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Caridina bruneiana, a new species of freshwater shrimp (Decapoda, Caridea, Atyidae) from Negara Brunei Darussalam, Borneo

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A new species of the freshwater atyid shrimp, *Caridina bruneiana* from Negara Brunei Darussalam, Borneo is described. *Caridina bruneiana* is characterized by its moderately long and deep rostrum, pereiopod shape, spination and segmental ratios, the shape and spination of its posterior telsonic margin, egg size and the presence of an appendix interna on the endopod of the first male pleopod. The distribution of atyid shrimps in forested streams and their possible use as bio-indicators of stream water quality in tropical rainforests are briefly discussed.

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Introduction

During a reconnaissance trip to the Bukit Patoi Forest Reserve, Belalong, Temburong District, Negara Brunei Darussalam, several specimens of a new atyid shrimp were collected at the confluence of the Belalong River and the Temburong River on 16 May 1990. The collection site is close to the Universiti Brunei Darussalam (UBD) Field Studies Centre and within the area of the 1991–1992 UBD/Royal Geographic Society (RGS) Brunei Rainforest Project. The stream characteristics (under flooded conditions) were as follows: width 10–30 m, depth 0.5–2.5 m, water velocity 3–150 cm s^{-1}, pH 6.3, sandstone and gravel substratum. More specimens were subsequently collected from further downstream in the Temburong River near the Mini-Zoo at Batang Duri on 28 September 1990. Stream characteristics here were similar to those at the confluence. Other fauna caught with *Caridina* were the freshwater crab *Parathelphusa valida* Ng & Goh, the prawn *Macrobrachium* sp., and fishes *Rasbora cephalotaenia* (Bleeker), *R. taeniata* Ahl, *Nemachilus* sp., and *Gastromyzon* sp.

The material studied is deposited in the British Museum (Natural History), London (BMNH) and the Brunei Museum, Negara Brunei Darussalam (BM).

Caridina bruneiana sp.n. (Figs 1–4, Tables I–II)

Type material. Holotype (BMNH 1990:52) ovigerous female, from Negara Brunei Darussalam, on the upper reaches of Temburong River at Batang Duri (04°36′05″N, 115°06′45″E; altitude approx. 33 m), 28 September 1990, coll. S. C. Choy. Allotype (BMNH 1990:51) adult male, same locality as holotype (dissected). Paratypes (BM 2/90) female #1, same locality as holotype; (BM 3/90) female #2, from Negara Brunei Darussalam at the confluence of Belalong River and Temburong River (4°33′15″N, 115°09′15″E; altitude approx. 66 m), 16 May 1990, coll. Dr Kamariah Abbu Salim (dissected); (BMNH 1990:51) female #3, same locality as female #2 (dissected); (BM 4/90) female #4, same locality as female #2 (dissected).

Etymology. The specific epithet is given after Brunei.

Description

Body. Small, slender and subcylindrical. Holotype ovigerous female, total length (TL) 23.6 mm, post-orbital carapace length (CL) 4.6 mm, pre-orbital rostral length (RL) 3.6 mm, mean diameter of elliptical, non-eyed eggs 0.26 × 0.42 mm. Allotype adult male, TL 17.2 mm, CL 3.4 mm, RL 2.7 mm, 1st, 3rd and 4th right pereiopods regenerating, not of full size. Paratype female #1, TL 21.8 mm, CL 4.2 mm, ovigerous with eyed eggs 0.27 × 0.45 mm. Paratype female #2, TL 22.3 mm, CL 4.5 mm, ovigerous with non-eyed eggs 0.23 × 0.38 mm. Paratype female #3, TL 25.9 mm, CL 5.1 mm, ovigerous with eyed eggs 0.27 × 0.45 mm. Paratype female #4, TL 23.5 mm, CL 4.7 mm. Dimensions of pereiopod segments and ratios of some morphometric characters are given in Tables I and II, respectively.

Rostrum (Fig. 1A–C). Broad, length about 4.5 times breadth; of intermediate length, reaching, or just beyond, tip of antennular peduncle, either convex or straight; tip unarmed; straight or directed slightly downwards; 24–28 dorsal rostral teeth, immovable, with 3–5 situated above- to behind-posterior orbital margin, setation between each pair of teeth; 3–5 ventral rostral teeth; a notch sometimes present and placed well in front of these; lateral carina dividing rostrum into 2 unequal parts and continuing posteriorly to orbital margin.

Eyes (Fig. 1A, B). Small, on a short ocular peduncle; cornea globular, well developed.

