The Atyid shrimps of Fiji with description of a new species

S. C. Choy

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Fourteen species of shrimps belonging to four genera of the family Atyidae are reported from the Fiji Islands. Three genera are represented by only one species each: *Antecaridina lauensis* (Edmondson, 1935), *Atyoida pilipes* (Newport, 1847) and *Atyopsis spinipes* (Newport, 1847) while the fourth, *Caridina* is represented by eleven species (including one new, *Caridina devaneyi* spec. nov. which is described and illustrated). Keys are provided to separate the genera and species. Two species, *Caridina japonica* De Man, 1892 and *C. longirostris* H. Milne Edwards, 1837 are recorded from Fiji for the first time. *C. devaneyi* spec. nov., *C. fijiana* Choy, 1983 and *C. nudirostris* Choy, 1984 are so far known only from Fiji and may be endemic to the island of Viti Levu. All three have relatively large eggs and are thought to undergo either direct or abbreviated larval development, thus resulting in their restricted distribution. Most of the other species recorded have a wide Indo-Pacific distribution.

Satish C. Choy, Universiti Brunei Darussalam, Gadong 3186, Brunei Darussalam.

Introduction

Between 1979 and 1983 a survey was carried out on the flora and fauna of the freshwater habitats on the islands of Fiji. This paper deals with the atyid shrimps which were collected during this survey. Representative specimens have been deposited with the Nationaal Natuurhistorisch Museum (former Rijksmuseum van Natuurlijke Historie; RMNH), Leiden, The Netherlands and the Bernice P. Bishop Museum (BPBM), Hawaii, USA. The rest of the material is retained in the reference collection of the University of the South Pacific (USP), Fiji.

A list of the sampling stations and the species of shrimps collected at each of these localities (fig. 1) is given in table 1. The physico-chemical characteristics of the freshwater habitats in Fiji may be found in Choy (1984, 1987), Haynes (1985), Ryan et al. (1979) and Southern et al. (1986).

Twelve species of atyid shrimps belonging to four genera were collected during the survey. Two other species namely, *Caridina brevicarpalis* De Man, 1892 and *Caridina* species (Edmondson, 1935), although not collected during the present survey, are also included in this paper. These two species were reported from Fiji (the latter only as *Caridina* species) by Edmondson (1935). Examination of his specimens (deposited in BPBM Cat. Nos. S3942 and S4442) confirms his identification of *C. brevicarpalis*. The catalogue number of *Caridina* spec. was wrongly cited by Edmondson (1935: 12) as S3932. The specimens were deposited by Edmondson himself under Cat. No. S3946 (Ms B. L. Burch, pers. comm.). In this paper *Caridina* spec. is fully described as a new species *Caridina devaneyi*.

All fourteen species are keyed out and, as *Antecaridina* Edmondson, 1954, *Atyoida* Randall, 1840 and *Atyopsis* Chace, 1983 are represented by only one species each, these are included in a single key.

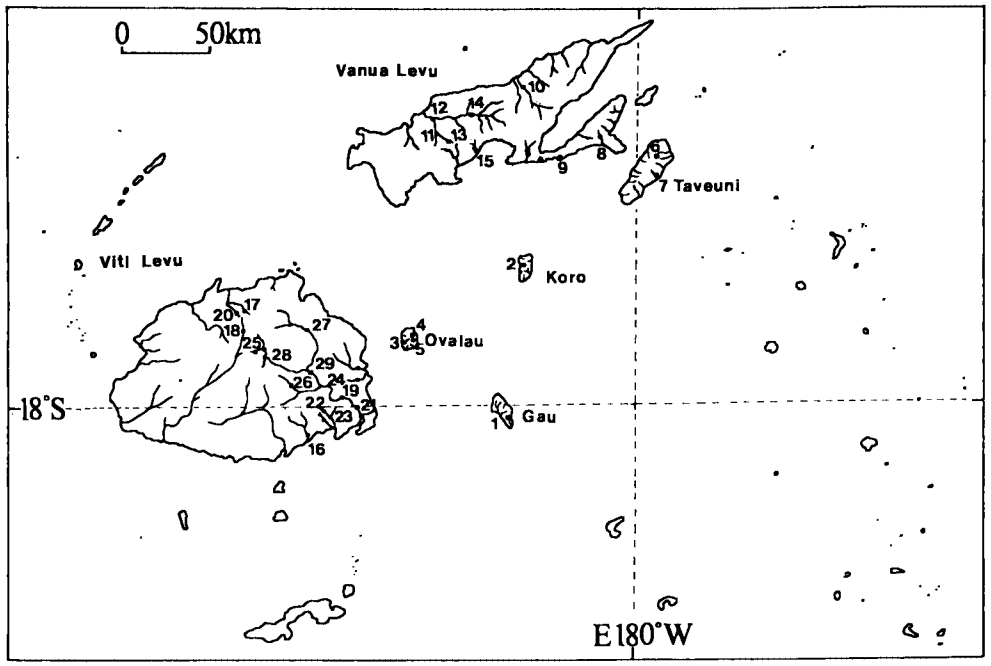

Fig. 1. Map of the Fiji Islands showing the major river systems and the sampling stations. The station numbers correspond to those given in the text under "Material". Further details are given in table 1.

Key to genera of the Fijian Atyidae

1. Exopods present on all pereiopods. Eyes degenerate, cornea strongly reduced and poorly pigmented. Live body colour usually bright red ..... ***Antecaridina*** Edmondson, 1954
- Exopods absent from all pereiopods. Eyes well developed and well pigmented. Live body colour never red 2
2. Carpus of second pereiopod elongate, more than three times as long as wide, not deeply excavated. Chelae always with well developed palmar portion ..... ***Caridina*** H. Milne Edwards, 1837
- Carpus of second leg short, less than twice as long as wide, deeply excavated. Chelae without a palmar portion 3
3. Third maxilliped with terminal spine (sometimes partially concealed by setae). Mastigobranchs on all five pereiopods. Endopod of pleopod of male tapering from base to tip; possibly protandrous ..... ***Atyoida*** Randall, 1840
- Third maxilliped terminating in numerous stout setae but lacking single terminal spine. No mastigobranchs on pereiopods. Endopod of first pleopod of male expanded into a broad lamina, not tapering from base to tip; not protandrous ..... ***Atyopsis*** Chace, 1983

