

Two New Species of the Genus *Hemicyclops* (Copepoda, Poecilostomatoida, Clausidiidae) from Crab Burrows in the Yellow Sea

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Two new species of the genus *Hemicyclops*, *H. gomsoensis* n. sp. and *H. saxatilis* n. sp., taken from crab burrows on each of mud flat and rocky shore, are described from the Yellow Sea coast of southwest Korea.

KEY WORDS: Symbiotic Copepoda, *Hemicyclops*, New species, Yellow Sea

Copepods of the genus *Hemicyclops* are symbiotic with various invertebrates. Humes (1984) summarized relationships between *Hemicyclops* and their hosts, in which four phyla (Porifera, Cnidaria, Mollusca, and Arthropoda) of marine invertebrates were recorded as hosts. However, some of them are free-living and can be found in burrows in intertidal zone. Additionally, Boxshall & Humes (1987) recorded a new species of *Hemicyclops* from an echiuran. The species of *Hemicyclops* are so far found chiefly in the intertidal and shallow coastal waters, but occasionally they can invade brackish water (Ho & Kim, 1990). Ten species of *Hemicyclops* were recorded by Humes (1984) to be in association with crustaceans or from curstacean burrows, therefore, crustaceans seem to be the most preferred hosts.

Recently, one of us (IHK) had opportunity to examine the crab burrows at 3 locations in southern Korea facing the Yellow Sea: a mud flat, an estuary (muddy), and a rocky shore. Each location is less than 20 km apart. More than a hundred burrows at each mud flat and estuary, and about thirty burrows at rocky shore were examined. Waters in the burrows were extracted by using a large pipette and these water sample were in turn examined for copepods. Four species of *Hemicyclops* were collected from the mud flat samples and one species from each of the estuary and rocky shore. One species from the mud flat and

another species from the rocky shore are treated in the present paper. The other four species are not included in the following descriptions due to the insufficient number of specimens.

The specimens were dissected and measured in lactic acid. All the figures were drawn with the aid of camera lucida. The unit of scale in the figures is in mm.

Hemicyclops gomsoensis, new species (Figs. 1-3)

Material Examined.-Five ♀♀ and 4 ♂♂, from more than a hundred of crab burrows (mainly occupied by *Macrophthalmus japonicus* De Haan) on mud flat of lower intertidal zone at Gomso (35°35'N, 126°36'E), Korea; collected by Il-Hoi Kim on Oct. 22, 1990. Undissected types (Holotype, ovigerous ♀, allotype, and paratypes, 2 ♀♀, 1 ♂) are deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington D.C.

Female.-Body (Fig. 1A) 1.45 mm long, excluding setae of caudal rami. Greatest width 0.66 mm. Prosoma broad, 1.2 times longer than wide. Last somite of prosoma with almost parallel lateral margins, its posterior corners pointed. Somite bearing leg 5 (Fig. 1B) fringed with long hairs along posterior border. Genital somite of complex appearance, constricted at middle, with 2 kinds of

