs 1–4 (P1–P4) and endopods of leg 1 (P1) three-segmented, endopods of legs 2–4 (P2–P4) two-segmented (Fig. 5a–d). Endopod P1 longer than exopod (Fig. 5a). Endopods P2–P4 with seta on inner side of first segment, shorter than exopods. Terminal segments of endopods bearing setae and spines: three on P1, five on P2, six on P3, and four on P4. Terminal segments of exopods bearing setae and spines: four on P1, five on P2, six on P3, and six on P4 (Fig. 5a–d). Margins of body somites distinctly serrate at dorsal side and smooth at ventral side (Fig. 6a, b). Abdominal somites at both sides covered with rows of very thin and short setulae. Second and third abdominal somites furnished by rows of strong and rather long dorsal spinules, discontinuous on third somite and reaching dorsal side. Fourth abdominal somite with a row of spinules at lateral sides. Second abdominal somite at ventral side with a short row of eight thin spines in middle. Anal operculum rounded, with 16 small spines (Fig. 6a). Caudal rami slightly extended, being narrowed distally (Fig. 6b). Their length 0.028 mm, greatest width 0.19 mm. Ramus bearing two lateral setae with spines near base, and three terminal setae. Apical setae simple, bloated basally; medial seta 3.5 times as long as lateral ones. Outer apical setae slightly curly in middle, intersecting with medial apical seta (Fig. 6b). Medial lobe of baseopod of leg

5 (P5) short, bearing four setae (Figs 5e, 6b). Exopod extended and narrow, with almost parallel margins. Length of exopod of P5 0.032, width of exopod 0.011 mm. Exopod with three apical setae and two ones on outer margin (Fig. 5e). Longest seta (fourth at inner side) 0.123 mm.

Diagnosis. Differences of *E. fatimae* sp. nov. from some other species of the genus are given in Table 2. The new species is most similar to *E. bidens* in serrating of body segments, their arming by setulae and the structure of P5, but these two species can be distinguished in the structure of caudal rami (Table 2).

Etymology. The new species is named in honor of an aquatic ecologist from Malaysia, Prof. Fatimah Md. Yusoff.

***Elaphoidella superpedalis* Shen et Tai, 1964**

(Fig. 7a–g)

Material examined. Female, **Malaysia, Sabah**, collected within wet leaf litter from Kinabatangan virgin forest in a laboratory at room temperature, 13 June 2011 (ZIN, 55179).

Description. Body length from apex of rostrum to apices of caudal rami 0.7 mm. Antennules eight-segmented (Fig. 7a). Exopod of A2 one-segmented, with four setae (Fig. 7b). Posterior margins of abdominal somites smooth (Fig. 7e, g). Two latest abdominal somites with row of small spines (Fig. 7f, g). Anal operculum large, rounded, with many fine and rather long spinules (Fig. 7e, f). Caudal rami slightly extended, narrowed apically, with row of small spinules under caudal apical spines at dorsal side (Fig. 7e). Leg 5 two-segmented; basal segment with four spines, exopod 4.7 times as long as wide (Fig. 7d).

Remarks. The specimen of *E. superpedalis* from our sample is identical to specimens of Chinese population studied by Shen & Tai (1964) and Japanese specimens studied by Ishida & Kikuchi (2000) in absence of arming on margins of abdominal somites, caudal rami, anal operculum, A1, A2, P2, and P5.

Subfamily Epactophaninae

Genus *Epactophanes* Mrázek, 1893

Epactophanes prope *richardi* Mrázek, 1893

Material examined. Three females, **Malaysia, Sabah**, Papar Riv., shallow river bank, 9 June 2011.

Table 2. Main differential characters of females in *E. fatimae* sp. nov. and some *Elaphoidella* species from Borneo, Java and Sumatra.