Key to the Fijian species of the genus *Caridina*

1. Endopod of first pleopod of male with appendix interna 2
- Endopod of first pleopod of male without appendix interna 3
2. Upper border of rostrum without teeth ..... ***C. typus***
- Upper border of rostrum with teeth 5
3. Upper border of rostrum without teeth. Eggs few (<20) and large (0.6-0.9 × 0.9-1.2 mm) ..... ***C. nudirostris***
- Upper border of rostrum with teeth 4
4. Stylocerite long, always reaching beyond the basal segment of the antennular peduncle. Upper margin of rostrum bearing 16 to 29 teeth with more than 4 placed behind the orbital margin. Eggs numerous (250-2000) and small (0.23-0.28 × 0.36-0.45 mm) ..... ***C. serratirostris***
- Stylocerite short, never reaching beyond the basal segment of the antennular peduncle. Upper margin of rostrum bearing 10 to 19 teeth with 4 or less placed behind the orbital margin. Eggs few (< 20) and large (0.6-0.8 × 1.0-1.2 mm) ..... ***C. devaneyi*** spec. nov.
5. Rostrum straight or curving downwards and short, tip not curving upwards and not reaching beyond the second segment of the antennular peduncle. Antennal spine placed on lower orbital angle, seldom below 6
- Rostrum with distal part straight or curved upwards, reaching distinctly beyond the second segment of the antennular peduncle, distal part of upper margin of rostrum unarmed apart from one or more subapical teeth. Antennal spine placed below lower orbital angle. 9
6. Distal part of upper margin of rostrum unarmed, no subapical teeth. Lateral carina of rostrum distinct but not reaching the tip of rostrum. First of the 5 to 7 teeth on the posterior margin of the dactylus of the third pereiopod distinctly smaller than the claw that precedes it and the tooth just behind it; from the second to the proximal, the posterior teeth diminish regularly in size. Stylocerite not reaching the tip of the basal segment of the antennular peduncle ..... ***C. japonica***
- Distal part of upper margin of rostrum usually armed; one or more subapical teeth present. Lateral carina of rostrum distinct and reaching the tip of the rostrum. Distal to proximal teeth on the posterior margin of the dactylus of the third pereiopod diminish regularly in size. Stylocerite reaching to or beyond the tip of the basal segment of the antennular peduncle 7
7. Carpus of first pereiopod slender, distal margin not deeply excavated. Number of spinules on uropodial diaeresis 9 to 12. Spines on posterior margin of dactylus of the fifth pereiopod 26 to 35 ..... ***C. vitiensis***
- Carpus of first pereiopod stout and distal margin deeply excavated. Number of spinules on uropodial diaeresis 11 to 21. Number of spines on posterior margin of dactylus of the fifth pereiopod > 40 8
8. Posterior margin of telson with a short median tooth. Teeth on lower margin of rostrum 2 to 7. Number of spinules on uropodial diaeresis 17 to 21. Eggs small (0.26 ± 0.03 × 0.44 ± 0.03 mm) and numerous (500-5000) ..... ***C. weberi***
- Posterior margin of telson rounded and without any median tooth. Teeth on lower margin of rostrum 0 to 2. Number of spinules on uropodial diaeresis 11 to 15. Eggs large (0.65 ± 0.02 × 1.11 ± 0.03 mm) and few (< 30) ..... ***C. fijiana***

9. Posterior margin of telson rounded; preanal carina blunt and without a spine. Eggs few and large (0.5 ± 0.1 × 0.9 ± 0.2 mm) ..... ***C. nilotica***
- Posterior margin of telson ending in a median point; preanal carina with a sharp, posteriorly directed spine. Eggs numerous and small (0.3 ± 0.1 × 0.4 ± 0.2 mm) 10
10. Carpus of first pereiopod short and cup-shaped (deeply excavated anteriorly), fifth pereiopod short. Subapical tooth on dorsal margin of rostrum absent ..... ***C. brevicarpalis***
- Carpus of first pereiopod relatively long and not deeply excavated anteriorly, fifth pereiopod long. Subapical tooth on dorsal margin of rostrum present ..... ***C. longirostris***

Systematic account

Family Atyidae De Haan, 1849

Antecaridina lauensis (Edmondson, 1935)

Mesocaris lauensis Edmondson, 1935: 13, fig. 14.
Antecaridina lauensis; Edmondson, 1954: 368; Holthuis, 1965: 13, fig. 2; Smith & Williams, 1981: 51, figs. 3-4.

Material.— Eleven specimens (5 RMNH) anchialine pools near the village of Naweni, Vanua Levu, 0 m altitude (table 1, fig. 1 stn. 9), 19.vii.1983, coll. S. C. Choy. Paratypes: 4 specimens (BPBM Cat. No. S3900), Wangava (sic.) Is., Lau Group, Fiji, coll. Edmondson, 1933.

Remarks.— *Antecaridina lauensis* was first described from a brackish pool in a cave in the middle of Namuka Island in the Lau Group, Fiji by Edmondson (1935). Other specimens from an anchialine pool on Vuagava (incorrectly spelt by Edmondson, 1935 as Wangava) Island, Lau Group were also obtained by him. The present collection contained both, the "gracile" and "robust" forms (with respect to the first three pereiopods) as described by Smith & Williams (1981).

Antecaridina lauensis is a widely distributed species, known from the Red Sea, Indian Ocean and the Pacific Ocean as far east as Fiji.

Atyoida pilipes (Newport, 1847)

For full list of synonyms see Chace, 1983.

Material.— Fifteen specimens (5 RMNH, 10 USP), trib. of Bagasau Creek, Vanua Levu, 100 m altitude (table 1, fig. 1 stn. 14), 16.vii.1980; 10 specimens (6 RMNH, 4 USP), Waitovu Creek, Ovalau, 30 m altitude (table 1, fig. 1 stn. 4), 30.viii.1980; 49 specimens (8 RMNH, 8 BPBM, 33 USP), inland streams on Viti Levu, 15-700 m altitude (table 1, fig. 1 stns. 17, 20, 23, 27 & 28), vi-x.1980; 6 specimens (USP), Naivilali Creek near Nawaikama village, Gau Island, 15 m altitude (table 1, fig. 1 stn. 1), 15.iv.1983, 12 specimens (USP), small streams near Somosomo village, Taveuni, 8 m altitude (table 1, fig. 1 stn. 7), 19.viii.1983, coll. S. C. Choy, P. A. Ryan & B. Cowie.

Remarks.— This species was recently reviewed by Chace (1983) who also provided some ecological notes. In Fiji it is usually found in moderately fast streams

(velocity 0.1-0.8 ms^{-1}) and sheltering among overhanging bank vegetation, dead leaves and other debris. On Ovalau, it was also collected from crevices on waterfalls and from rock surfaces over which water cascaded. Three specimens were found with pupae of the simuliid fly *Simulium (Hebridosimulium) jolyi laciniatum* Edwards attached to the exoskeleton. This association is thought to be fortuitous and unlikely to be evidence of a general phoretic relationship (R. W. Crosskey, pers. comm.) such as that found between *Simulium* and *Atya* from tropical Africa (Hobbs & Hart, 1982).