Carapace (Fig. 1A–C). Smooth, glabrous; rostrum (RL)

Table I. *Length (L) and width (W), in mm, of pereiopod segments of a primary and a secondary type specimen of* Caridina bruneiana *sp.n*

	Dactylus		Propodus		Carpus		Merus		Ischium	
	L	W	L	W	L	W	L	W	L	W
Allotype male										
Pereiopod I	0.44	0.10	0.76	0.29	0.49	0.25	0.78	0.18	0.37	0.15
Pereiopod II	0.49	0.11	0.88	0.29	0.86	0.20	1.05	0.15	0.44	0.14
Pereiopod III*	0.15	0.09	0.76	0.11	0.49	0.15	0.98	0.20	0.49	0.20
Pereiopod IV	0.18	0.11	1.62	0.11	0.88	0.17	1.74	0.22	0.47	0.20
Pereiopod V	0.20	0.09	1.72	0.10	0.86	0.14	1.45	0.18	0.59	0.18
Paratype female #3										
Pereiopod I	0.88	0.20	1.32	0.61	0.81	0.54	1.05	0.34	0.47	0.25
Pereiopod II	0.98	0.22	1.40	0.56	1.32	0.34	1.72	0.29	0.74	0.20
Pereiopod III	0.25	0.16	2.13	0.17	1.27	0.27	2.74	0.42	0.74	0.37
Pereiopod IV	0.22	0.15	2.38	0.17	1.25	0.27	2.50	0.40	0.71	0.32
Pereiopod V	0.32	0.16	2.70	0.17	1.18	0.25	1.94	0.29	0.83	0.28

*Small regenerating pereiopod.

about 0.7–0.8 of carapace length (CL). Pterygostomian angle obtuse, slightly produced anteriorly. Antennal spine pointed sharply and placed below lower orbital angle, straight or slanting downwards dorsally and slightly concave ventrally.

Antennule (Fig. 1D). Peduncle 3-segmented; stylocerite 0.75 length of basal segment; pointed anterolateral angle of basal antennular segment acute reaching about 0.66 length of second segment, which is about 0.66 length of basal antennular segment and about 1.5 times as long as third. First two segments with submarginal plumose setae (setal terminology after Pohle & Telford 1981); third segment fringed laterally and apically with same. Flagella long and simple.

Table II. Caridina bruneiana *sp.n. Ratios (mean ± S.D., N = 5) of some morphometric characters selected from 30 that were calculated*

r/CL	0.75 ± 0.03
t/CL	0.58 ± 0.04
a/CL	0.85 ± 0.17
p3/CL	0.58 ± 0.19
p5/CL	0.54 ± 0.18
h1 l/w	2.31 ± 0.22
h2 l/w	2.65 ± 0.21
c1 l/w	1.92 ± 0.33
c2 l/w	4.38 ± 0.32
m1 l/w	3.35 ± 0.64
m2 l/w	6.36 ± 0.74
h1/c1	1.52 ± 0.09
h2/c2	0.99 ± 0.07
d3/p3	0.16 ± 0.02
d4/p4	0.12 ± 0.03
d5/p5	0.13 ± 0.01
c3/p3	0.65 ± 0.05
c4/p4	0.53 ± 0.03
c5/p5	0.46 ± 0.03
m3/p3	1.29 ± 0.03
m4/p4	1.06 ± 0.04
m5/p5	0.78 ± 0.04

a, antennule peduncle length (from orbital margin); CL, post-orbital carapace length; t, telsonic length; r, pre-orbital rostrum length; c, carpus; d, dactylus; h, hand; m, merus; p, propodus; numbers refer to pereiopod numbers.

Antenna (Fig. 1E). Scaphocerite reaching well beyond tip of antennular peduncle; outer margin straight or slightly concave, without setae and ending in strong subapical tooth, tip of which lies just beyond tip of antennular peduncle, both being overreached by the lamella which has plumose setae on inner and anterior margins. Antennal peduncle about 0.5 length of scaphocerite and in line with or just before tip of basal antennular segment. Flagella long and simple.

Mandibles (Fig. 1G, H). Right mandible with 4–6 strong, sharp incisor teeth laterally; medially two groups of simple setae, one group with 18–20 distinctly bent setae and other with 40–50 finer straight ones; molar process ridged. Left mandible with 4–6 strong, sharp teeth separated by sharply ridged gap; 9 adjacent setae finely serrated, below which are about 15 simple setae adjacent to ridged molar process which has short brush-like setae.