Features	<i>E. fatimae</i> sp. nov.	<i>E. bidens</i> , specimens examined from Borneo	<i>E. grandidieri</i> , specimens examined from Borneo	<i>E. superpedalis</i> , specimens examined from Borneo	<i>E. longipedis</i> from Sumatra (Chappuis, 1931)	<i>E. intermedia</i> from Sumatra (Chappuis, 1931)
Margins of body somites	distinctly serrate at dorsal side	distinctly serrate at dorsal side	smooth	smooth	smooth	slightly serrate at dorsal side
Anal operculum	small, rounded, with spinulae	small, rounded, with spinules	large, rounded, with many thin setulae	large, with many thin setulae	with spinules	with spinules and hyaline plate
Caudal rami and setae	conical	subquadrate, with apophysis at dorsal side	conical	conical	conical	conical
Form and sizes of P5 exopod	subrectangular, length about 3.0 times width	oval, length 2.6 times width	oval, length about twice width	length about 4.7 times width	subrectangular, length about 3.0 times width	oval, length about twice width
Setae and spinules on P5 exopod	five setae: three apical and two at outer side	five setae: one at inner side, two at apex, and two at outer side	three setae	two setae and two spines	three setae	five setae: one at inner side, two at apex, and two at outer side
Distribution	Borneo	cosmopolitan	Africa, Asia, Central and South America	South-East and East Asia	Madagascar, Southeast Asia	Africa, Southeast Asia

Description. Body length from apex of rostrum to apices of caudal rami 0.5–0.52 mm. Antennules (A1) seven-segmented. Abdominal somites smooth at dorsal side and with rows of small spinules at ventral side. Anal operculum rounded, large, with four or five strong spines and row of thin spinules. Caudal rami conical, longer than last abdominal somite.

Remarks. *Epactophanes richardi* is cosmopolitan and rather variable species. It is capable of parthenogenetic reproduction, and its dioecious and parthenogenetic populations differ morphologically (Lang, 1935). Two species of *Epactophanes* were found in Indonesia: Chappuis (1931) and Löffler (1973) recorded *E. richardi* and Bruno and Cottarelli (1999) described *E. philippinus* as a new species. These species differ in the structure of mandibular palp (Bruno & Cottarelli, 1999). However, we did not have the opportunity to study the mandibular palp in our specimens from Borneo because it was impossible to examine the structure on permanent slides.

Family Phyllognathopodidae

Genus *Phyllognatopus* Mrázek, 1893

Phyllognatopus viguieri (Maupas, 1892)

Material examined. Female and two males, **Malaysia, Sabah**, Papar Riv., shallow river bank, 9 June 2011.

Description. Female body length 0.55 mm (excluding caudal setae). Rostrum large. Margins of body segments smooth at ventral and dorsal sides. Caudal rami oval, with three apical, two lateral and one dorsal setae. Middle apical seta thickened basally; inner and outer apical setae both short and thin.

Remarks. The Bornean specimens studied by us fully correspond to the early description of *Ph. viguieri* by Galassi et al. (2011).

Discussion

Previously, only six species of the harpacticoids were known in Borneo (Spandl, 1924; Brehm, 1953; Löffler, 1973). Our research has in-



Fig. 4. *Elaphoidella fatimae* sp. nov., holotype, female. **a**, antennula; **b**, antenna; **c**, mandible. Scale bars: 0.1 mm (a–c).