A. pilipes has been reliably reported (Chace, 1983) from the Philippines and the eastern lesser Sunda Islands and eastwards through the Pacific high islands to Mangareva, French Polynesia (between 14°N - 27.5°S latitudes and 120°E - 135°W longitudes).

Atyopsis spinipes (Newport, 1847)

For full list of synonyms see Chace, 1983.

Material.— Fourty-five specimens (27 USP, 10 RMNH, 8 BPBM) inland streams of Vanua Levu, 30-100 m altitude (table 1, fig, 1 stns. 8, 14 & 15), vii-x.1980; 10 specimens (5 RMNH, 5USP) Bureta River & its tributaries, Ovalau, 35 m altitude (table 1, fig. 1 stn. 3); 26.vii.1980; 72 specimens (50 USP, 14 RMNH, 8 BPBM) inland streams on Viti Levu, 35-700 m altitude (table 1, fig. 1 stns. 17, 18, 20, 23, 25, 27, 28 & 29); vii.1979 - x.1980, coll. S. C. Choy, B. Cowie & P. A. Ryan.

Remarks.— Chace (1983) made a new combination for this species. It was previously better known as *Atya spinipes* (Newport) and *A. moluccensis* De Haan. The habitat of this species is similar to that of *Atyoida pilipes* although some specimens were found in much faster flowing waters (current velocities of up to 2.3 ms^{-1}).

A. spinipes is common in the Fiji Islands and was first reported from there by Ortmann (1890). Most reliable records suggest that *A. spinipes* ranges from the Philippines and the eastern lesser Sunda Islands to Samoa in the South Pacific.

Caridina brevicarpalis De Man, 1892

Caridina brevicarpalis De Man, 1892: 397, pl. 24, fig. 3a-e; Edmondson, 1935: 7, fig 2a-f; Holthuis, 1978: 37.

Material.— Cat. No. BPBM S3942 (Vunidawa, Viti Levu, Edmondson, 1935); Cat No. BPBM S4442, Draiba Trail, Ovalau, Edmondson, 1933).

Remarks.— This species was not collected during the present survey but has been reported from Vunidawa, Viti Levu, Fiji Islands by Edmondson (1935). Examination of his specimens confirms the identity. Amongst his collection were three more specimens of *C. brevicarpalis* that were collected from the Draiba trail, Ovalau in 1933.

This species is known from the Philippines and the lesser Sunda Islands eastwards to Fiji. Interestingly, it has not been reported from New Caledonia despite extensive collections there (Holthuis, 1969).

Caridina devaneyi spec. nov.
(figs. 2-4)

Caridina species Edmondson, 1935: 12, fig. 4a-f.

Material.— Holotype, ovigerous ♀, total length 19 mm, total carapace length 6.1 mm, post-orbital carapace length 3.0 mm, mean diameter of ovoid eggs (with developed embryo inside) 0.77 x 1.20 mm (BPBM nr. S3946A), stream at 8-mile Point near Suva, Viti Levu, Fiji Islands, 30.i.1933, coll. C. H. Edmondson. Allotype: 1 adult ♂, total length 16.5 mm, totat carapace length 5.5 mm, post-orbital carapace length 3.0 mm (BPBM nr. S3946B), same locality as holotype. Paratypes: 4 ♂♂, 9 ♀♀ (BPBM nr. S3946C) in four lots: Lot 1 (3 ♂♂, 1 ♀), Lot 2 (1 ♂, 5 ♀♀), Lot 3 (1 ♀) and Lot 4 (2 ovig. ♀♀), same locality as holotype but some were collected on 9.ii.1933. 1 ♂ and 1♀ from Lot 1 and 1 ovigerous from Lot 4 requested to be deposited in RMNH.

Description.— Body (fig. 2a) slender. Rostrum (figs. 2a, b) short, reaching middle of second to tip of third antennular segments, either convex or straight; tip may be directed slightly upwards or downwards; 10-19 dorsal rostral teeth, immovable, with 1-4 situated above- to behind- the posterior orbital margin; 3-7 ventral rostral teeth; minute obscure notches and weak serration sometimes be present behind these; lateral carina dividing rostrum into two unequal parts and continuing posteriorly to orbital margin. Pre-orbital carapace length 1.6-3.1mm. Eyes small, on a short ocular peduncle; cornea globular, well developed. Post-orbital carapace length 2.0-4.0 mm; pterygostomian angle acute to broadly rounded, slightly produced anteriorly. Antennal spine below lower orbital angle, short but strong and straight dorsally and slightly concaved ventrally. Antennular peduncle (fig. 2c) three-segmented; stylocerite 0.75 length of basal segment; pointed anterolateral angle of basal antennular segment acute reaching about 0.33 length of second segment, which is about 0.67 the length of basal antennular segment and about 1.33 times as long as the third segment. Flagella long and simple. Scaphocerite (fig. 2d) reaching well beyond tip of antennular peduncle; outer margin straight, without setae and ending in a strong subapical tooth, the tip of which lies in line with or is beyond the tip of the antennular peduncle; both being overreached by the lamella. Antennal peduncle about 0.5 length of scaphocerite and reaching almost to tip of the second segment of antennular peduncle. Flagellum long and simple.

Right mandible (fig. 2f) with five or six very strong, sharp incisor teeth; medially two groups of simple setae: nine with marginal ridges and 20 being finely serrate; molar process ridged. Left mandible (fig. 2g, h) with three strong, sharp teeth separated by sharply ridged gap; nine adjacent setae finely serrated, below which are about 15 simple setae adjacent to ridged molar process. Lower lacinia of first maxilla (fig. 2e) with broadly rounded margin, bearing several rows of different types of setae (from simple to setose); submarginal row of short simple setae, the lower ones spinose, some setae proximally. Upper lacinia broadly elongate, inner edge straight with several rows of strong spines as well as short, simple and plumose setae. Simple and plumose setae on outer and lower inner margins. Palp truncate with long plumose setae near tip plus row of spines and simple setae. Upper and middle endite of second maxilla (fig. 2i) with marginal and submarginal plumose setae. Lower endite with simple setae; palp longer than cleft of upper endite, narrow and simple. Scaphognathite with regular row of plumose setae on distal margin continuing down the proximal triangular process which has many long simple setae, each