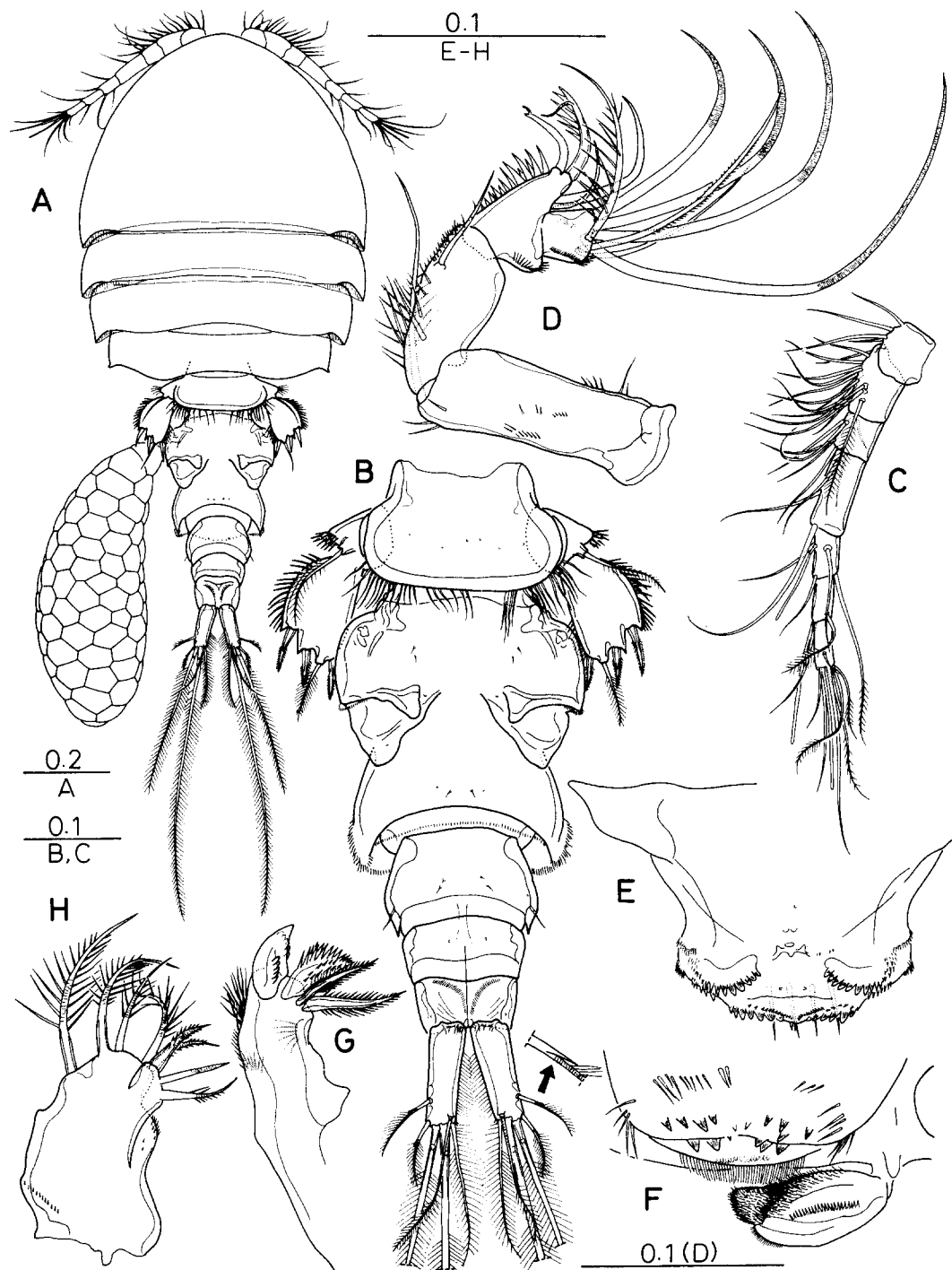


Fig. 1. *Hemicyclops gomsoensis*, n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, first antenna; D, second antenna; E, labrum, ventral; F, postoral area and paragnath, ventral; G, mandible; H, first maxilla.

flaps at area of constriction, and fringed with fine hairs on posteroventral border. Three postgenital somites wider than long, gradually shortened and narrowed from anterior to posterior. Anal somite with 1 row of spinules along posterior border.

Caudal ramus 2.7 times longer than wide, with fine hairs along inner lateral margin. All setae plumose, but outer lateral seta plumose only on outer edge. Both outer lateral (85 μm) and outermost (78 μm) setae with thorn-like process on outer edge. Dorsal seta 163 μm long, articulated at base. Innermost seta 158 μm long. Two median terminal setae 425 μm (outer) and 670 μm (inner) long.

Egg sac (Fig. 1A) longer than urosome, 683 \times 256 μm in size, narrower and curved inward anteriorly, containing eggs of about 72 μm in diameter.

First antenna (Fig. 1C) 7-segmented. Formula for armature: 4, 15, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete and 7 + 1 aesthete. Plumose setae are one on each of second, fifth and sixth segments, and 3 on terminal segment.

Second antenna (Fig. 1D) 4-segmented, with armature 1, 1, 4, 7. First segment with a few spinules on outer and inner margins. Second segment with longer spinules on proximal two-thirds of outer margin and minute spinules on distal one-third of outer margin. Third segment with large spinules on outer margin and small spinules near inner distal corner; outer distal corner projected, projection as long as its basal width, with 2 smooth setae, 1 barbed seta and 1 thin, smooth seta. Fourth segment slightly wider than long, ratio 1:1.15.

Labrum (Fig. 1E) dorsally with transverse row of denticles on each side. Posterior border armed with 1 row of denticles and 1 row of fine spinules.

Mandible (Fig. 1G) with 2 stout elements and 2 setae. Basal segment with many hairs on ventral margin and several hairs on dorsal margin. Paragnath (Fig. 1F) with 1 row of spinules on ventral margin, and fine hairs on anterior and apical areas. First maxilla (Fig. 1H) ramified distally, with 8 setae (5 + 3); one seta on smaller ramification enlarged. Second maxilla (Fig. 2A) with 2 large, barbed spines and accompanied, small seta; second segment with 3 setae and 1 large, ramified element. Maxilliped (Fig. 2B) with armature formu-

la of 2, 2, 0, 6; first segment with 2 setae and 2 semi-circular rows of spinules; fourth segment with 6 setae, but one of them originating from base of second largest seta.

Legs 1-4 (Figs. 2C-F) with endopods longer than exopods. Armature as follows (Roman numerals representing spines, and Arabic numerals, setae):

P1:	Prp 0-1; 1-I	Exp I-0; I-1; I, 7
		Enp 0-1; 0-1; I, 5
P2 & P3:	Prp 0-1; 1-0	Exp I-0; I-1; II, 7
		Enp 0-1; 0-2; III, 3
P4:	Prp 0-1; 1-0	Exp I-0; I-1; I, 7
		Enp 0-1; 0-2; III, 2

Leg 1 (Fig. 2C) with inner spine on basis of 73 μm long (this spine absent in legs 2-4). Intercoxal plate of leg 1 with row of hairs on ventral margin, but in legs 2-3, replaced by spinules. All spines on first exopod with terminal flagellum. Median terminal seta on third segment of first exopod naked. Outer terminal seta on this segment weakly plumose (as in other legs) on outer edge.

