

Four New Species of Freshwater Harpacticoid Copepods (Canthocamptidae: Copepoda) from Mountain Lakes of Taiwan

台灣高山湖泊四種淡水生猛水蚤 (Canthocamptidae: Copepoda)新種

Shuh-Sen Young*

楊樹森*

Department of Applied Science, National Hsinchu University of Education, Hsinchu, Taiwan

國立新竹教育大學應用科學系 新竹市南大路 521 號

* Corresponding author: shuh@mail.nhcue.edu.tw

* 通訊作者：shuh@mail.nhcue.edu.tw

Abstract

This paper describes four new species of harpacticoid copepods (Canthocamptidae: Copepoda) from freshwater ponds and lakes in the Central Mountain Range of Taiwan. They are *Bryocamptus nenggaoensis* sp. nov., *Elaphoidella formosanus* sp. nov., *E. hirsutus* sp. nov., and *Echinocamptus shihi* sp. nov. *B. nenggaoensis* was found in abundance in Bai-Shi-Chi and a small puddle near Mt. Neng-Gao, *E. formosanus* was collected from Tun-Lu-Chi, a small pond with bottom rich in detritus from decayed plants and grazer's droppings, and *E. hirsutus* and *E. shihi* were collected from a wetland with muddy sediment near grassy pad adjacent to Yuan-Yan-Hu.

摘要

本文描述 4 種棲息在台灣高山湖泊的新種淡水猛水蚤(Canthocamptidae: Copepoda)，其分別為 *Bryocamptus nenggaoensis* sp. nov.、*Elaphoidella formosanus* sp. nov.、*E. hirsutus* sp. nov. 及

Echinocamptus shihi sp. nov. ◦ *B. nenggaoensis* 棲息在能高山附近的白石池及附近草坡的積水小水窪內，數量相當豐富。◦ *Elaphoidella formosanus* 的採集地為屯鹿池，池底有豐富的植物碎屑及偶蹄類排遺。◦ *E. hirsutus* and *Echinocamptus shihi* 的採集地為鴛鴦湖邊緣的草澤溼地。

Key words: taxonomy, Copepoda, *Bryocamptus*, *Elaphoidella*, *Echinocamptus*

關鍵詞：分類、淡水橈足類、*Bryocamptus*、*Elaphoidella*、*Echinocamptus*

Received: March 16, 2010

Accepted: August 6, 2010

收件日期：99年3月16日

接受日期：99年8月6日

Introduction

Inland waters such as rivers and lakes are parts of the landscape mosaic separated from one another by geological formations and geographical structures. They have often evolved to have unique and diverse fauna after a long period of the isolation. In the Central Mountain Range of Taiwan, there are many such isolated lakes and ponds that have no fish but plankton and aquatic insects. Some of them are shallow, and the surface water often freezes in winter for a period of time.

Small cyclopod and harpacticoid copepods always find suitable niche in inland waters. Most of the freshwater harpacticoids are smaller than 0.5 mm in length, and are easily missed in sampling with large mesh nets. Ishida (1992) described a new species *Bryocamptus pacificus* from Taichung, Taiwan. This is the only paper on the freshwater harpacticoid copepod that has been reported so far from the island (Wang 1998).

In past few years we conducted a survey of freshwater copepods of Taiwan, and some

harpacticoids were collected from pools and lakes in the Central Mountain Range. This paper describes four new species, *Bryocamptus nenggaoensis* sp. nov., *Elaphoidella formosanus* sp. nov., *E. hirsutus* sp. nov., and *Echinocamptus shihi* sp. nov., belonging to the family Canthocamptidae (Copepoda). They were collected with a plankton net with a mesh size of 55 μm , 30 cm in length, 15 cm in diameter at the opening, and equipped with a small collecting bottle at the cod end. Some specimens were collected with a scoop in a puddle at night.

The samples were fixed with 5% formalin-water solution in the field, sorted and preliminarily identified under a stereomicroscope in the laboratory, and preserved in 70% ethanol-water solution. Appendages were dissected and mounted on microscopic slides with polyvinyl lactophenol tinted with lignin pink. Images were made with a camera Lucida. All specimens and samples are deposited at the Systematics and Biodiversity Laboratory of the National Hsinchu University of Education (SBNHCUE), Hsinchu, Taiwan.

***Bryocamptus nenggaensis* sp. nov.**

Figs. 1 and 2

Type material

Holotype: A female (dissected and mounted on slide) collected from Bai-Shi-Chi (White-Stone Pool) (23°55'40"N, 121°16'00"E) located near Mt. Neng-Gao at an elevation of 2,900m on 4 May 1997 by Shuh-Sen Young (SBNHCUE 001). Collection site water temperature was 11°C and pH 6.0.

Paratypes: A female (dissected and mounted on slide, SBNHCUE 002); a male (dissected and mounted on a slide, SBNHCUE 003); and 5 males and 5 females preserved in the 70% alcohol-water solution (SBNHCUE 004). Same collection data as holotype.

Description

Female (holotype): Body length (excluding caudal setae) 0.44 mm. Rostrum short. Prosome with cephalosome and 4 free pedigerous somites; urosome 4-segmented; posterior margin of pedigerous and urosomal somites smooth. First

urosomal somite with two transverse rows of spinules from lateral to ventral, one along the anterior margin and the other along the posterior margin: the former longer than the latter. Second urosomal somite with a transverse row of spinules along the posterior margin from lateral to ventral surface. Third urosomal somite with a row of spinules along the posterior margin of dorsal surface. Fourth urosomal somite with a row of spinules along the posterior margin of lateral surface. Anal operculum convex, armed with a crescent row of spinules. Caudal ramus length about equal to the width; terminal accessory seta short; inner and outer terminal setae with fracture plane at base; outer seta about a half of the length of the inner seta. Antennule 8-segmented; segment 4 with a long esthetasc, reaching the last segment. Antenna 3-segmented, exopod 2-segmented with 1 seta and 3 setae. Swimming legs 1-3 with 3-segmented exopod and 3-segmented endopod; leg 4 with 3-segmented exopod and 2-segmented endopod. Spine and seta formula of legs 1-4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	I-1	I-0; I-1; I- (I+2) -0	0-1; 0-1; 0- (I+2) -0
Leg 2	0-0	I-0	I-0; I-1; II- (I+2) -1	0-1; 0-1; 0- (I+2) -1
Leg 3	0-0	I-0	I-0; I-1; II- (I+2) -2	0-1; 0-0; 0-2-2
Leg 4	0-0	I-0	I-0; I-1; II- (I+2) -2	0-1; 1- (II+1) -2