Maxillula (Fig. 1I). Lower lacinia with broadly rounded margin, bearing several rows of different types of setae (simple, denticulate and plumose); anteriorly long submarginal rows of denticulate and spatulate setae, lower ones more spinose, some setae placed proximally. Upper lacinia broadly elongate, inner edge straight with several rows of strong spines as well as short, simple, denticulate and plumose setae. Simple and plumose setae on outer and lower inner margins. Palp truncate with long plumose setae near tip plus row of simple setae.

Maxilla (Fig. 1J). Upper and middle endite with marginal simple and denticulate setae and submarginal plumose ones. Lower endite with simple setae; palp shorter than cleft of upper endite, narrow and simple. Scaphognathite with regular row of long plumose setae on distal margin with shorter simple ones continuing down proximal triangular process which has many long simple setae, some with prominent dilation near base.

First maxilliped (Fig. 1K). Ultimate and penultimate segments of endopod indistinctly divided; inner margin of ultimate segment with marginal and submarginal long rows of plumose and simple setae plus transverse rows of plumose setae on proximal portion. Palp broadly triangu-

lar with prominent finger-like tip. Exopod flagellum distinct, well developed and with marginal plumose setae. Caridean lobe not broad, with marginal plumose setae and two rows of submarginal denticulate and pectinate setae.

Second maxilliped (Fig. 2A). Ultimate and penultimate segments of endopod fused, reflected against basal segments. Inner margins of ultimate, penultimate and basal segments with long, plumose setae of various types. Exopod long and narrow with marginal plumose setae