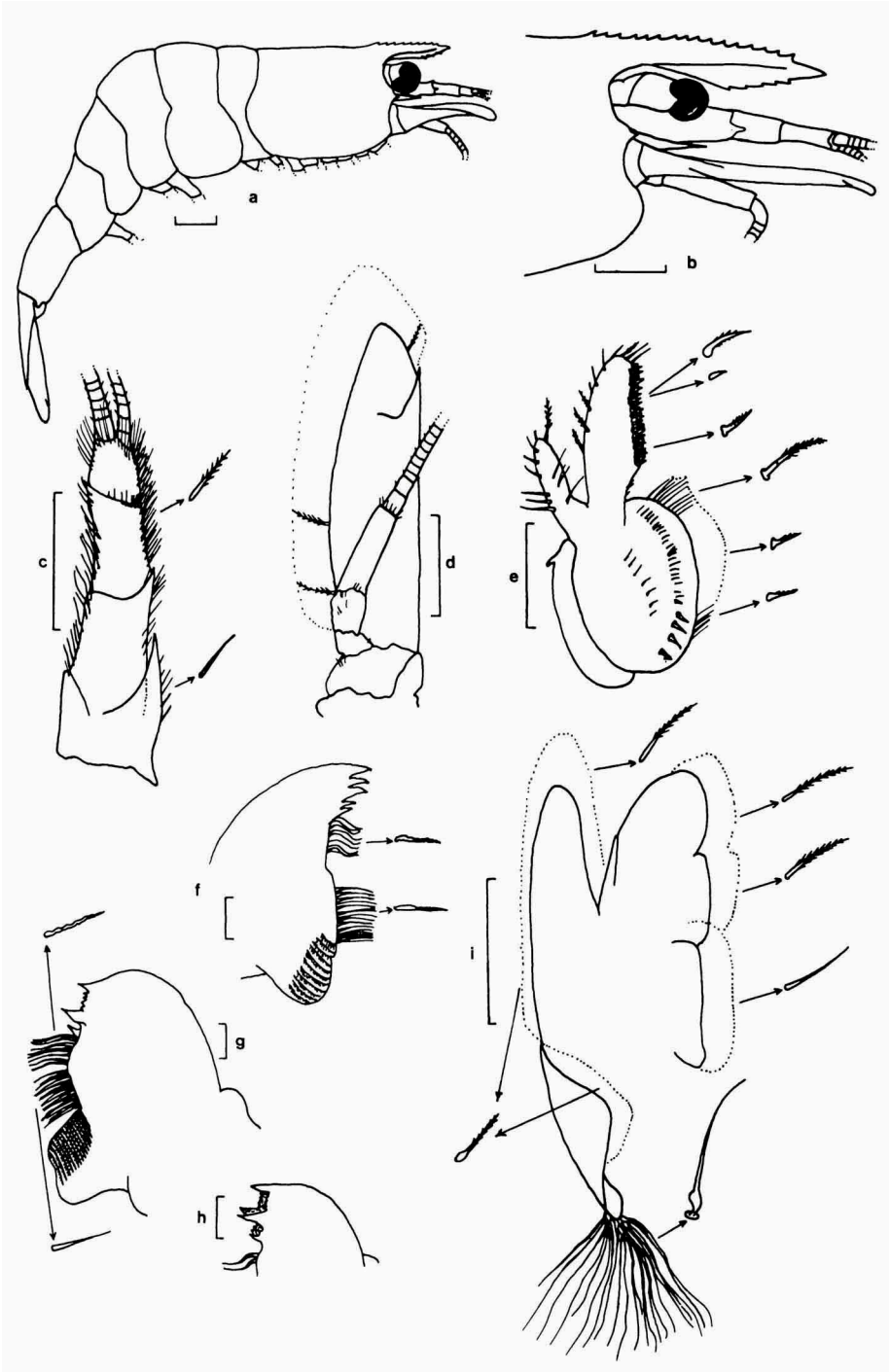

Fig. 2. *Caridina devaneyi* spec. nov. Female holotype; a, whole animal; b, head region (male paratype); c, antennule; d, antenna; e, first maxilla; f, right mandible; g, left mandible; h, distal region of left mandible; i, second maxilla. Scale bars represent 0.1 mm (g, h), 0.5 mm (e) and 1.0 mm (a-d, f, i).

with prominent dilation near base. Inner margin of ultimate segment of endopodite of first maxilliped (fig. 3a) with long denticulate setae plus transverse rows of simple setae on lower portion. Palp triangular. Exopod flagellum long and narrow distally with marginal plumose setae. Caridean lobe not broad, with denticulate and pectinate setae on proximal and inner margin and short simple setae on body.

Ultimate and penultimate segments of endopodite of second maxilliped (fig. 3b) fused, reflected against basal segments. Inner margins of ultimate, penultimate and basal segments with long, plumose setae of various types. Exopodite long and narrow with marginal plumose setae distally, and simple and plumose ones proximally (near base). Podobranch broad and flat, with reduced branchial lamella. Third maxilliped (fig. 3c, d) reaching tip of third antennular peduncle; distal segment about 9.5 times as long as wide, slightly shorter than the penultimate, ending in 2 distinct claws and bearing about 5 spines on distal half of posterior margin. Penultimate segment about 9 times as long as wide, with groups of transverse rows of simple setae. Exopodite well developed, reaching about a third of second endopodite segment, distal margin with long plumose setae.

First pereiopod (fig. 4a) reaching tip of eye to tip of basal antennular peduncle segment in situ. Chela about twice as long as wide, movable finger much shorter than palm and about twice as long as wide. Carpus attached to chela ventrally, excavated antero-dorsally, about 0.75 the length of chela. Ischium about 0.75 the length of merus and over twice length of coxa.

Second pereiopod (fig. 4b) reaching tip of second antennular peduncle segment, more slender than first. Chela more than twice as long as wide, free finger slightly longer than palm and about four times as long as wide. Carpus not excavated anteriorly, about four times as long as wide and a bit longer than chela and merus. Ischium less than 0.75 the length of merus and over twice that of coxa.

Third pereiopod (fig. 4c, e) reaching tip of antennular peduncle. Dactylus 2.5-3.5 times as long as wide, ending in 2 distinct claws, behind which posterior margin bears 3-4 spines. Propodus about 4-6 times as long as dactylus, bearing 8-11 spines on posterior margin plus a few on the anterior and lateral margins. Carpus 0.5-0.7 length of propodus, bearing 2 anterior spines and 2-4 posterior spines on the margin of the outer surface. Merus twice as long as carpus, longer and broader than propodus, bearing 2-3 strong, movable spines on the anterior part of the outer surface, 2 distally and 1 near the middle. Ischium about 0.33 the length of propodus and twice that of the coxa, bearing no spines or spinules.