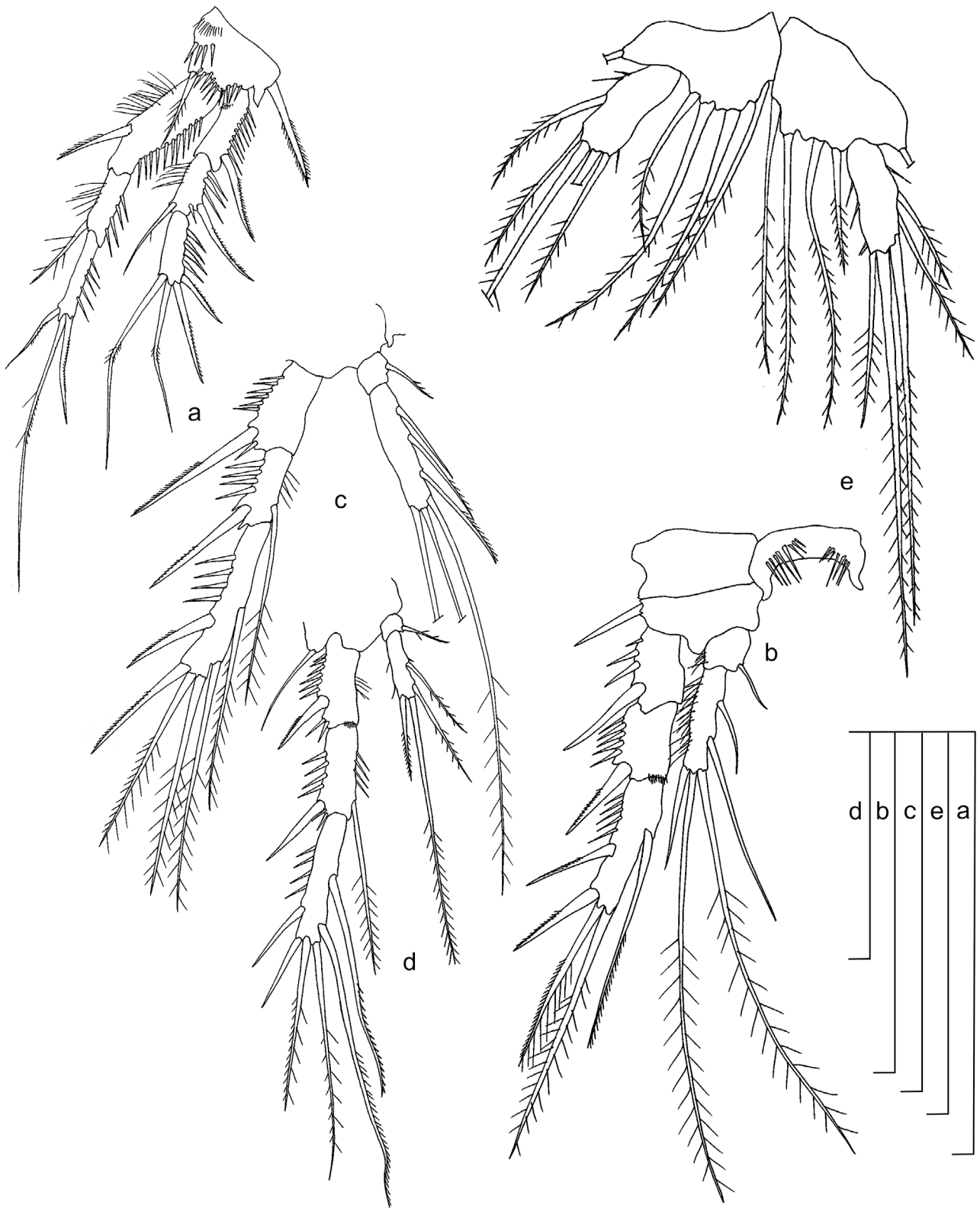


Fig. 5. *Elaphoidella fatimae* sp. nov., holotype, female. a–e, legs 1–5. Scale bars: 0.1 mm (a–e).