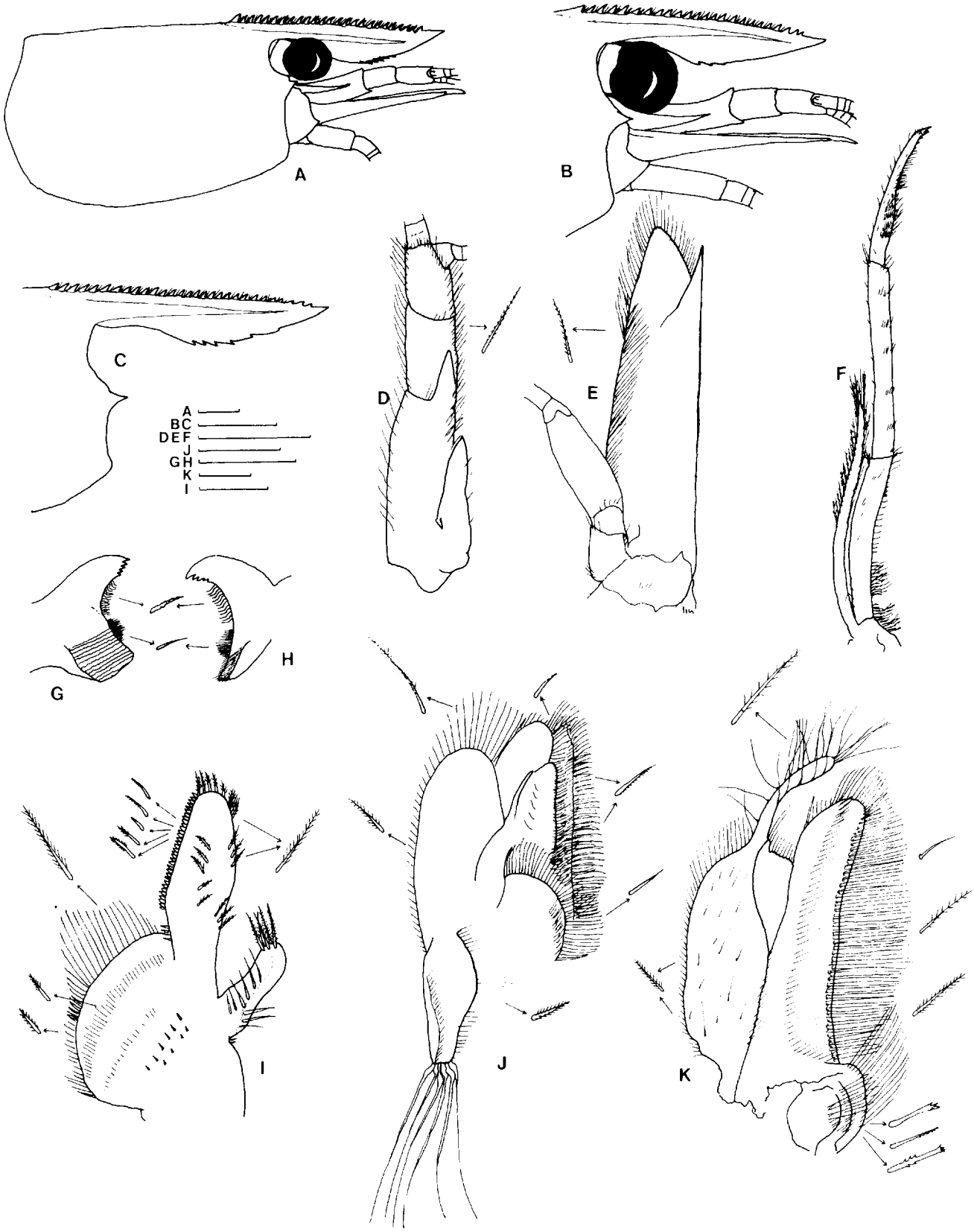

Fig. 1. Caridina bruneiana sp.n.—*A*. Holotype female: head region.—*B*. Paratype female #2: rostral region.—*C*. Allotype male: rostral region of carapace.—*D–K*. Paratype female #4.—*D*. Antennule.—*E*. Antenna.—*F*. Third maxilliped.—*G*. Distal region of right mandible.—*H*. Distal region of left mandible.—*I*. Maxillula.—*J*. Maxilla.—*K*. First maxilliped. Scale bars: 1 mm (*A–F*); 0.5 mm (*G, H, J*); 0.25 mm (*I, K*).