Fourth pereiopod reaching beyond tip of antennal spine; length, proportion and spination similar to third pereiopod.

Fifth pereiopod (fig. 4d, f) reaching tip of antennular peduncle. Dactylus ending in a claw-like tip and bearing a comb-like row of 40-50 spinules on posterior margin. Propodus about four times as long as dactylus, bearing a row of 10-11 spinules on posterior margin and a few on the anterior margin. Carpus about half the length of propodus, bearing a large distal spine and 3 smaller proximal ones on outer surface. Merus distinctly shorter but wider than propodus, bearing 2 strong, movable spines on anterior part of outer surface. Ischium about twice the length of coxa, no spination.

Measurements of the pereiopodal segments of the primary type specimens are given in table 2. Branchial formula is typical of genus:

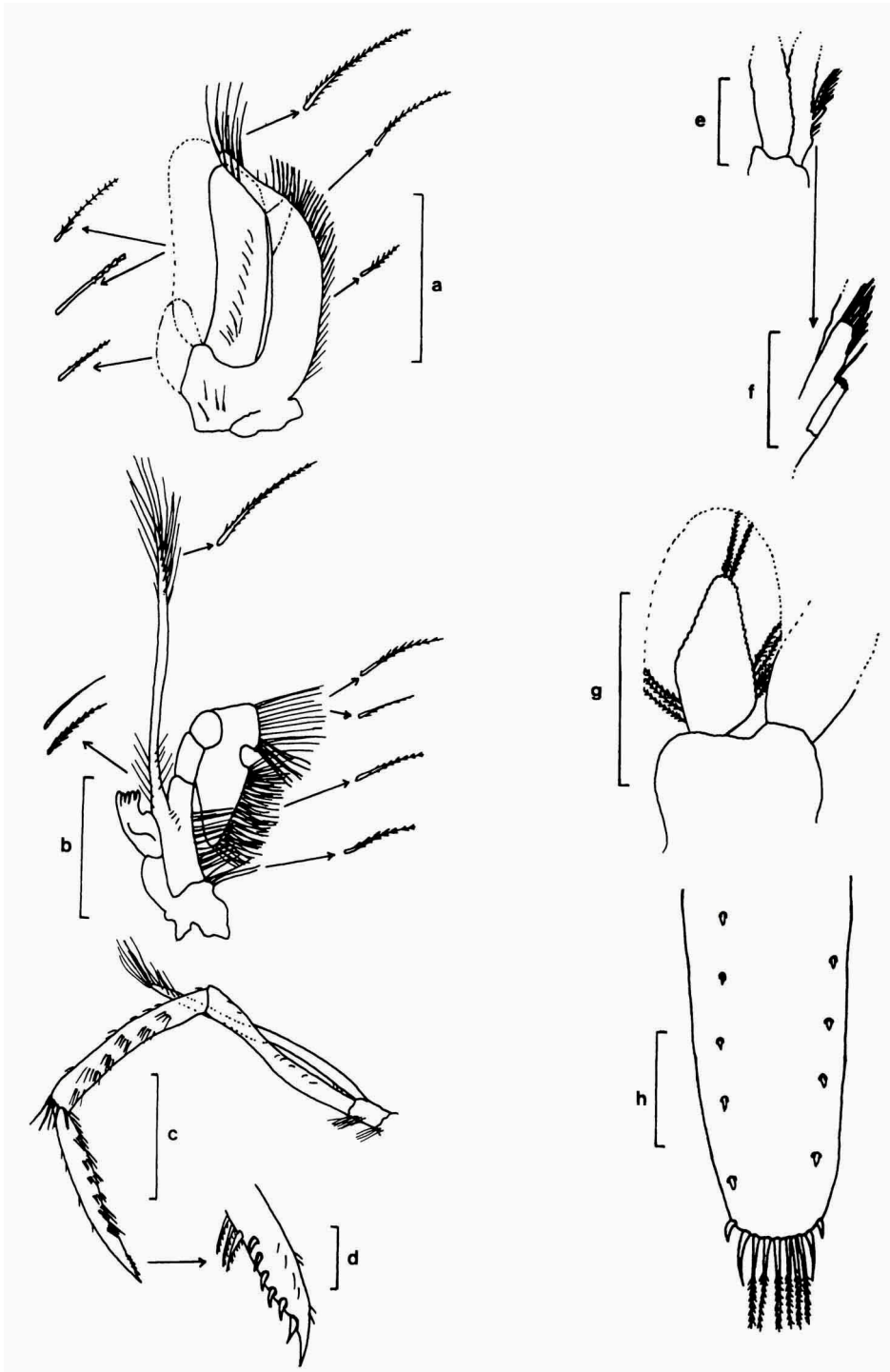

Fig. 3. *Caridina devaneyi* spec. nov. Female holotype (a-d) and male paratype (e-h); a, first maxilliped; b, second maxilliped; c, third maxilliped; d, distal margin of third maxilliped; e, second male pleopod; f, appendix interna and appendix masculina on endopodite of second male pleopod; g, endopodite of first male pleopod; h, telson. Scale bars represent 0.2 mm (d), 0.5 mm (f-h) and 1.0 mm (a-c, e).