Basipod of leg 5 with an expansion on the inner side with 6 setae, middle depressed, saddle-shaped, and the outer corner with 2 setae; exopod 1-segmented, its length longer than basipod, with 5 setae, order of length short to long from inner to outer seta: 1, 5, 3, 4, 2.

Male (paratype): Body length (excluding caudal setae) 0.42 mm. Rostrum short. Prosome

with cephalosome and 4 free pedigerous somites; urosome 6-segmented, the posterior margin of pedigerous and urosomal somites smooth. Second to fourth urosomal somites, each with a row of spinules along the posterior margin of lateral and ventral surfaces. Fifth urosomal somite with a row of spinules along the posterior margin. Posterior margin of anal operculum crescent-shaped, armed

with spinules. Length of caudal ramus almost equal to the width with two terminal setae that have fracture plane at base, and outer seta about half length of inner seta. Antennule 7-segmented. Antenna 3-segmented and exopod 2-segmented with 1 seta and 3 setae, respectively. Swimming legs 1-4, fairly similar to those of female but with some differences: leg 2, endopod 2-segmented, segment 2 with 4 setae; leg 3, exopod without inner seta on segment 2, and endopod 3-segmented, its segment 2 with a long inner apophysis extending past the setae of segment 3; leg 4, endopod without inner setae on segment 2; basipod of leg 5 not expanded on inner side with 2 setae; and exopod 1-segmented with 6 setae.

Etymology: The name “*nenggaoensis*” derived from the type locality, Neng-Gao Mountain.

Habitat: Bai-Shi-Chi, the type locality of *B. nenggaoensis* sp. nov., was a small pool with a surface area of 0.6 ha, and the maximum depth of 6m. Its bottom was covered with coarse sand. Water temperature was 4-15°C and pH 5.0-6.0 (Cheng and Wang 1997). *B. nenggaoensis* was also found in another pool Neng-Gao-Chi (23° 59'30"N, 121°15'10"E), a small pool located near Neng-Gao Mountain at an elevation of 2,900m, and had the surface area of 0.1 ha, maximum depth of 0.5m, and bottom covered with coarse sand.

Remarks: Female *B. nenggaoensis* sp. nov. is fairly similar in characters to *Bryocamptus vejovsky* (Mrazek, 1893) and *Bryocamptus intercalaris* Shen and Tai, 1973. However, *B. nenggaoensis* has a continuous row of spinules along both lateral and dorsal posterior margins on the third urosomal somite, whereas *B. vejovsky* and *B. intercalaris* have a discontinuous row on the dorsal surface (Borutsky 1952; Shen *et al.* 1979). Also, *B. nenggaoensis* has a small inner

seta on segment 1 and no seta on segment 2 of the leg 3 endopod, whereas *B. vejovsky* and *B. intercalaris* have both segments 1 and 2 of leg 3 endopod with a full grown inner seta (Bourstkii 1952; Shen *et al.* 1979).

Elaphoidella formosanus sp. nov.

Figs. 3 and 4

Type material

Holotype: A female (dissected and mounted on slide) collected from Tun-Lu-Chi (Dear Pool) (23°53'30"N, 121°15'10"E) at an elevation of 2,850m on 5 May 1997 by Shuh-Sen Young (SBNHCUE 005). Collection site water temperature 10°C, pH 6.5.

Paratypes: A male (dissected and mounted on slide) (SBNHCUE 006); 5 males and 5 females preserved in 70% ethanol-water solution (SBNHCUE 007). Same collection data as holotype.

Description

Female (holotype): Body length (excluding caudal setae) 0.55 mm. Rostrum short. Prosome with cephalosome and 4 free pedigerous somites; urosome 4-segmented; posterior margins of pedigerous and urosomal somites smooth. Each of the first to fourth urosomal somites with a row of spinules along the posterior margins on the lateral and ventral surfaces. Anal operculum convex without spinules. Caudal ramus length and width subequal; terminal accessory outer setae short; inner terminal seta long and strong without fracture plane at base. Antennule with 8-segments; segment 4 with long esthetasc, reaching the end of terminal segment. Antenna with 3-segments; exopod with a single segment and 4 setae. Swimming legs 1-4 with exopod of 3 segments