Leg 5 two-segmented. First segment (Fig. 1B) about as long as wide, with plumose seta on elevated base; outer distal margin spinulated. Second segment (Fig. 2G) 1.7 times longer than wide, with 4 elements on distal margin; both outer margin and distal half of inner margin armed with spinules.

Male.—Body (Fig. 3A) almost same as that of female, but with narrower prosome. Length 1.37 mm, and greatest width 0.54 mm. Ratio of length to width of prosome 1.35:1. Genital somite (Fig. 3B) wider than long, ratio 0.9:1. spermatopore (Fig. 3C) long and curved. First postgenital somite slightly longer than succeeding somite. Third postgenital somite shortest.

Caudal ramus like that of female. Outer lateral seta plumose on both edges, without proximal spiniform process.

First and second antennae, labrum, mandible, paragnath, first maxilla as in female. Second maxilla (Fig. D) different from female in having inner seta on second segment replaced by stout process (Fig. 3E). Maxilliped (Fig. 3F) with 1 long seta on first segment; second segment widely expanded at base, with 1 smaller smooth seta, 1 longer plumose seta, and 3 rows of spines. Third segment

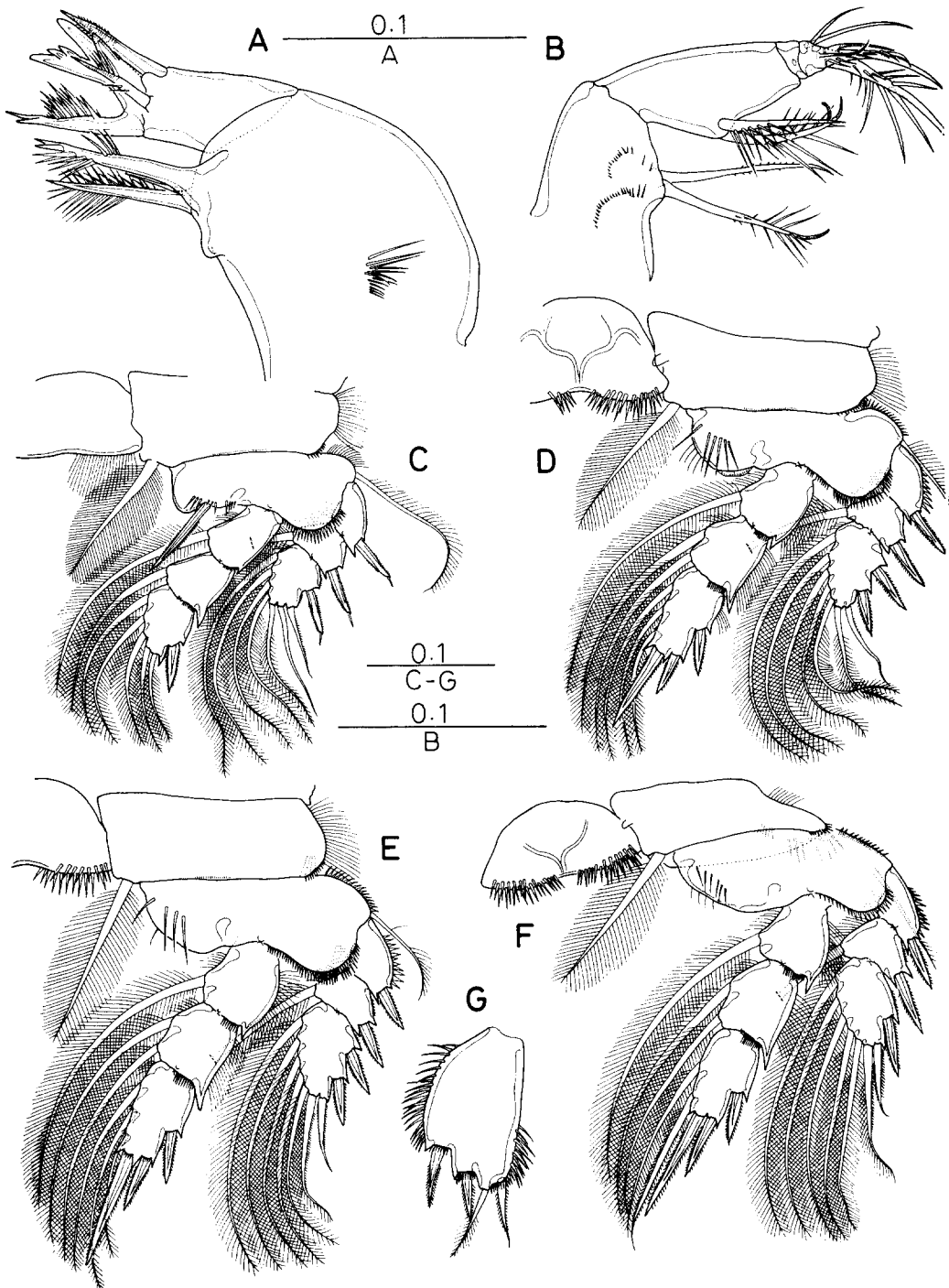


Fig. 2. *Hemicyclops gomsoensis*, n. sp., female. A, second maxilla; B, maxilliped; C, leg 1; D, leg 2; E, leg 3; F, leg 4; G, free segment of leg 5.