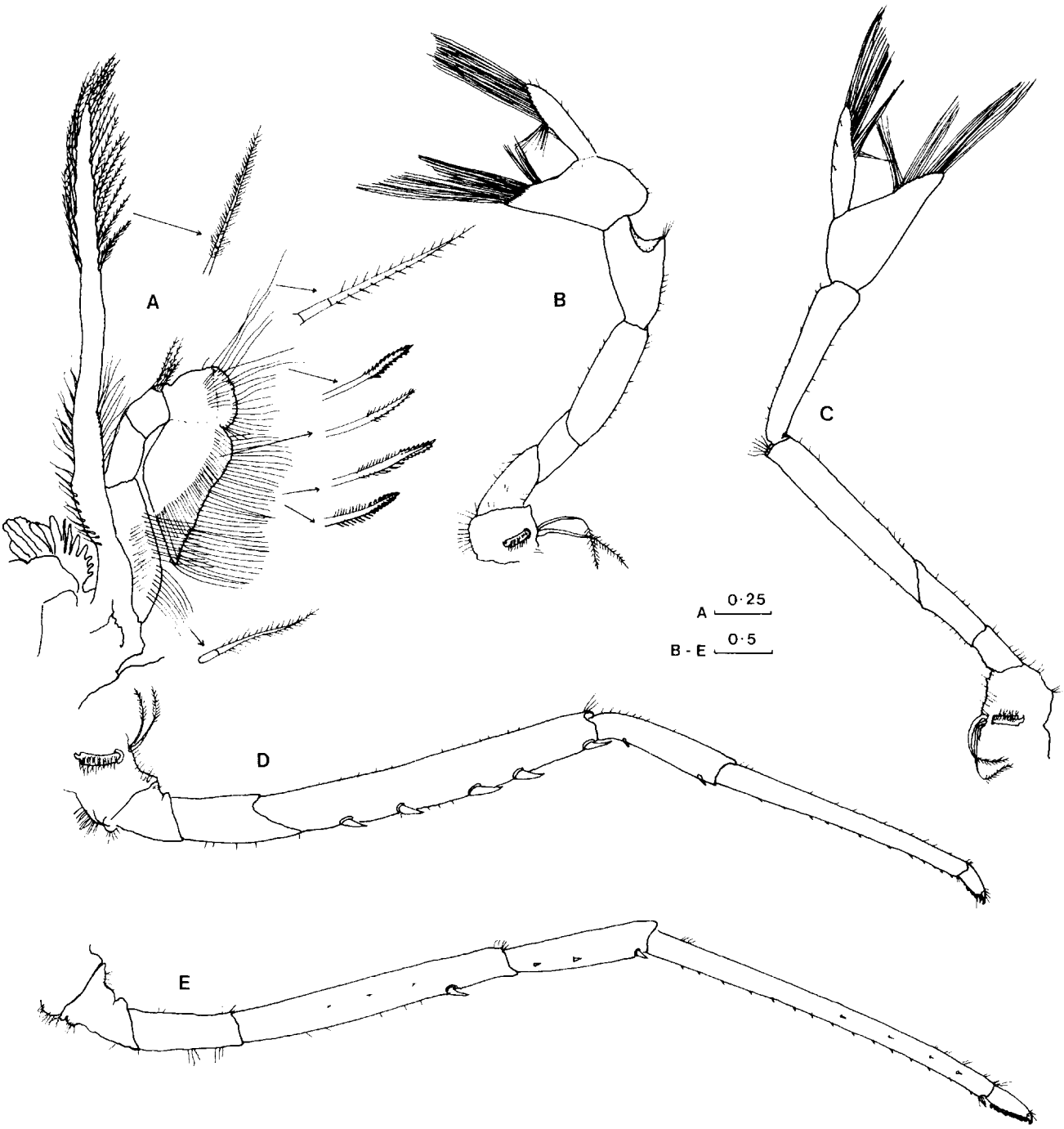

Fig. 2. Caridina bruneiana sp.n.—*A*. Paratype female #4: second maxilliped.—*B–E*. Paratype female #3.—*B*. First pereiopod.—*C*. Second pereipopod.—*D*. Third pereiopod.—*E*. Fifth pereiopod. Scale bars in mm.

distally, and simple and plumose ones proximally (near base). Podobranch broad and flat, with reduced branchial lamella.

Third maxilliped (Figs 1F, 4C). Reaching tip of antennular peduncle; endopod 3-segmented, basal segment about 6 times as long as broad, with plumose marginal setae. Second segment about 10 times as long as broad and 1.17 times longer than basal segment; with transverse rows of spine-like simple setae. Distal segment about 0.79 times length of second segment, ending in large claw-like apical spine surrounded by simple setae behind which are about 5 spines on distal half of posterior margin; proximally about 12 transverse rows of finely denticulate setae. Exopod narrow and reaching about 0.33 of second endopod segment; distal margin with long plumose setae.

First pereiopod (Figs 2B, 3E). Reaching tip of basal segment of antennular peduncle *in situ*. Chela about 2.3 times as long as wide, movable finger slightly longer than palm and about 4 times as long as wide. Finger tips rounded without hooks but with numerous long setae. Carpus attached to chela ventrally, excavated anterodorsally, about 0.66 length of chela and about 0.7 length of merus. Merus narrower than carpus. Ischium about 0.5 length of merus and about length of basis.

Second pereiopod (Figs 2C, 3F). Reaching tip of second antennular peduncle segment, more slender and longer than first pereiopod. Chela about 2.7 times as long as wide, free finger slightly longer than palm and about 4 times as long as wide; tips of fingers without hooks but with numerous long setae. Carpus may be slightly exca-