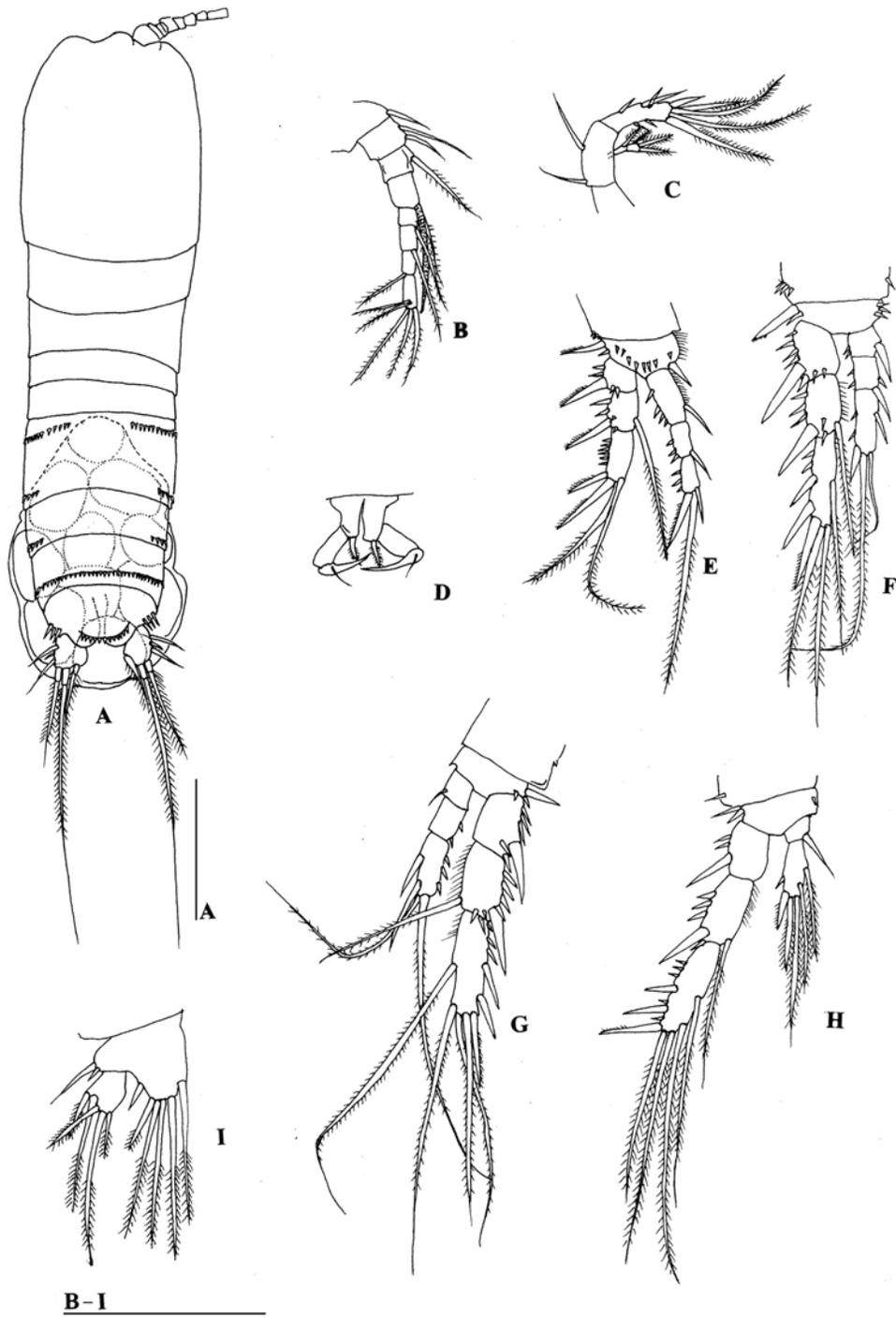


Fig. 1. *Bryocamptus nenggaoensis* sp. nov. female (holotype): A, dorsal view of habitus; B, antennule; C, antenna; D, maxilliped; E, left leg 1; F, left leg 2; G, right leg 3; H, left leg 4; I, left leg 5; posterior views of legs 1-5; scales = 0.1 mm.