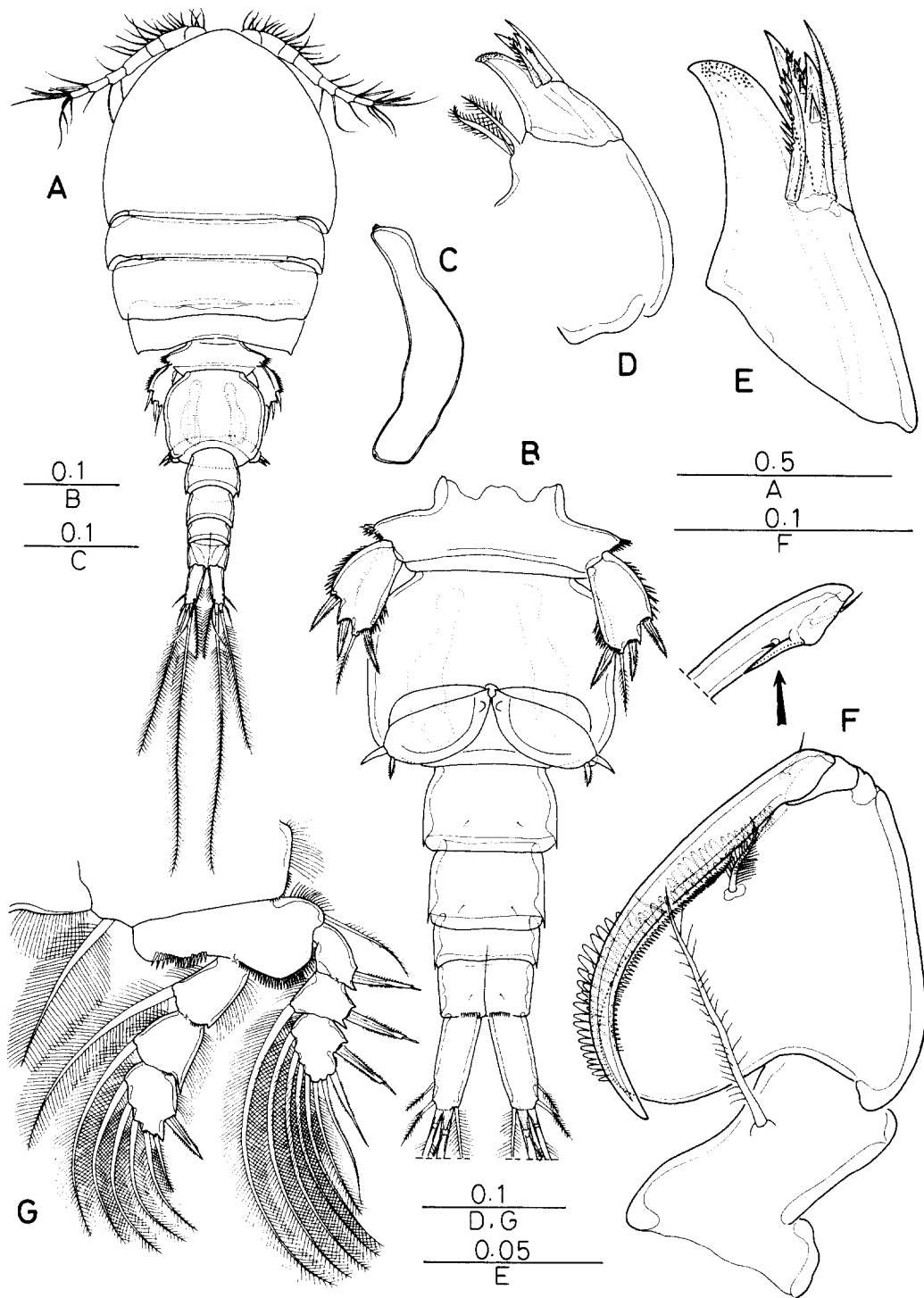


Fig. 3. *Hemicyclops gomsoensis*, n. sp., male. A, habitus, dorsal; B, urosome, ventral; C, spermatophore; D, second maxilla; E, terminal segment of second maxilla; F, maxilliped; G, leg 1.

short and unarmed. Claw slightly longer than second segment, with proximally 2 setae and 1 process.

Leg 1 (Fig. 3C) same as that of female, but without inner spine on basis. Legs 2-5 same as those of female.

Leg 6 (Fig. 3B) represented by 1 outer smooth seta and 1 shorter, barbed inner seta on postero-lateral corner of genital somite.

Etymology.—The specific name is taken from the type locality, Gomso.

Comparison with other species.—Since the recognition of twenty-five species of *Hemicyclops* by Vervoort & Ramirez (1966) four species have been added.