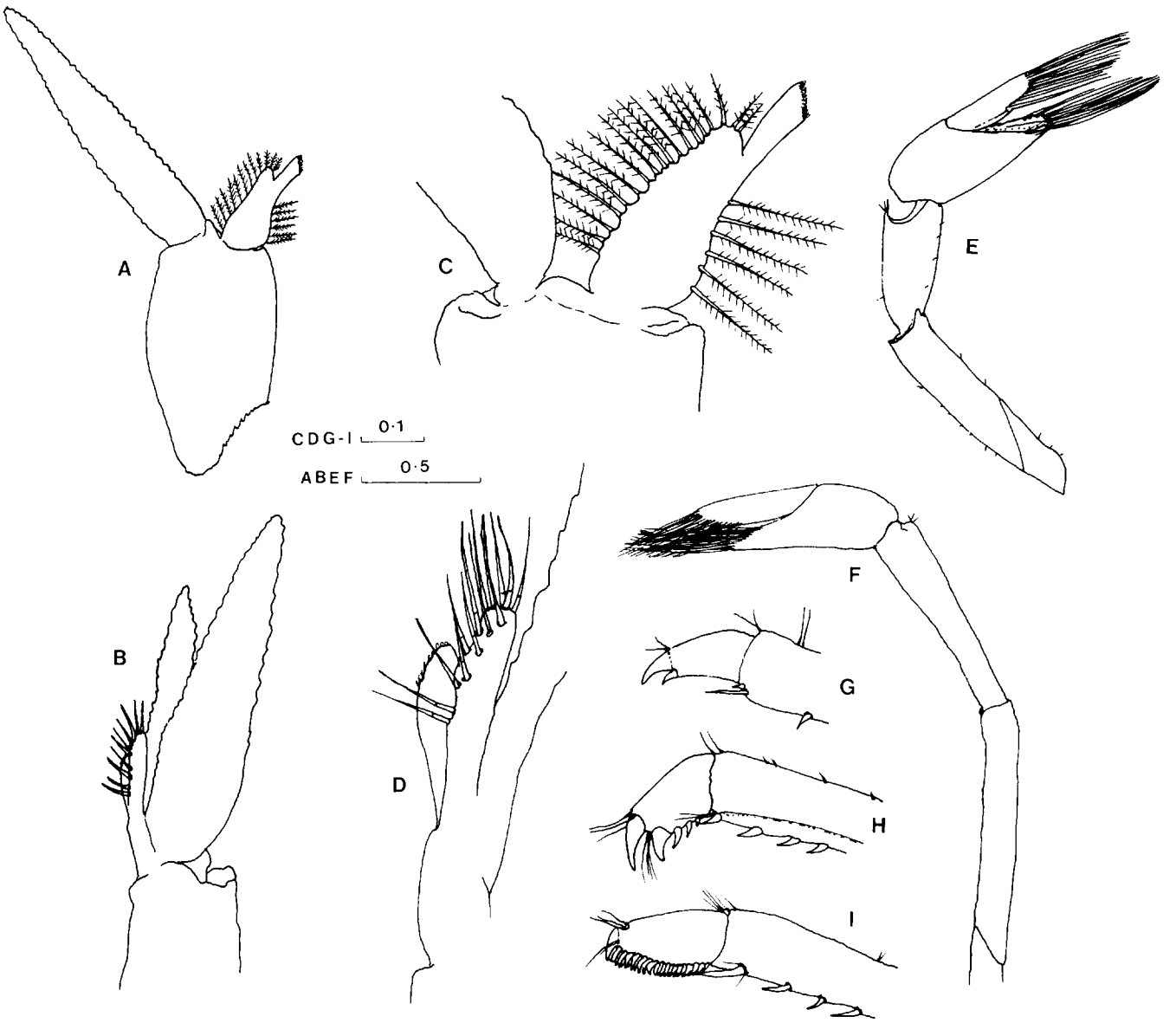

Fig. 3. Caridina bruneiana sp.n. Allotype male.—*A*. First pleopod.—*B*. Second pleopod.—*C*. Endopod of first pleopod.—*D*. Appendix interna and appendix masculina on second pleopod.—*E*. First pereiopod.—*F*. Second pereiopod.—*G*. Dactylus of third pereiopod (regenerating).—*H, I*. Dactylus of fourth and fifth pereiopods, respectively. Scale bars in mm.

vated anteriorly, about 4.4 times as long as wide, and a bit longer than chela but slightly shorter than merus. Ischium less than 0.5 length of merus and over twice that of basis.

Third pereiopod (Figs 2D, 3G, 4E). Almost reaching tip of antennular peduncle. Dactylus 1.6–2.0 times as long as wide, ending in 1 or 2 prominent claw-like apical spines, behind which posterior margin bears 4–6 spines, generally reducing in size proximally. Propodus about 6.8 times length of dactylus, bearing 10–13 spines on posterior margin plus few on anterior and lateral margins. Carpus 0.6–0.7 length of propodus, bearing 1–2 anterior spines and 1–2 posterior spines on margin of outer surface. Merus about twice as long as carpus, longer and broader than propodus, bearing 3–5 strong, movable spines on posterior margin of outer surface. Ischium about 0.33 length of propodus and twice that of the basis, bearing no spines or spinules.

Fourth pereiopod (Figs 3H, 4D). Reaching just before or to tip of second antennular segment. Somewhat similar to third pereiopod. Dactylus about 0.1–0.2 length of propodus, ending in prominent claw-like apical spine and 4–6 marginal spines reducing in size proximally. Propodus about twice length of carpus, bearing 12–16 spines on posterior margin. Carpus with strong spine distally and 2–4 smaller spines proximally. Merus about 3.4 times length of ischium with 2–4 strong latero-posterior spines. Ischium about twice length of basis, bearing no spines or spinules.