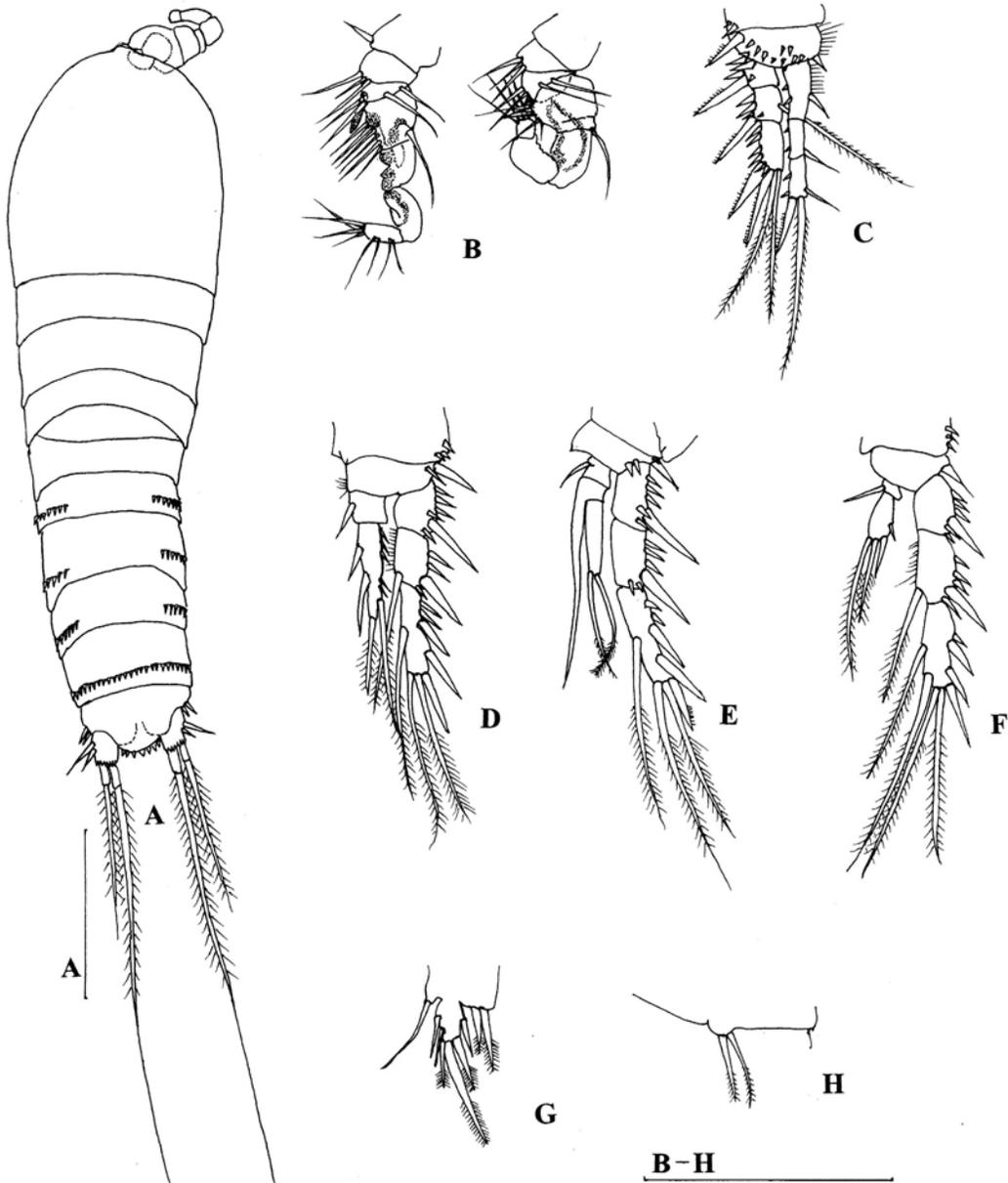


Fig. 2. *Bryocamptus nenggaoensis* sp. nov. male (paratype): A, dorsal view of habitus; B, antennule; C, left leg 1; D, right leg 2; E, right leg 3; F, right leg 4; G, left leg 5; H, leg 6; posterior views of legs 1-5; scales = 0.1 mm.

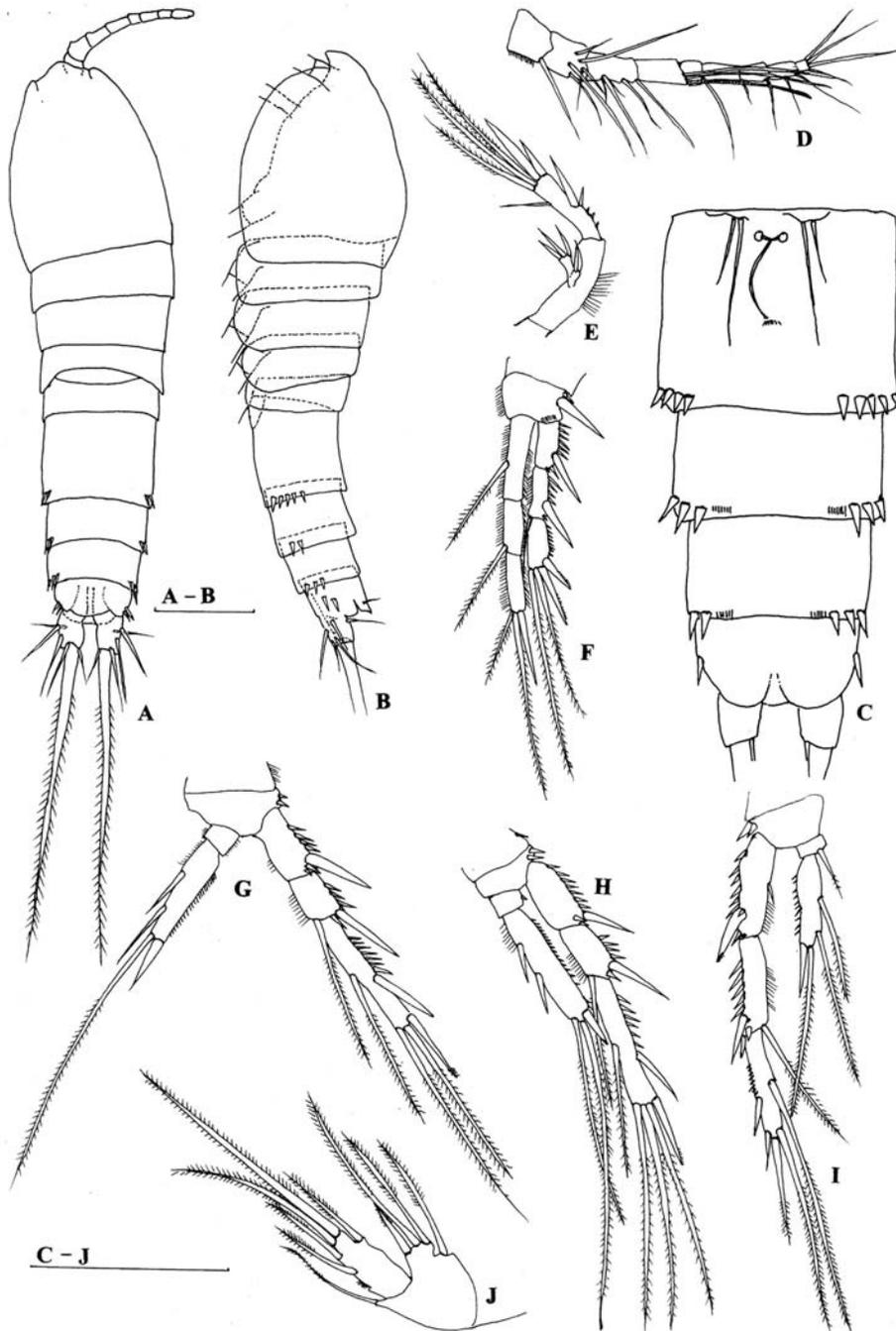


Fig. 3. *Elaphoidella formosanus* sp. nov. female (holotype): A, dorsal view of habitus; B, lateral view of habitus; C, ventral view of urosome; D, antennule; E, antenna; F, right leg 1; G, right leg 2; H, right leg 3; I, left leg 4; J, left leg 5; posterior views of legs 1-5; scales = 0.1 mm.