The new species seems to be related to *H. amplicaudatus* Humes, *H. axiophilus* Humes, *H. mortoni* Boxshall & Humes, and *H. thalassius* vervoort & Ramirez by sharing the following sets of characters: (1) first antenna with 4 setae on the first segment; (2) urosome 5-segmented; (3) body of female moderately long, but not more than 2.0 mm (1.45 mm in *H. gomsoensis*); (4) genital somite less than 1.5 times as long as wide (1.15 times in *H. gomsoensis*); (5) caudal ramus twice or more longer than wide (2.7 times in *H. gomsoensis*). Having a constriction at the middle of genital somite, *H. gomsoensis* is comparable to *H. mortoni* from Hong Kong and *H. axiophilus* from Madagascar. The other two species have usual genital somite.

H. gomsoensis can be distinguished from *H. mortoni* with the possession of a larger egg mass, which is as long as the urosome. Besides, in the new species the armature of the terminal segment of the fourth endopod is III, 2, whereas in *H. mortoni*, it is IV, 1.

H. gomsoensis differs from *H. axiophilus* chiefly in the male. The major differences are found in the shape of the spermatophore and the component of leg 6. The female *H. axiophilus* also differs in having a shorter caudal rami (ratio 2.0).

***Hemicyclops saxatilis*, new species**
(Figs. 4-6)

Material Examined.—Eight ♀♀ and 2 ♂♂, from crab burrows occupied by *Heteropanope (Pilumnopus) makinana* (Rathbun) on rocky

shore in low intertidal zone at kyukpo (35°38'N, 126°28'E), Puan, Korea; collected by Il-Hoi Kim on July 26, 1990. Undissected types (holotype ♀, allotype and 5 female paratypes) are deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Female.—Body (Fig. 4A) with moderately broad prosome. Length (not including setae on caudal rami) 2.04 mm and greatest width 0.79 mm. Prosome 1.43 times longer than wide. Somites bearing legs 2-5 fringed with transparent membrane.

Genital somite (Fig. 4B) 1.25 times longer than wide, with 2 recurved, leaf-like extensions on both anterior lateral sides. Postgenital somites equal in width, but decrease in length toward posterior somite. Genital somite and first 2 postgenital somites fringed with transparent membrane on posterior borders. Anal somite (Fig. 4C) 0.52 times longer than wide, with transverse row of fine spinules on posteroventral and posterolateral borders.

Caudal ramus (Figs. 4C, D) short, 1.27 times longer than wide, with hairs on inner lateral margin and minute spinules on posteroventral margin. All setae plumose except for dorsal seta which is naked and articulate at base. Outermost terminal seta with proximal process on outer edge. Inner terminal seta longest, 929 μ m long.

First antenna (Fig. 4E) with formula of armature 4, 14, 6, 3, 4 + 1 aesthete, 2 + 1 aesthete and 7 + 1 aesthete. Plumose setae one each on second and fourth to sixth segments, and 2 on seventh segment.

Second antenna (Fig. 4F) 4-segmented. First segment with 1 outer distal seta and spinules on both outer and inner sides. Second segment with 1 barbed seta on outer median side, longer spinules on outer proximal area and rows of short spinules on inner side; outer distal area naked. Third segment with short but broad outer distal corner, bearing 1 barbed, 1 weakly plumose and 2 naked setae; outer margin armed with longer spinules on distal half and short spinules on proximal half; posterior area with 1 row of minute spinules. Fourth segment shorter than wide, ratio 0.9:1, with 7 setae, one of which is recumbent and barbed.

Labrum (Fig. 4G) with dorsal row of denticles on both sides. Posterior margin fringed with 1 row