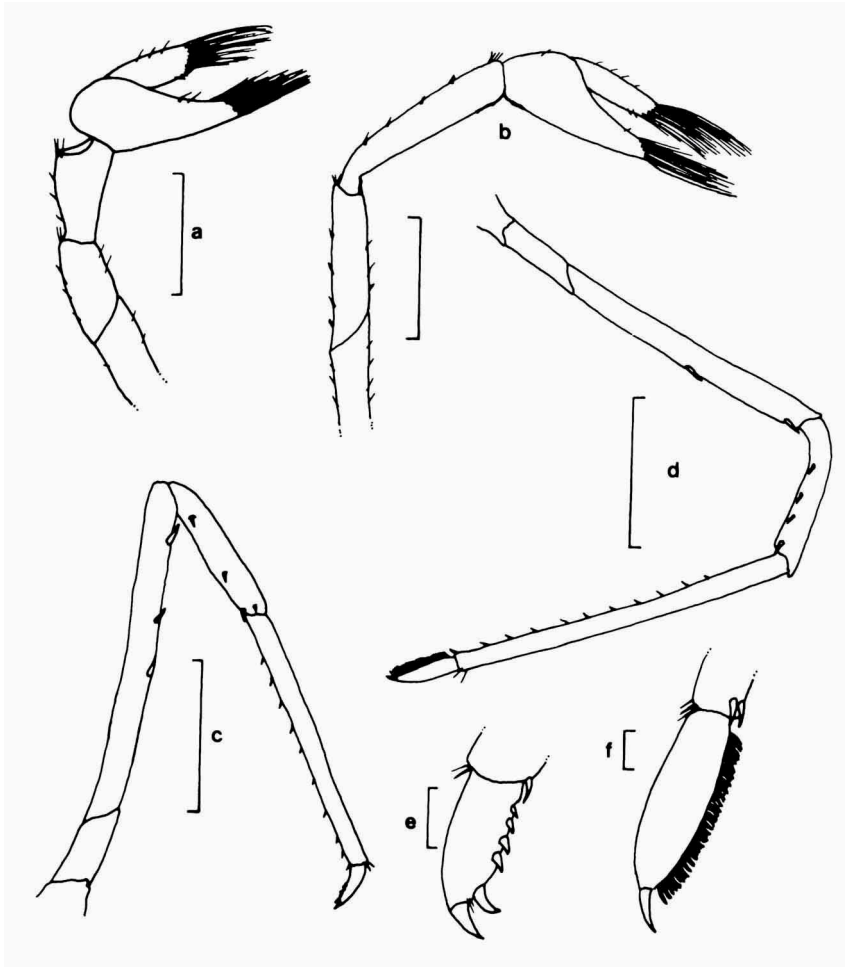

Fig. 4. *Caridina devaneyi* spec. nov. Female holotype; a, first pereiopod; b, second pereiopod; c, third pereiopod; d, fifth pereiopod; e, dactylus of third pereiopod; f, dactylus of fifth pereiopod. Scale bars represent 0.1 mm (e, f) and 1.0 mm (a-d).

	Maxillipeds			Pereiopods				
	1	2	3	1	2	3	4	5
pleurobranchs	-	-	-	1	1	1	1	1
arthrobranchs	-	-	2	1	-	-	-	-
podobranchs	-	1	-	-	-	-	-	-
epipodites	-	1	1	1	1	1	1	-
exopodites	1	1	1	-	-	-	-	-

Endopodite of first pleopod of male (fig. 3g) about 0.25 times as long as exopodite, with marginal plumose setae; no appendix interna. Endopodite of second pleopod of male (fig. 3e, f) only slightly shorter than exopodite; both with marginal plumose setae. Appendix interna of endopodite with many retinacula at tip. In adult

males, appendix masculina strong and almost twice as long as appendix interna, bearing a cluster of spine-like setae distally and inner-laterally.

Telson (fig. 3h) about 0.8 length of post-orbital carapace and nearly as long as sixth abdominal segment, bearing 3-5 pairs of dorsal spines on distal two-thirds; posterior margin broad and strongly convex; outer posterior spines short, about 0.3 times as long as inward-curved lateral pair; 6-8 intermediate posterior setose spines which are 1.5-2.0 times as long as lateral pair, each with a chitinous plug. Exopodite of uropod slightly longer and wider than endopodite, both with marginal plumose setae; diaeresis bearing 12-14 spines.

Remarks.— This species was first described but not named by C.H. Edmondson (1935: 12). It is worth noting that although Edmondson prepared the specimen labels as S3946 (and that the specimens have always been kept under this number at BP BM), it was somehow wrongly cited as S3932 in his paper (Edmondson, 1935: 12). Catalogue number S3932 was assigned to *Caridina rapaensis* from Rapa Is., French Polynesia. As stated by Edmondson (1935: 12) this species bears some resemblance to *C. weberi* and *C. vitiensis* (and additionally, to *C. japonica*), but it can be separated from these on the basis of a combination of characters given in table 3. In addition, *C. devaneyi* spec. nov. has larger and fewer eggs than these three species. *C. devaneyi* spec. nov. can also be quickly separated from other known large-egged species from the South Pacific on the basis of the following:

1. *C. fijiana* Choy, 1983 - males of this species have an appendix interna on the endopodite of their first pleopod.

2. *C. novaecaledoniae* Roux, 1926 - the proximal part of this species' rostrum bears movable dorsal teeth and the posterior margin of the telson bears a sharp median spine.

3. *C. nudirostris* Choy, 1984 - this species has no rostral teeth.

Etymology.— This species is named in honour of the late Dr Dennis M. Devaney, formerly head of the Division of Invertebrate Zoology, Bernice P. Bishop Museum, Honolulu, Hawaii.

Caridina fijiana Choy, 1983

Caridina fijiana Choy, 1983: 147, fig. 1a-m.

Material.— Fifty-eight specimens (31 RMNH, 29 BPBM nr. S10461, 15 USP), Nadala & Nukunuku Creeks, Viti Levu, 640-690 m altitude (table 1, fig. 1 stns. 17 & 20); 3.vii.1980, coll. S.C. Choy.

Remarks.— This is a montane species having few, large eggs thus suggesting abbreviated or direct larval development. At present it is known only from Viti Levu, Fiji.

Caridina japonica De Man, 1892

Caridina japonica De Man, 1892: 261, pl. 9, fig. 7; Kubo, 1938: 89, figs. 17-19; Holthuis, 1965: 12, fig. 4.

Material.— Twelve specimens (2 RMNH, 10 USP), Saivou Creek; 21 specimens (7 RMNH, 14 USP), Bagasau Creek; 34 specimens (10 RMNH, 20 USP, 4 BPBM), Waqativikei Creek, all on Vanua Levu, 30-300m altitude (table 1, fig. 1 stns. 11, 14 & 15), 29-30.x.1980, coll. S. C. Choy, B. Cowie & P. A. Ryan.

Remarks.— The specimens of C. *japonica* from Fiji resemble specimens described from elsewhere (De Man, 1892; Kubo, 1938; Holthuis, 1965) in most respects except for the shape of the dactylus of the last three pereiopods and the placement of (sometimes) one superior rostral tooth on the rostrum proper. A comparison of original descriptions with the Fijian material (table 3) indicate that the morphometric and meristic variations of many of the characters are large and overlap considerably thus not justifying the separation of the Fijian form to a distinct subspecies. This species can be distinguished from the other closely related species (*C. weberi*, *C. vitiensis* and *C. devaneyi* spec. nov.) on the basis of the characteristics given in table 3.

This new record of *C. japonica* in Fiji extends of its range of distribution considerably (from Madagascar and southern Japan). Its absence from the other islands of Fiji as well as from the other countries to its west (e.g. New Caledonia) is interesting and warrants further investigation.