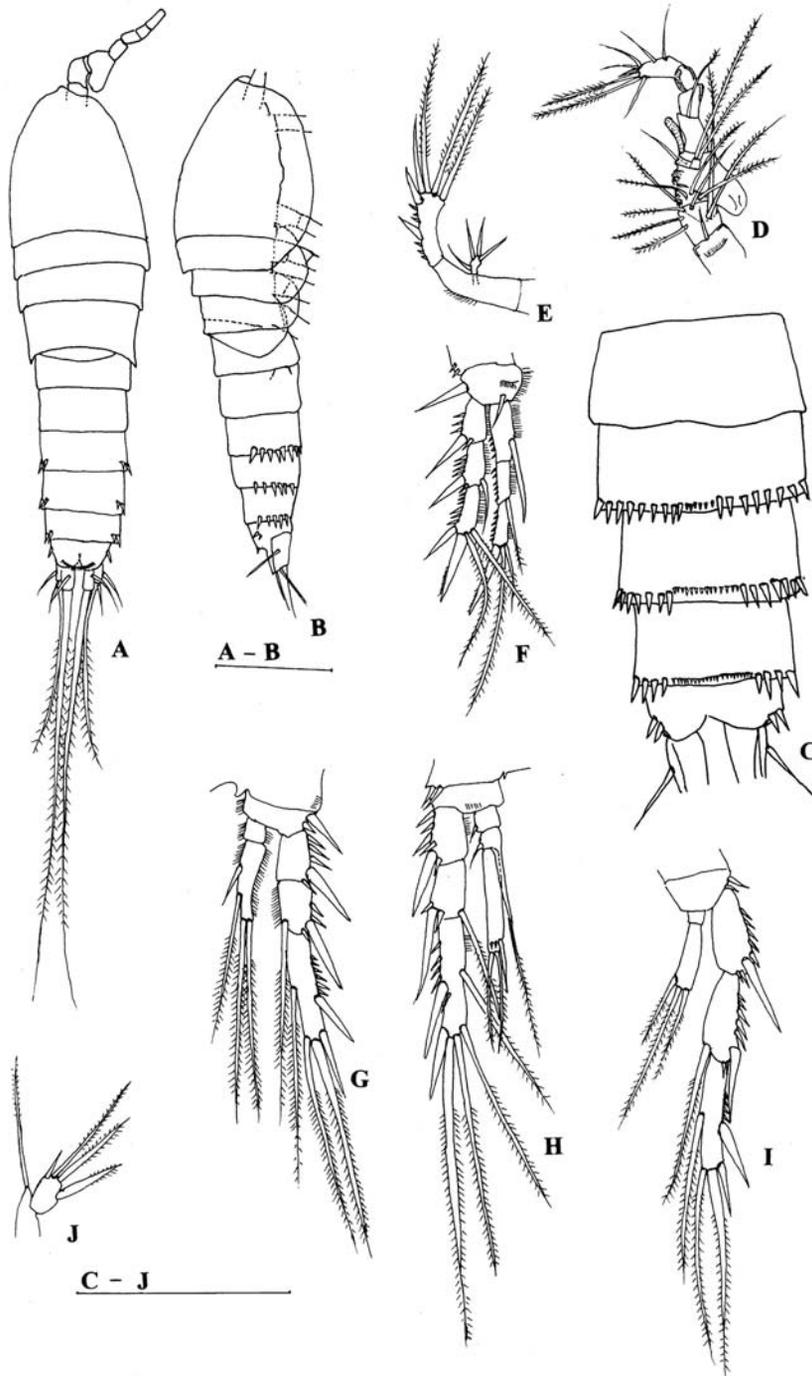


Fig. 4. *Elaphoidella formosanus* sp. nov. male (paratype): A, dorsal view of habitus; B, lateral view of habitus; C, ventral view of urosome; D, antennule; E, antenna; F, left leg 1; G, right leg 2; H, left leg 3; I, right leg 4; J, left leg 5; posterior views of legs 1-5; scales = 0.1 mm.

and endopod of 3 segments for leg 1 and 2 segments as follows:
for legs 2-4. Spine and seta formula of legs 1-4

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	I-0	I-0; I-1; I- (I+2) -0	0-1; 0-1; 0-I+2-0
Leg 2	0-0	0-0	I-0; I-1; I- (I+2) -1	0-0; 0- (I+1) -2
Leg 3	0-0	0-0	I-0; I-1; I- (I+3) -1	0-0; 0- (I+2) -2
Leg 4	0-0	0-0	I-0; I-1; I- (I+2) -1	0-1; 0- (I+1) -2

Basipod of leg 5 with large inner expansion with 4 setae and narrow outer expansion with a terminal seta; exopod 1-segmented with 5 setae, order of length short to long from inner to outer seta: 3, 5, 4, 2, 1; outer margin with hair-like small spinules.

Male (Paratype): Body length (excluding caudal setae) 0.45 mm. Rostrum short. Prosome with cephalosome and 4 free pedigerous somites; urosome 5-segmented, posterior margin of pedigerous and urosomal somites smooth. Each of the second to fifth urosomal somites with a row of spinules along posterior margins of lateral and ventral surfaces. Posterior margin of anal operculum crescent-shaped, armed with spinules. Caudal ramus length and width subequal with two terminal setae; terminal setae without fracture plane at base; outer seta an half length to that of inner seta. Antennule 8-segmented; Antenna 3-segmented; exopod 1-segmented with 4 setae. Exopod of legs 1-4 similar to that of female. Leg 3 with endopod 3-segmented; segment 2 with a long inner apophysis, extending beyond the setae of segment 3. Basipod of leg 5 small with an outer seta; exopod 1-segmented with 4 setae.

Etymology: The name “*formosanus*” derived from Formosa (Taiwan).

Habitat: Tun-Lu-Chi (Deer pond), the type locality of *E. formosanus* sp. nov. is a small water

pond with a surface area of about 1 ha. Its depth is 2m and bottom covered with thick layer of detritus from decayed plants and deer droppings. Water temperatures are 4-18°C and pH 6.0-6.6 (Chen and Wang 1997).