Fifth pereiopod (Figs 2E, 3I, 4F, 4G). Reaching tip of basal segment of antennular peduncle. Dactylus bent, spatulate; ending in claw-like apical spine and bearing comb-like row of 19–21 spinules on posterior margin. Propodus about 7.6–8.3 times as long as dactylus, bearing row of 13–16 spinules on posterior margin, few spinules on anterior margin; large spine at distal end may be present. Carpus about 0.5 propodus length, large spine distally, couple of smaller ones proximally. Merus distinctly shorter but wider than propodus, bearing strong anterior spine on outer surface plus 2 smaller marginal

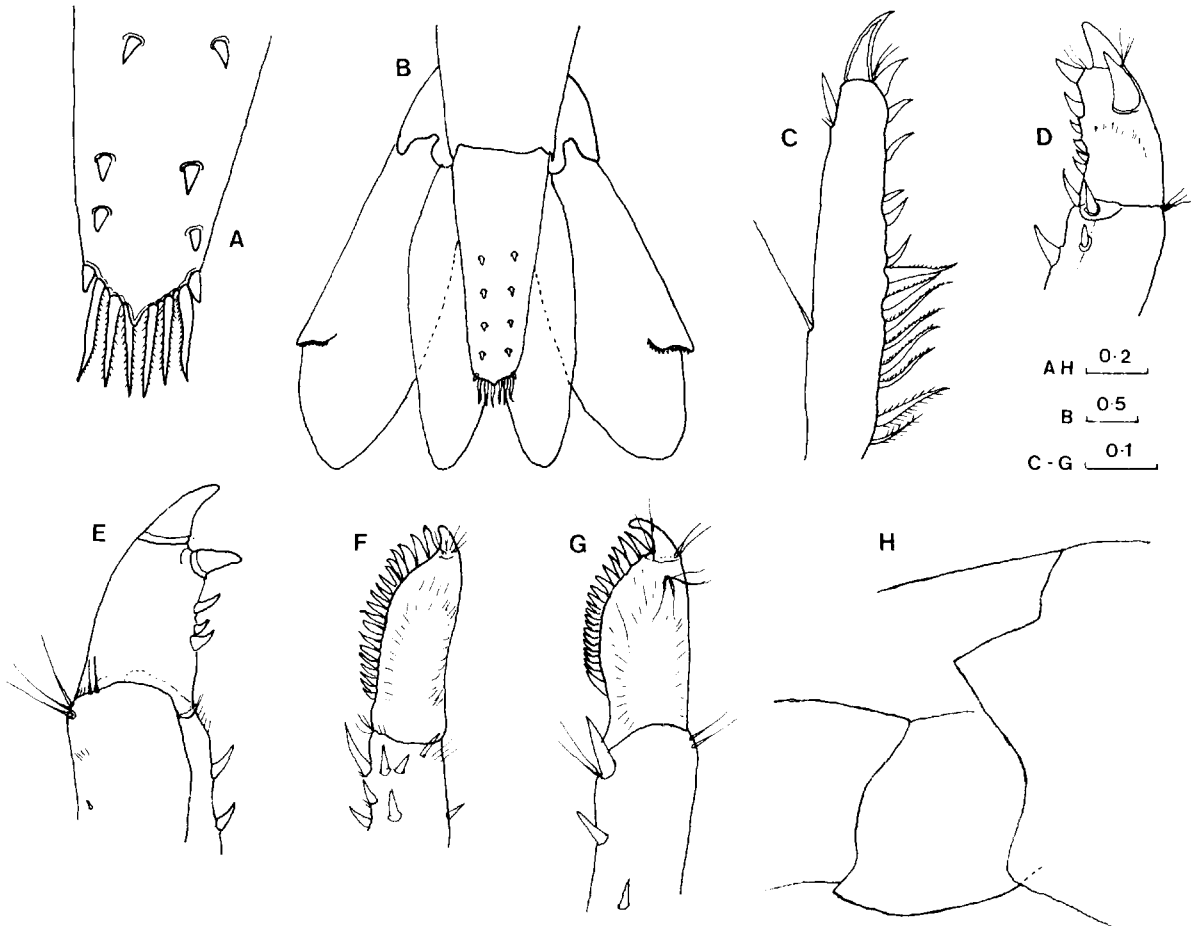

Fig. 4. Caridina bruneiana sp.n.—*A*, *B*, *E*, *G*. Paratype female #3.—*C*, *D*, *F*. Paratype female #4.—*H*. Paratype female #2.—*A*. Posterior margin of telson.—*B*. Telson and uropods.—*C*. Distal segment of third maxilliped.—*D*, *E*. Dactylus of fourth and third pereiopods, respectively.—*F*, *G*. Dactylus of fifth pereiopod.—*H*. Postero-lateral margin of sixth abdominal segment. Scale bars in mm.

ones behind it. Ischium about twice length of basis, no spination.

Branchial formula. As for other species of the genus.