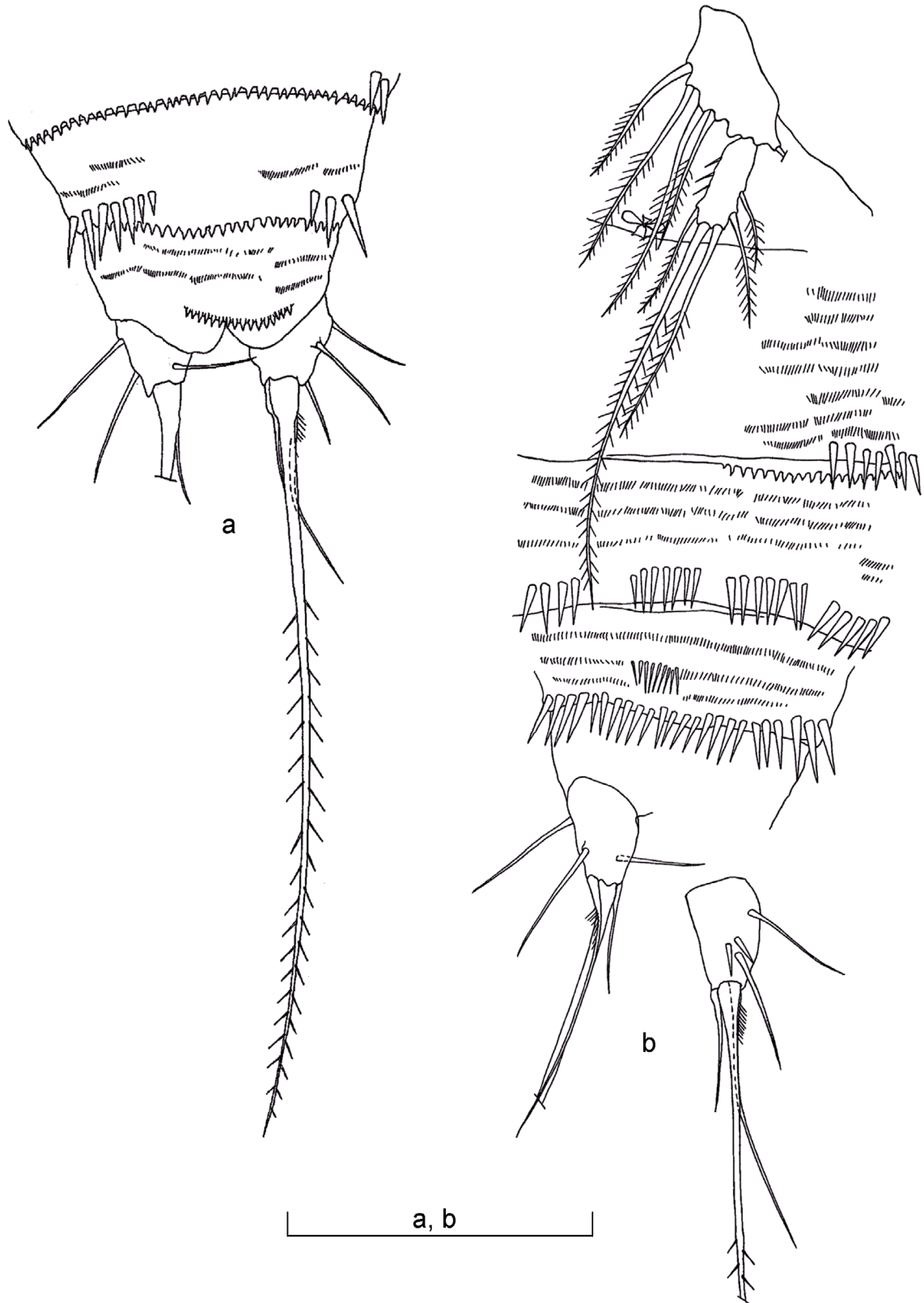


Fig. 6. *Elaphoidella fatimae* sp. nov., holotype, female. **a**, two last abdominal somites, caudal rami and anal operculum, dorsal view; **b**, ventral view of abdomen and leg 5. Scale bars: 0.1 mm (a, b).