Caridina longirostris H. Milne Edwards, 1837

Caridina longirostris H. Milne Edwards, 1837: 363; Holthuis, 1965: 20, fig. 6; Holthuis, 1969: 94; Holthuis, 1978: 36.
Caridina nilotica brachydactyla; Bouvier, 1925: 155; Edmondson, 1935: 4, fig. la-f.
Caridina nilotica gracilipes; Roux, 1926: 203.
Caridina nilotica brevidactyla Roux, 1926: 204.
Caridina nilotica meridionalis Roux, 1926: 207.

Material.— Twenty-seven specimens (9 RMNH, 18 USP), Bureta River & its tributaries, Ovalau, 35 m altitude (table 1, fig, 1 stn. 3), 26.vii. 1980; 29 specimens (14 RMNH, 15 USP), coastal and inland streams on Vanua Levu, 0-350 m altitude (table 1, fig. 1 stns. 10, 11, 12, 13 & 14), viii-x. 1980; 42 specimens (USP), lowland streams on Viti Levu, 2-50 m altitude (table 1, fig. 1 stns. 16, 19 & 21) 5.viii-26.xi. 1980; coll. S. C. Choy.

Remarks.— Although this species closely resembles *C. nilotica* (P. Roux, 1833) it can be separated from the latter on the basis of: smaller and more numerous eggs (viz. 0.20-0.31 x 0.44-0.51 mm and 264-3,000 eggs *vs.* 0.50-0.75 x 0.75-1.20 mm and 30-500 eggs), the preanal carina bearing a strong spine and the posterior margin of the telson ending in a median point. These variations were originally pointed out by Holthuis (1965). His fourth character namely, shorter dactyli of the last three pereiopods of *C. longirostris* shows some variation in the Fiji material.

This species is a new record for Fiji. Its exact range of occurrence is difficult to ascertain because of the taxonomic confusion. However, it is expected to have a wide range.

Caridina nilotica (P. Roux, 1833)

Pelias niloticus P. Roux, 1833: 73, pl. 7, fig. 1.
Caridina nilotica var. *typica* Bouvier, 1925: 146.
Caridina nilotica Holthuis, 1956: 64; Holthuis, 1965: 15, fig. 5; Holthuis, 1969: 94.

Material.— Seven specimens (2 RMNH, 2 BPBM, 3 USP), Bureta River & its tributaries, Ovalau, 0-35 m altitude (table 1, fig. 1 stn. 3), 26.vii.1980; 12 specimens (4 RMNH, 8 USP), Kuludrusi & Bagasau

Creeks, Vanua Levu, 80-100 m altitude (table 1, fig. 1 stns. 8 & 14) 16.vii- & 30.x.1980; 17 specimens (5 RMNH, 12 USP), tributaries of the Rewa River, Viti Levu, 20-60 m altitude (table 1, fig. 1 stns. 19, 23 & 26), viii-x.1980, coll. S. C. Choy, B. Cowie & P. A. Ryan.

Remarks.— The varieties of C. *nilotica* are of dubious status. As stated by Holthuis (1965, 1969) a thorough study of a large series of specimens of the *nilotica* complex from various localities is necessary to solve the present taxonomic problem.

The exact range of C. *nilotica* is not known due to the confused state of its taxonomy but it seems to have a wide Indo-Pacific distribution.

Caridina nudirostris Choy, 1984

Caridina nudirostris Choy, 1984: 288, fig. 1a-m.

Material.— One hundred thirty specimens (58 RMNH D 35329-35332, 59 BPBM nr. S10462, 13 USP), Nanuku & Wainisavulevu Creeks, central Viti Levu, 160-700 m altitude (table 1, fig. 1 stns. 18 & 28), 2-7.vi.1979, coll. S. C. Choy & P. A. Ryan.

Remarks.— This is another montane species having a few, large eggs thus suggesting abbreviated or direct larval development. At present it is known only from the island of Viti Levu, Fiji.

Caridina serratirostris De Man, 1892

Caridina serratirostris var. *typica* De Man, 1892: 385, pl. 23, fig. 28a-e; Bouvier, 1925: 219, figs. 480-486; Edmondson, 1935: 8, fig. 2g-l.

Caridina serratirostris var. *celebensis;* Roux, 1926: 210 (non *Caridina serratirostris* var. *celebensis* De Man, 1892).

Caridina celebensis; Holthuis, 1978: 39, fig. 14.

Caridina serratirostris Holthuis, 1965: 25, fig. 8; Holthuis, 1969: 97; Holthuis, 1978: 38, fig. 13; Shokita, 1979: 216; Costa, 1980: 691.

Material.— Two specimens (1 RMNH, 1 USP), Qelemumu Creek, Coqeloa, Vanua Levu, 10 m altitude (table 1, fig. 1 stn. 10), 3.viii.1980; 12 specimens (3 RMNH, 3 BPBM nr. S10463, 6 USP), Tacilevu Creek, Vanua Levu, 5 m altitude (table 1, fig. 1 stn. 13), 30.x.1980, coll. S.C. Choy; 2 specimens of Edmondson (1935) (2 BPBM nr. S3943), Vunidawa River, Viti Levu (table 1, fig. 1 stn. 24) 1933.

Remarks.— This species has been previously reported from the Fiji Islands by Edmondson (1935) and Shokita et al. (1985). Two varieties of this species are recognised namely, *typica* and *celebensis* (Bouvier, 1925). Holthius (1978) tentatively treated the two varieties as good species (based mainly on the characteristics of the adults and despite the presence of intermediate forms). However, he emphasized the need for the careful study of the biology of the two forms to help solve this taxonomic problem. The morphological attributes which have been used to separate the two forms vary and overlap greatly for the Fijian specimens; it is therefore not possible to treat them as two varieties.

C. *serratirostris* is often found close to the sea, even in slightly brackish water. It has, however, been also reported from an altitude of 130 m (Costa, 1980). This

species is widely distributed in the Indo-Pacific, being reported from Madagascar, Seychelles, Mauritius, Comores Is., Okinawa, S.E. Asia, N.E. Australia, New Caledonia, Fiji, Tahiti and the Marquesas in French Polynesia.