	Maxillipeds			Pereiopods				
	1	2	3	1	2	3	4	5
pleuropbranchs	—	—	—	1	1	1	1	1
arthrobranchs	—	—	2	1	—	—	—	—
podobranchs	—	1	—	—	—	—	—	—
epipods	—	1	1	1	1	1	1	—
exopods	1	1	1	—	—	—	—	—

First pleopod (Fig. 3A, C). Endopod in male about 0.3 length of exopod, both with marginal plumose setae; appendix interna well developed, over-reaching tip of endopod by about 0.3 length, many retinacula at tip.

Second pleopod (Fig. 3B, D). Endopod in male about 0.8 length of exopod; both with marginal plumose setae. Appendix interna of endopod with many retinacula at tip. Appendix masculina strong, bearing about 12 long, spine-like setae distally and inner-laterally.

Telson (Fig. 4A, B). About 0.6 of post-orbital carapace length and slightly longer than sixth abdominal segment, tapering posteriorly and ending in a small, sharp median spine; 3–4 pairs of submarginal spines on posterior two-thirds of dorsal surface. Posterior margin with a pair of short, outermost spines, about 0.3 times as long as inward-curved or slightly sigmoid lateral pair; 4 intermediate posterior spines which may be slightly shorter to slightly longer than lateral pair; none with a chitinous plug. Exopod of uropod slightly longer and wider than endopod, both with marginal plumose setae; diaeresis bearing 12–14 spines.

Colouration. Colour varies in live specimens and tends to match their background. A majority of the specimens were semi-transparent with pale brown to reddish chromatophores all over the body. Few were dark brown to black, with a light cream longitudinal streak along the median dorsal surface. The colouration is eventaully lost on preserved animals.

Discussion

Caridina bruneiana most closely resembles *C. japonica* De Man, 1892, *C. sundanella* Holthuis, 1978 and *C. typus* H. Milne Edwards, 1837. Although *C. japonica* has not yet been reported from this region, its occurrence here cannot be ruled out. It has a wide distribution, ranging from Madagascar to Japan and to Fiji (Choy in press). It is likely that future work will reveal the presence of more species of *Caridina* in Borneo and so it would be premature to offer a key to the species that might be expected to

occur here. However, *C. bruneiana* can readily be distinguished from *C. japonica*, *C. sundanella*, *C. typus* and other Indo-Pacific species described by Borradaile (1898), Bouvier (1925), Edmondson (1929, 1935), Blanco (1935, 1939), Kubo (1938), Johnson (1961), Arudpragasam & Costa (1962), Holthuis (1965, 1969, 1978), Kamita (1967), Tiwari & Pillay (1971), Fujino & Shokita (1975), De Silva (1982), Gurney (1984), Jalihal *et al.* (1984) and Choy (in press), on the basis of a combination of the following characters: the length, shape and spination of the rostrum, pereiopod shape, spination and segmental ratios, shape and spination of the posterior telsonic margin, placement of the antennal spine, number of spinules on the diaeresis, presence or absence of the appendix interna on the endopod of the first male pleopod and egg size.

Caridina bruneiana is the first record of the family Atyidae from Negara Brunei Darussalam as well as from Borneo. The occurrence of atyid shrimps here is not surprising considering the fact that they are found elsewhere all around Borneo (e.g. Peninsula Malaysia and Singapore, Sumatra, Java, Sulawesi and the Philippines). Their rather late discovery may be due to inadequate sampling in combination with identification problems. To an untrained eye, atyids look like juveniles of the larger and more conspicuous *Macrobrachium*. The distribution of atyid shrimps seems to be restricted to less acidic waters, a feature not too common in Brunei Darussalam, where stream and river waters vary in pH range between 3 and 6. This may explain the rather restricted distribution of atyids within Brunei Darussalam and possibly in Borneo. This also seems to apply to freshwater molluscs (pers. obs.).

Some atyid shrimps are sensitive to changes in water quality and could serve as bio-indicators (Choy 1984, 1987). Impounding water to form reservoirs causes the shrimps to move further upstream where water is clearer and faster-flowing. In reservoirs they quickly succumb to changing environmental conditions and increased predation. A similar situation could well apply to rainforest streams from where these animals were collected. Logging and other forest-cover disturbances invariably lead to increased sediment load and sedimentation in the nearby streams. Atyids are seldom found in muddy, turbid waters or on silty bottoms. It is likely that such conditions interfere with their respiratory processes. One of the objectives of the 1991–1992 UBD/RGS Rainforest Project is to study the effects of silt on the physiology of atyid shrimps. This will hopefully increase our understanding of the off-site impact of changing environments in tropical rainforests.

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