Remarks: *E. formosanus* sp. nov. is closely related to *Elaphoidella superpedalis* Shen and Tai, 1964 and *Elaphoidella longipedis* Chappuis, 1931. However, *E. formosanus* has the exopod length/width ratio of 2.4 for leg 5 that is smaller than 4.6 of *E. superpedalis* and 3.3 of *E. longipedis*. The third segment of exopod of leg 4 has the spine and seta formula of I- (I+2) -1 (total 5) for *E. formosanus* that differs from I- (I+2) -2 (total 6) of *E. superpedalis* and *E. longipedis* (Shen *et al.* 1979; Ishida and Kikuchi 2000).

***Elaphoidella hirsutus* sp. nov.**

Fig. 5

Type material

Holotype: A female (dissected and mounted on slide) collected from Yuan-Yang-Hu (Mandarin duck lake) (24°34'50"N, 121°23'50"E) in the northern Taiwan at an elevation of 1,670m on 19 August 1996 by Shuh-Sen Young (SBNHCUE 008). Collection site water temperature 14°C, pH 6.5.

Paratype: A female (dissected and mounted

on slide) (SBNHCUE 009); 5 females preserved in 70% ethanol-water solution (SBNHCUE 010). Same collection data as holotype.

Description

Female (holotype): Rostrum short. Body length (excluding caudal setae) 0.67 mm. Prosome with cephalosome and 4 free pedigerous somites; urosome 4-segmented, all somites coarsely serrated posteriorly. Dorsal surface of pedigerous and urosomal somites armed with numerous transverse rows of minute spinules. First to third urosomal somites with a row of spines along posterior margins of lateral and ventral surfaces, a row of spines on the third urosomal somite that is broken

into three sections on ventral surface. Anal operculum convex, armed with comb like spinules on the posterior margin. Caudal ramus length about twice the width; dorsal surface bulging and bearing a spine; terminal accessory seta short; inner and outer terminal setae without fracture plane at base; outer seta an half the length of the inner seta. Antennule 8-segmented, segment 4 with long esthetasc, reaching beyond the end of terminal segment. Antenna 3-segmented, exopod 1-segmented with 4 setae. Exopod 3-segmented for swimming legs 1-4 and endopod 3-segmented for leg 1 and 2-segmented for legs 2-4. Spine and seta formula of legs 1-4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	I-1	I-0; I-1; I- (I+2) -0	0-1; 0-1; 0- (I+2) -0
Leg 2	0-0	I-0	I-0; I-1; I- (I+2) -1	0-1; 0- (I+2) -2
Leg 3	0-0	0-0	I-0; I-1; I- (I+2) -2	0-1; 0- (I+2) -3
Leg 4	0-0	1-0	I-0; I-1; I- (I+2) -2	0-0; 0-2-2

Basipod of leg 5 with a large inner expansion with 4 setae and a narrow outer expansion with a terminal seta; exopod 1-segmented with 5 setae, order of length from short to long from the inner to outer seta, 1, 2, 4, 5, 3; both outer and inner margins with 2 small spines.

Male: Unknown.

Etymology: The name “*hirsutus*” derived from Latin “hairs”, referring to small spinules on somites.

Habitat: Yuan-Yang-Hu (Mandarin duck lake), the type locality of *E. hirsutus* sp. nov., is a small lake with a surface area of 3.6 ha, depth of 4.3m, and bottom covered with thick layer of mud and detritus, water temperatures are 8-20°C and pH 6.5 (Chen and Wang 1997).

Remarks: Female *E. hirsutus* sp. nov. is fairly similar in characters to those of *E. grandidieri* (Guerne and Richard, 1893), *E. coronata* (Sars, 1904), *E. decorata* (Daday, 1904), and *E. nepalensis* (Ishida, 1994). However, *E. hirsutus* is distinguishable from *E. grandidieri* by having minute spinules on posterior margins of all somites, dorsal surface of pedigerous somites and urosomal somites, instead of smooth without spinules for *E. grandidieri* (Borutsky 1952; Shen *et al.* 1979). Kikuchi (1985) reported, based on SEM examination, that *E. grandidieri* also has spinulated somites, but these spinules were not shown by Ishida and Kikuchi (2000). *E. decorata*, *E. coronata* and *E. nepalensis* have no transverse rows of minute spinules on dorsal and ventral surfaces of all somites (Ishida

1994; Shen *et al.* 1979).

Family Canthocamptidae Brady, 1880

Genus *Echinocamptus* Chappuis, 1929

***Echinocamptus shihi* sp. nov.**

Fig. 6

Type material

Holotype: A female (dissected and mounted on slide, SBNHCUE 011) collected from Yuan-Yang-Hu in the northern Taiwan (24°34'50"N, 121°23'50"E) on 19 August 1996 by Shuh-Sen Young. Collection site water temperature 14°C, pH 6.5.

Paratypes: 3 females preserved in 70% ethanol-water solution (SBNHCUE 012). Same collection data as holotype.

Description

Female (holotype): Body length excluding caudal setae 0.40 mm. Rostrum short. Prosome

comprising cephalosome and 4 free pedigerous somites; urosome 4-segmented; posterior margin of pedigerous and urosomal somites smooth. A row of spinules along the posterior margins on both lateral surfaces of first and second urosomites, and on both lateral and ventral surfaces of third urosomite. Anal somite with a row of spinules along the posterior margins on lateral sides, and four spinules on ventral side. Anal operculum convex, armed with 4 spinules on the posterior margin. Caudal ramus, length subequal to width; terminal accessory seta short; inner and outer terminal setae with fracture plane at base; outer seta about half as long as inner seta. Antennule 8-segmented; segment 4 with long esthetasc, reaching distal border of the terminal segment. Antenna 3-segmented; exopod 1-segmented with 4 setae. Swimming legs 1-4 with 3-segmented exopod and 2- (leg 1) or 3-segmented (legs 2-4) endopod. Spines and setae formula of legs 1-4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	I-1	I-0; I-1; I- (I+2) -0	0-I; 0- (I+1) -0
Leg 2	0-0	I-0	I-0; I-1; II- (II+1) -1	0-1; 0- (I+1) -1
Leg 3	0-0	I-0	I-0; I-1; II- (I+3) -1	0-1; 0-2-2
Leg 4	0-0	I-0	I-0; I-1; I- (I+3) -1	0-1; I- (I+1) -2

Basipod of leg 5: inner expansion with 6 setae, inner 4 longer than outer 2, outer expansion with distal outer margin saddle shape, distal corner bearing a terminal seta exopod one segmented with 5 setae, order of length short to long from inner to outer seta: 1, 5, 2, 4, 3.