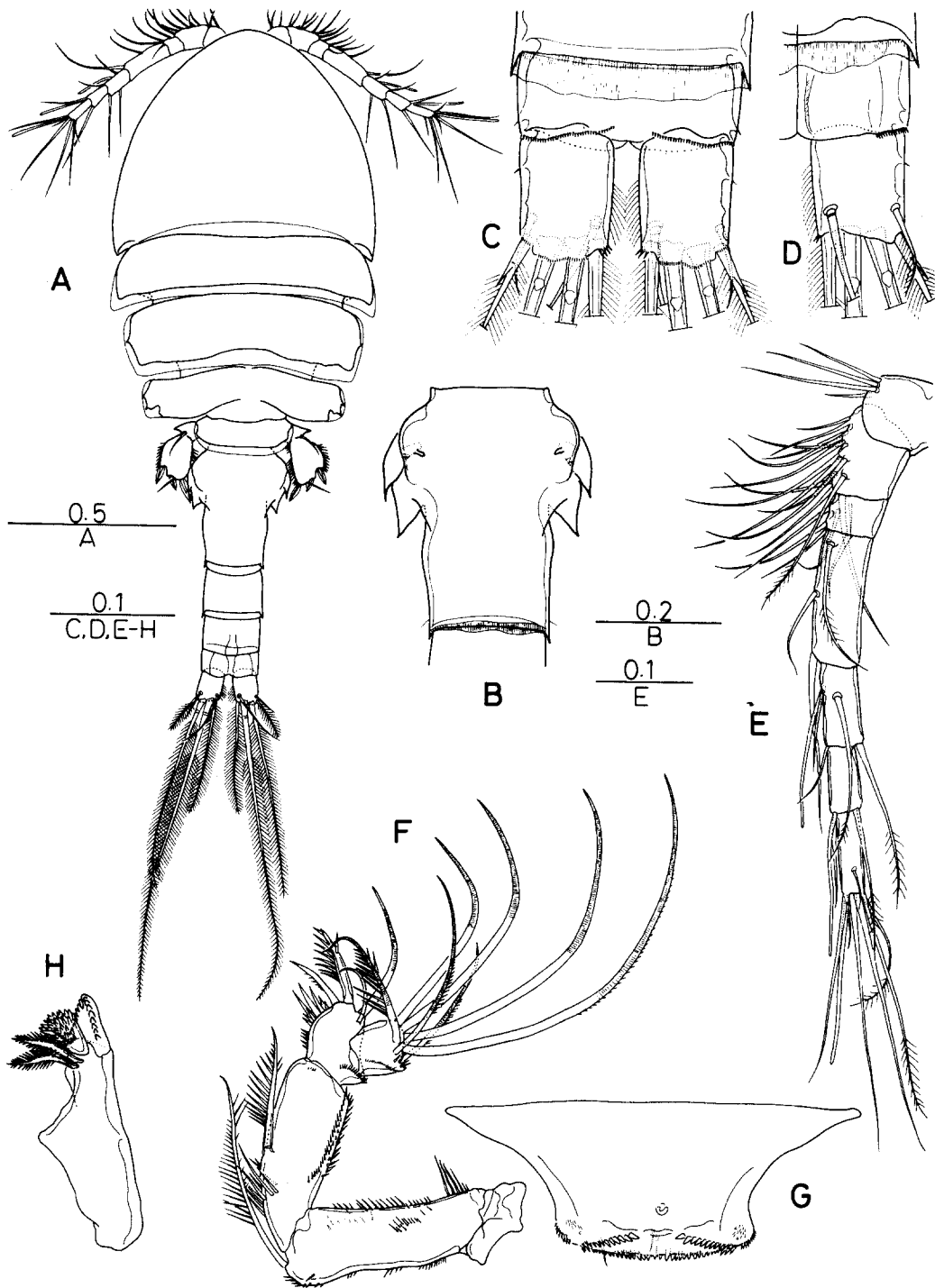


Fig. 4. *Hemicyclops saxatilis*, n. sp., female. A, habitus, dorsal; B, genital somite; C, anal somite and caudal rami, ventral; D, right side of anal somite and caudal ramus, dorsal; E, first antenna; F, second antenna; G, labrum, ventral; H, mandible.