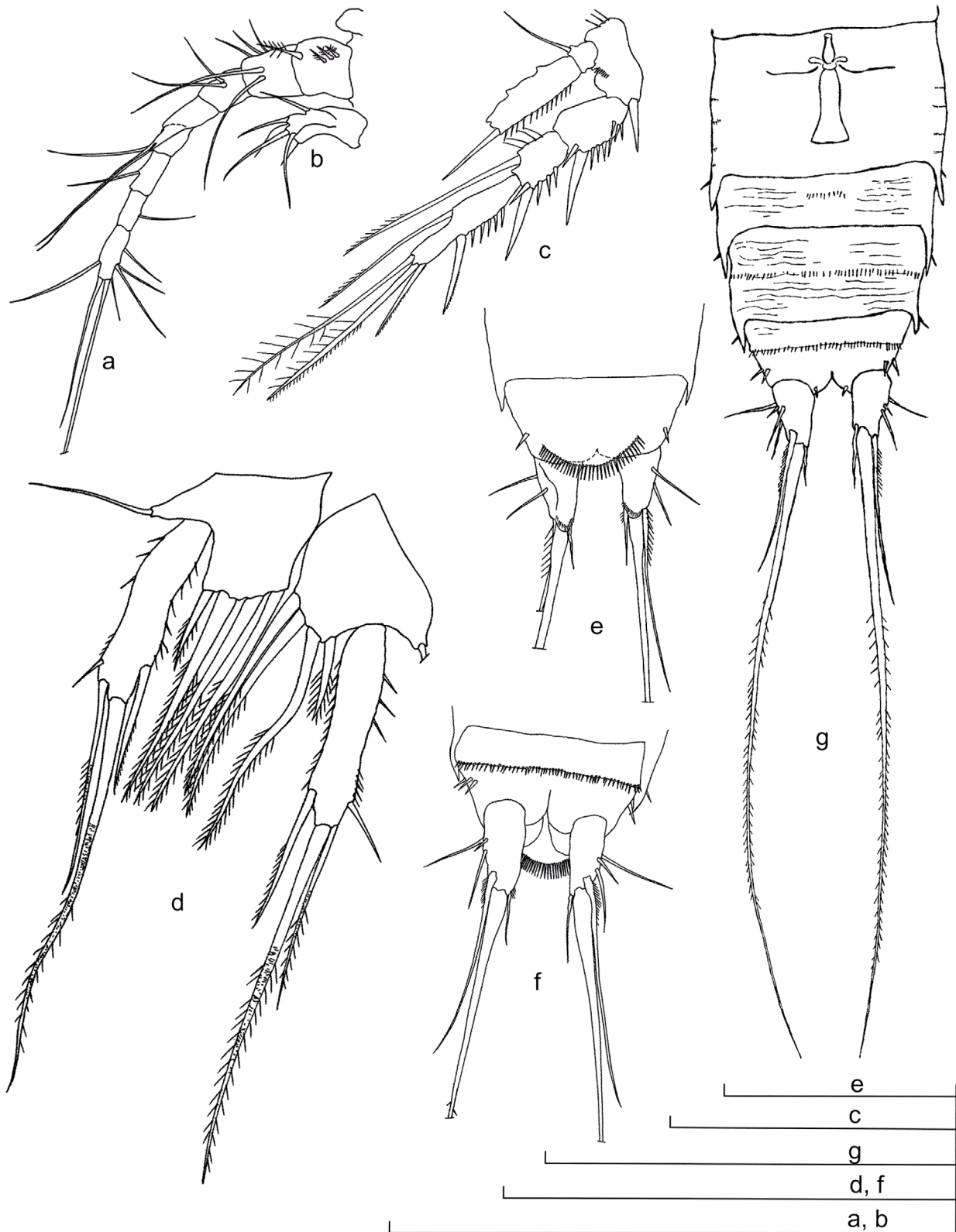


Fig. 7. *Elaphoidella superpedalis*, female. **a**, antennula; **b**, exopod of antenna; **c**, leg 2 (endopod partly); **d**, leg 5; **e**, **f**, caudal rami and anal operculum, dorsal and ventral view, respectively; **g**, ventral view of abdomen. Scale bars: 0.1 mm (c, e); 0.2 mm (a, b, d, f, g).

creased the number of species of this group to 12 in the fauna of the island. A complete list of harpacticoid species from Borneo and a key for the identification of them were presented in Alekseev et al. (2016). It is important to note that this list includes cold-loving species inhabiting the mountain part of the island (Löffler, 1973) as well as tropical species living at a water temperature of about 30 °C.

Thus, the harpacticoids in Borneo are represented by the following genera: *Canthocamptus* Westwood, 1836 with one species, *Maraenobiotus* Mrázek, 1893 with one species, *Attheyella* with two species, *Elaphoidella* with six species, *Epactophanes* with one species, and *Phyllognatopus* with one species. Three of these species (*Elaphoidella bidens*, *Epactophanes richardi*, and *Phyllognatopus viguieri*) are cosmopolitan; some species of *Attheyella* and *Maraenobiotus* are endemics of Indonesia or South-East and East Asia (Chappuis, 1931; Löffler, 1973). Other species are widely distributed, e.g. *Canthocamptus staphylinus* in the Palaearctic region (Borutsky, 1952) and *Elaphoidella grandidieri* in the Southern Hemisphere (Guerne & Richard, 1893; Chappuis, 1931; Borutsky, 1967). Parthenogenetic reproduction is known in the three found widely distributed species. In addition, the presence of parthenogenesis was assumed on the basis of scarcity of males in some other *Elaphoidella* species (Chappuis, 1955; Borutsky, 1952). The presence of this mode of reproduction can be an explanation of the fact that only females of *Elaphoidella* species were found in our samples. Actually, for some *Elaphoidella* species found, *E. superpedalis*, *E. fatimae* sp. nov., males are not known yet (Shen & Tai, 1964; Ishida & Kikuchi, 2000). Male of another species, *E. grandidieri*, was discovered and described in decades after the description of the female (Gutiérrez-Aguirre et al., 2011).

Compared with other copepods, the harpacticoids were not common in our samples; they were found only in three from 30 samples (frequency of occurrence is 10 %). This may be due to the methods of material collection. The majority of our samples were planktonic, whereas the harpacticoids, with rare exceptions, are meiobenthic animals. Some of harpacticoids can swim, others move along a substrate surface, but are trans-

ported to the upper horizons by water flows. And others specimens can be found in a bottom substrate, and we have the least chance to find them in plankton (Suarez-Morales, 2015).

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