Male: Unknown.

Etymology: The name “*shihi*” derived in honor of Dr. Chang-tai Shih, who encouraged the author to study freshwater copepods of Taiwan.

Habitat: Yuan-Yang-Hu (Mandarin duck lake), the type locality of *E. shihi* sp. nov. is a small lake with a surface area of 3.6 ha, depth of 4.3m, and bottom covered with thick layer of mud and detritus, temperatures are 8-20°C and pH 6.5 (Chen and Wang 1997).

Remarks: *E. shihi* sp. nov. is closely related to *Echinocamptus parvus* Borutskii, 1952, with 2-segmented endopod on leg 1. They differ in number of spines and setae on the third exopodite

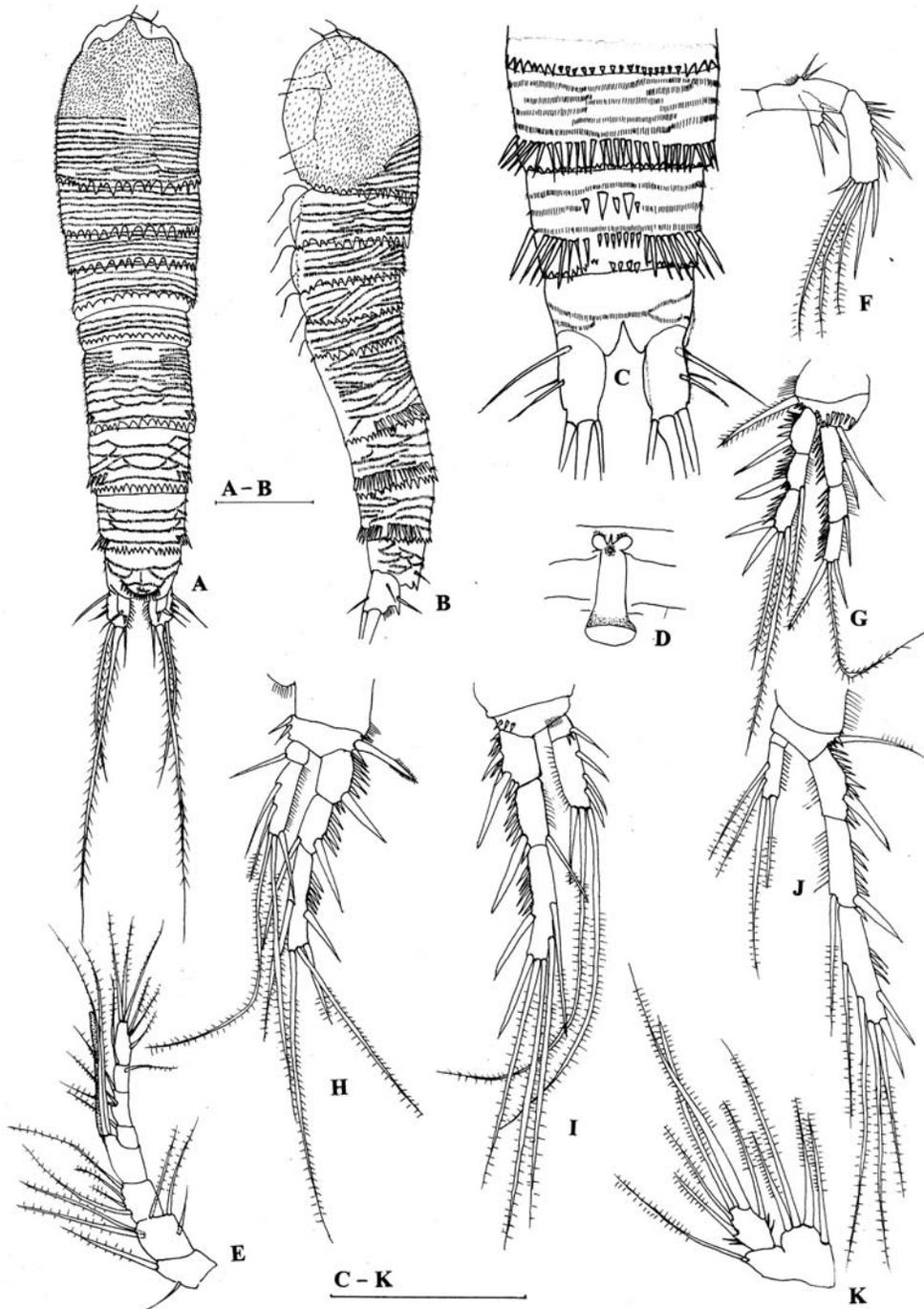


Fig. 5. *Elaphoidella hirsutus* sp. nov. female (holotype): A, dorsal view of habitus; B, lateral view of habitus; C, ventral view of Urosome; D, genital duct; E, antennule; F, antenna; G, left leg 1; H, right leg 2; I, left leg 3; J, right leg 4; K, right leg 5; posterior views of legs 1-5; scales = 0.1 mm.