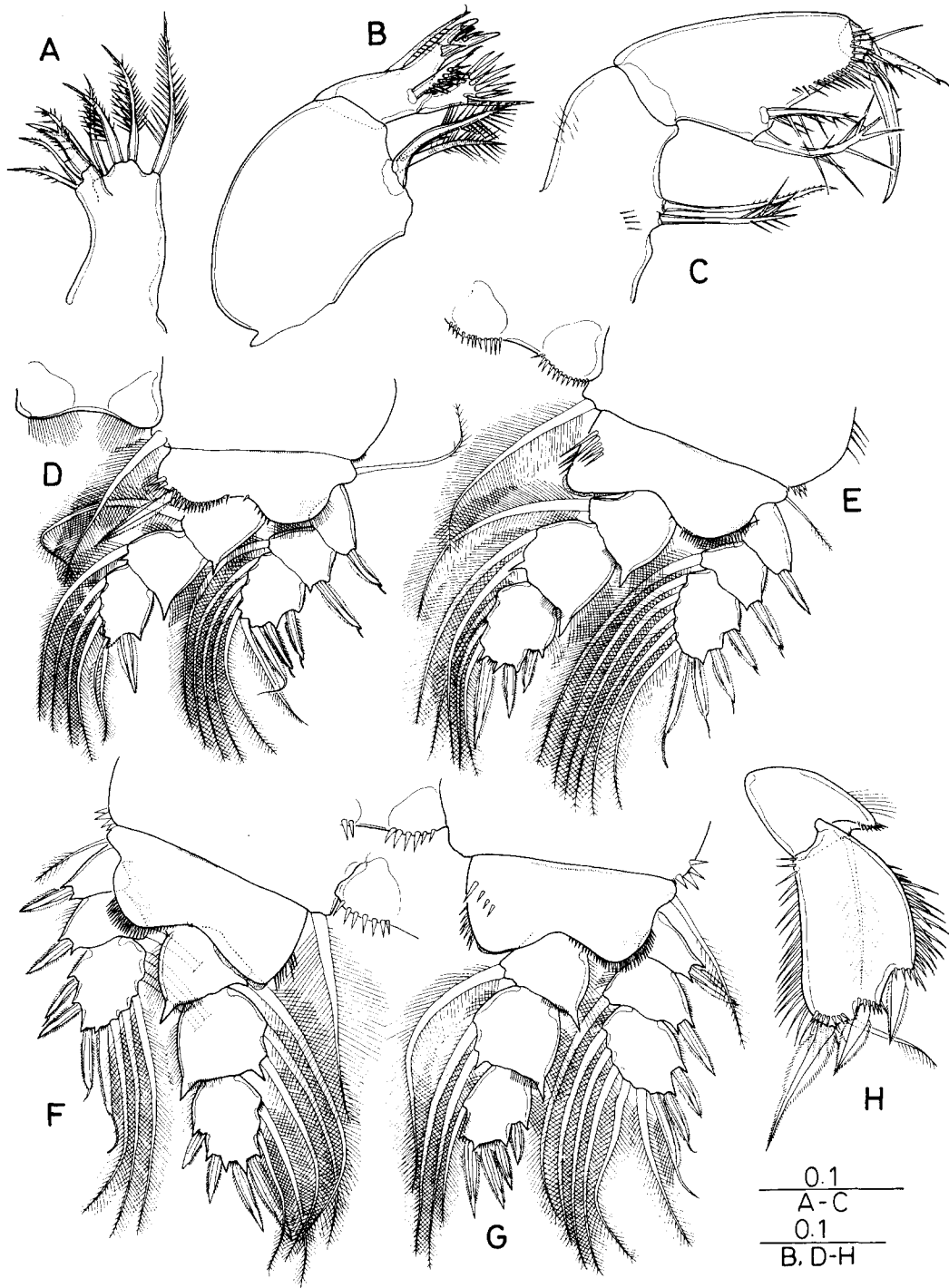


Fig. 5. *Hemicyclops saxatilis*, n. sp., female. A, first maxilla; B, second maxilla; C, maxilliped; D, leg 1; E, leg 2; F, leg 3; G, leg 4; H, leg 5, ventral.

of denticles and 1 row of small spinules.

Mandible (Fig. 4H) with 2 stout elements and 2 setae. Paragnath as in preceding species. First maxilla (Fig. 5A) ramified terminally, with 5 setae on larger ramification and 3 setae on smaller ramification, one of the latter group of setae enlarged. Second maxilla (Fig. 5B) with first segment bearing 2 setae and 1 small, accompanied seta; second segment with 4 unequal elements. Maxilliped (Fig. 5C) with first segment bearing 2 setae; second segment with 2 setae and 1 row of long spinules on inner distal side; third segment very short and unarmed; and fourth segment with 1 strong, claw-like seta, 1 thick, flagellum-bearing seta, 2 small setae and 1 small, basally ramified seta.

Legs 1-4 (Figs. 5D-G) with armature as follows (Roman numerals representing spines, and Arabic numerals, setae):

- P1: Prp 1-0; 1-1 Exp I-0; I-1; II, 6
 Enp 0-1; 0-1; I, 5
 P2: Prp 0-1; 1-0 Exp I-0; I-1; III, I, 5
 Enp 0-1; 0-2; III, 3
 P3: Prp 0-1; 1-0 Exp I-0; I-1; III, I, 5
 Enp 0-1; 0-2; IV, 2
 P4: Prp 0-1, 1-0 Exp I-0; I-1; II, I, 5
 Enp 0-1; 0-2; IV, 1

Leg 1 (Fig. 5D) with inner spine of 86 μ m long on basis (this spine absent in legs 2-4). Intercoxal plate on ventral edge and outer ventral margin of basis fringed with hairs (in legs 2-4 these areas bearing spinules). All spines on exopod with flagellum. One of terminal 2 setae on endopod third segment thinner, naked and accompanied with the other terminal seta.

Leg 5 (Fig. 5H) two-segmented. First segment as long as wide, with hairs on outer margin and spinules on outer distal angle. Dorsal seta plumose and shorter than second segment. Second segment 1.55 times longer than wide, with distal 3 broad spines and 1 seta; inner spine about twice longer than the other 2; both outer and inner margins with spinules.

Male.—Body (Fig. 6A) 1.66 mm long. Greatest width 0.66 mm. Ratio of length to width of prosome 1.40:1. Genital somite 1.33 times wider than long. Spermatophore as in Fig. 6C.

Postgenital somites and caudal ramus like

those of female. First and second antennae, labrum, mandible, paragnath and first maxilla as in female. Second maxilla (Fig. 6D) without sexual dimorphism. Maxilliped (Fig. 6E) with 2 long setae on first segment; second segment broad at base, with 3 rows of spines and 2 long plumose setae, of which proximal one curved upward; third segment short and unarmed; claw tapering and sharply pointed at tip, with 1 proximal seta.

Leg 1 (Fig. 6F), leg 2 (Fig. 6G) and legs 3, 4 like those of female.

Leg 5 (Fig. 6B) with second segment 1.70 times longer than wide, slender than that of female. Inner margin of second segment slightly concave and outer margin convex.

Leg 6 (Fig. 6B) consisting of 1 smooth spine sitting on protrusion at posterodistal corners of genital segment.

Etymology.—The specific name *saxatilis* is a Latin (meaning “to be found among rocks”), alluding to the occurrence of the new species on the burrows of rocky shore.

Comparison with others species.—Most species of *Hemicyclops* have long caudal rami, usually more than two times longer than wide. Shorter caudal rami, as in the new species (ratio 1.13), where the ratio of length to width is less than 1.5, is so far known in the following four species: *H. australis* Nicholls, *H. intermedius* Ummerkutty, *H. purpureus* Boeck and *H. tamilensis* Thompson & Scott. However, it is difficult to make a close comparison with this group of *Hemicyclops* because, except for *H. purpureus*, they are still poorly known of their fine anatomy. Nevertheless, with the unique structure of a pair of leaf-like elements on both sides of its female genital complex, *H. saxatilis* can still be separate from this group of *Hemicyclops* with short caudal rami.

Seven species of *Hemicyclops* are like *H. saxatilis* with an armature of IV, 2 on the terminal segment of the third endopod. It is interesting to point out that *H. australis* and *H. intermedius* are among this seven species. While *H. purpureus* is armed with III, 3, the armature of this leg segment in *H. tamilensis* is unknown.

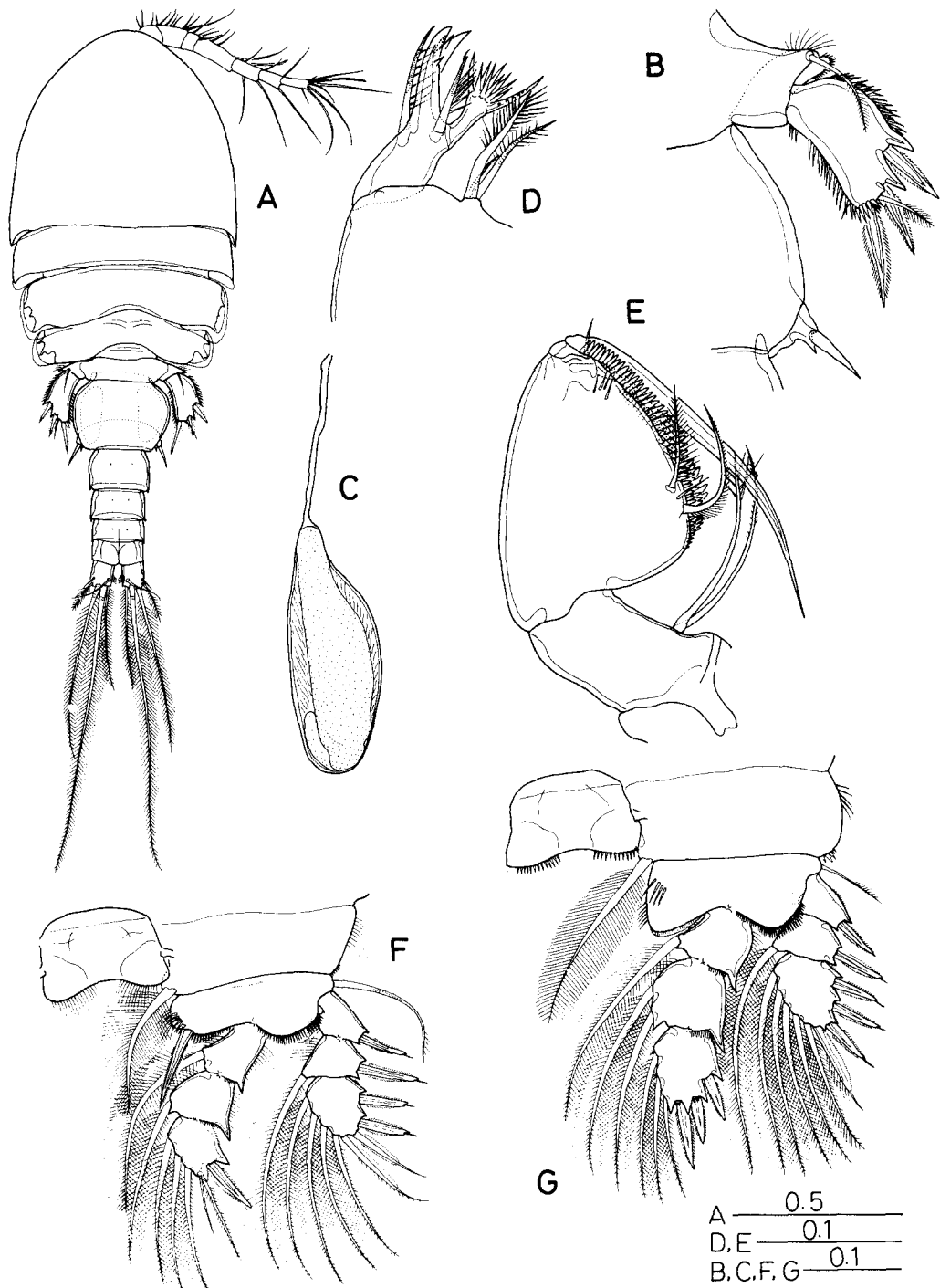


Fig. 6. *Hemicyclops saxatilis*, n. sp., male. A, habitus, dorsal; B, right side of leg 5 and genital somite, dorsal; C, spermatophore; D, distal part of second maxilla; E, maxilliped; F, leg 1; G, leg 2.

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황해의 계구멍에 서식하는 *Hemicyclops* 속의 요각류 2신종

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전북 부안, 곰소의 켈 해안에 있는 계구멍 및 격포의 암석지대에 나 있는 계구멍에 잡힌 *Hemicyclops* 속의 요각류 2신종, *H. gomsoensis* n. sp. 및 *H. saxatilis* n. sp.를 기재한다.