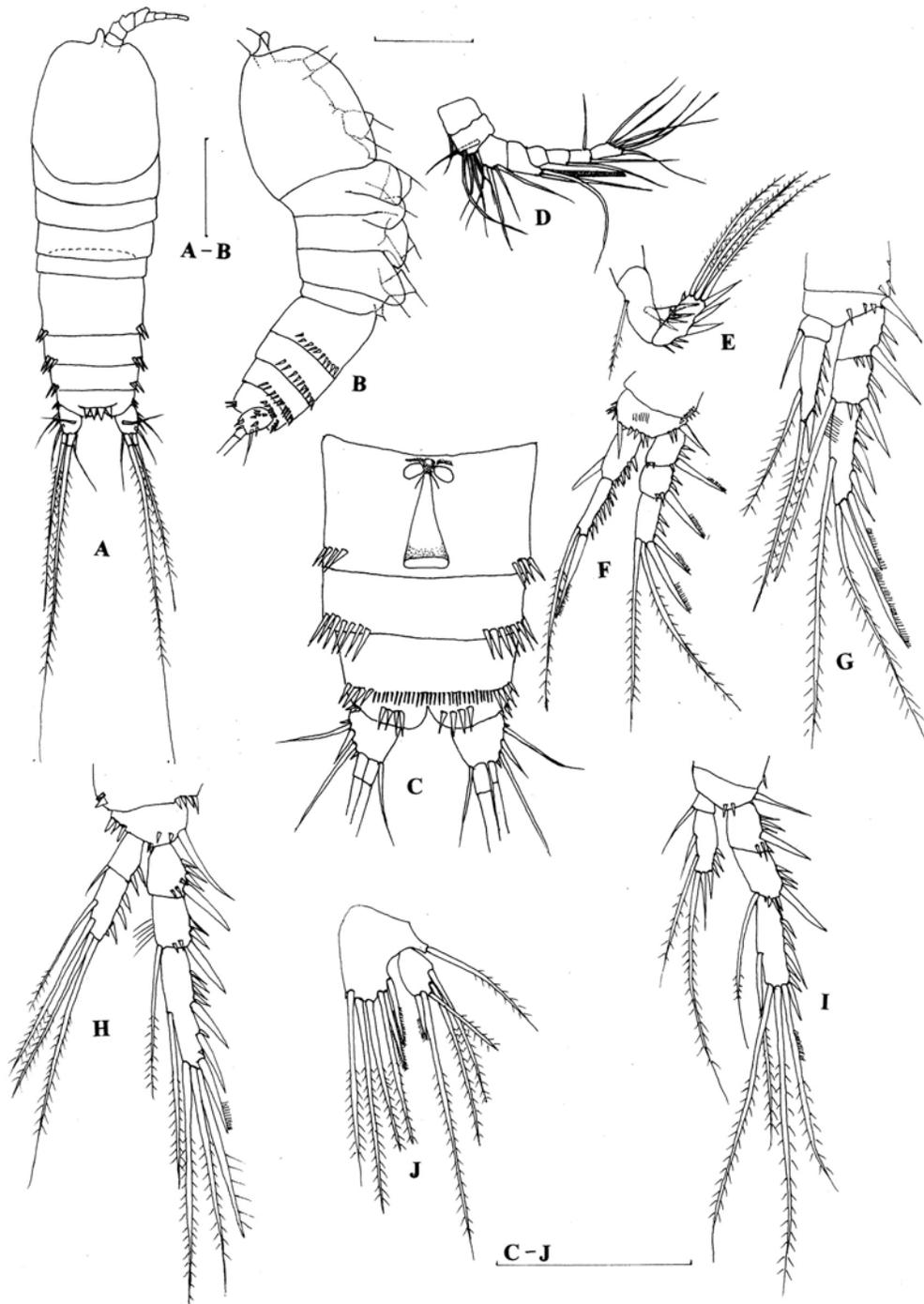


Fig. 6. *Echinocamptus shihi* sp. nov. female: A, dorsal view of habitus; B, lateral view of habitus; C, ventral view of urosome; D, antennule; E, antenna; F, right leg 1; G, right leg 2; H, right leg 3; I, right leg 4; J, right leg 5; posterior views of legs 1-5; scales = 0.1 mm.

segment of leg 2-4. The spine and seta formulae for *E. parvus* are leg 2: 1, 2, 2 (total 5); leg 3: 1 (2), 2, 2 (total 6); leg 4: 2, 2, 2. (total 6).

Acknowledgements

We are grateful to Dr. Chang-tai Shih and Dr. Chu-fa Tsai for their critical and constructive comments on the manuscript. This study was supported in part by a grant from the National Science Council for a grant (NSC-87-2311-B-134-001-).

Literature Cited

- Borutsky, E. V. 1952. Freshwater Harpacticoida. Fauna of USSR., Crustacea III. 4: 1-425 (English translation: Israel Program for Scientific Translations. Jerusalem, 1964).
- Chen, C. T. and B. J. Wang. 1997. The Lakes and Reservoirs of Taiwan. Bor-Hae-Tarng Press, Taipei. 504 pp. (in Chinese)
- Ishida, T. 1992. *Bryocamptus pacificus*, a new harpacticoid copepod (Crustacea) from Japan and the neighbouring areas. Bulletin of the Biogeographical Society of Japan 47(8): 77-81.
- Ishida, T. 1994. A new species of *Elaphoidella* (Crustacea: Harpacticoida) closely related to *E. bidens* (Schmell) and the Genus *Attheyella* from Nepal. Proceedings of the Biological Society of Washington 107(2): 256-261.
- Ishida, T. and Y. Kikuchi. 2000. Illustrated fauna of the freshwater harpacticoid copepods of Japan. Bulletin of the Biogeographical Society of Japan 55: 7-94.
- Kikuchi, Y. 1985. Redescription of a freshwater harpacticoid copepod, *Elaphoidella grandidieri* (Guerne and Richard, 1893), from a swamp at Itako, Central Japan. Publications of Itako Hydrobiological Station 2(1): 1-8.
- Shen, C. J., A. Y. Tai, C. Z. Chang, Z. Y. Li, D. X. Song, Y. Z. Song and G. X. Chen. 1979. Fauna Sinica, Crustacea, Freshwater Copepoda. Science Press, Peking. 450 pp. (in Chinese)
- Wang, J. P. 1998. A checklist of plankton in Taiwan. Taiwan Endemic Species Research Institute press. Nantou, Taiwan. 167 pp.