Caridina typus H. Milne Edwards, 1837

Caridina typus H. Milne Edwards, 1837, vol. 2: 363; vol. 4, pl. 25, figs. 4, 5; De Man, 1892: 367, pl. 21, fig. 22; Coutiere, 1900: 1267; Bouvier, 1904: 134; Bouvier, 1925: 249, figs. 271-297; Edmondson, 1935: 10, fig. 3 g-l; Holthuis, 1965: 10, fig. 3; Kamita, 1967: 3, fig. 3, pl. 1B.; Costa, 1980: 693.
Caridina exilirostris Stimpson, 1860: 98.
Caridina typa Bouvier, 1905: 88; Roux, 1926: 201.
Caridina typus typica Bouvier, 1925: 250, figs. 272-295.

Material.— Ovalau: Stn. 3, 35 m, 26.vii.1980, 18 specimens (4 RMNH, 14 USP); Stn. 5, 40 m, 31.viii. 1980, 12 specimens (USP). Vanua Levu: Stn. 10, 10 m, 3.viii.1980, 4 specimens (2 RMNH, 2 BPBM); Stn. 11, 300 m, 29.x.1980, 20 specimens (9 RMNH, 11 USP); Stn. 12, 12 m, 18.vii.1980, 17 specimens (USP); Viti Levu: Stn. 13, 5 m, 30.x.1980, 10 specimens (6 RMNH, 4 USP); Stn. 23, 30 m, 26.x.1981, 6 specimens (USP); Stn. 26, 35 m, 25.x.1981; 7 specimens (USP); Stn. 28, 160 m, 7.vi.1979, 16 specimens (USP). Taveuni: Stn. 6, 18.ii.1983, 9 specimens (USP). Gau Island: Stn. 1, 17 m altitude ,15.v.1983, 2 specimens (USP). Koro Island: Stn. 2, 15 m, 14.iv.1983, 7 specimens (USP). All collected by S.C. Choy.

Remarks.— Bouvier (1925) distinguished three forms of this species; the Fijian specimens resemble most closely the form *typica*. The species is characterized by the absence of teeth on the upper border of the rostrum; the inferior teeth ranging from zero (in juveniles) to three. This species is found in still pools as well as in cascades (with current velocities of up to 1.2 ms^{-1}). The species, together with *C. weberi*, is often found in association with submerged portions of taro plants (*Colocasia antiquorum* and *C. esculenta)* which are food plants spread by Polynesian migrants in the Pacific. *C. typus* has a wide ranging distribution extending from eastern and southern Africa to Japan, Australia, Fiji and French Polynesia.

Caridina vitiensis Borradaile, 1898

Caradina vitiensis Borradaile, 1898: 1003, figs. 3, 3a, pl. LXIII.
Caridina vitiensis Bouvier, 1925: 160, figs. 336-340.

Material.— Vanua Levu: Stn. 14, 100 m, 19.vii.1983, 5 specimens (1 RMNH, 4 USP); Stn. 15, 30 m, 30.x.1980, 3 specimens (1 RMNH, 2 USP), coll. S. C. Choy & P. A. Ryan.

Remarks.— Although this species is widely distributed in the Indo-Pacific region (recorded from Sri Lanka by Bouvier, 1925 and from New Guinea, the Bismark Archipelago and the Solomon Islands by Edmondson, 1935), the number caught at any one locality is very often rather low. Edmondson (1935) did not collect any from Fiji in 1933. This species is closely related to *C. devaneyi* spec. nov., *C. fijiana*, *C. japonica* and *C. weberi* but it can be separated from each on the basis of the characteristics given in table 3.

Caridina weberi De Man, 1892

Caridina Weberi De Man, 1892: 371, pl. 21., fig, 23; Bouvier, 1925: 242, figs. 562-571; Edmondson, 1935: 8, fig. 3a-f.
Caridina weberi var. *longicarpus* Roux, 1926: 212, figs. 37-39.

Material.— Ovalau: Stn. 3, 35 m, 26.vii.1980, 12 specimens (6 RMNH, 6 USP); Stn. 4, 30 m altitude, 30.viii.1980, 5 specimens (2 RMNH, 3 USP). Viti Levu: Stn. 22, 220 m, 19.vi.1980, 14 specimens (4 RMNH, 10 USP). Vanua Levu: Stn. 14, 100 m altitude, 16.vii.1980 and 19.vii.1983, 58 specimens (27 RMNH, 31 USP), coll. S. C. Choy; 10 specimens (BPBM nr. S3944 & S5694).

Remarks.— This species has been reported from Fiji by Edmondson (1935). Although Edmondson's (1935) figures of *C. weberi* do not match those of my material, examination of his specimens from Fiji (BPBM Cat. Nos. S3944 and S5694) indicates the presence of various forms (*sensu* Bouvier, 1925). However, the diagnostic characters of these forms are variable and overlap considerably and so I have included them in the same taxon. On this basis, *C. weberi* var. *longicarpus* (Roux, 1926) is of dubious status. Holthuis (pers. comm.) has suggested that *C. w. weberi* and *C. w. sumatrensis* may be good species and that *C. vitiensis canacorum* (Roux, 1926) may also belong to *C. weberi*. All these varieties need critical examination. *C. weberi* can be distinguished from the other closely related species (*C. japonicus* and *C. vitiensis*) on the basis of the characters given in table 3.

Discussion

A total of fourteen species of atyids are now known from Fiji. The present survey resulted in four new records and the discovery of two new species, *Caridina fijiana* and *C. nudirostris* (Choy, 1983; 1984). Future surveys, particularly of western Viti Levu and adjacent islands as well as of the islands of the Lau Group and Kadavu, will no doubt result in more new records or species.

Species now known from Fiji and having a wide distribution in the Indo-Pacific region include *Antecaridina lauensis, Atyoida pilipes, Atyopsis spinipes, Caridina japonica, C. longirostris, C. nilotica, C. serratirostris, C. vitiensis, C. typus* and *C. weberi*. Of these, *C. typus* seems to be the most widely distributed within Fiji; it was found on all of the six islands surveyed. *Atyoida pilipes* was collected from five of the six islands while *Atyopsis spinipes, Caridina longirostris, C. nilotica* and *C. weberi* were collected from three. *C. serratirostris* and *C. vitiensis* were found on two of the islands while *Antecaridina lauensis, C. brevidactyla, C. fijiana, C. japonicus* and *C. nudirostris* were found on only one of the six islands surveyed. Of those species found on only one island, all except *A. lauensis* and *C. japonica* occurred on Viti Levu, the largest and oldest of the islands in the Fiji Group. The largest number of species (twelve) was also found on Viti Levu. All the species found only here have large eggs, suggesting direct or abbreviated larval development. This can explain their restricted distribution. The absence of *A. lauensis* from this island can be explained by the fact that *A. lauensis* is an anchialine species and no such habitat is found on Viti Levu. However, it is known from Vatulele, a small island just a few kilometres offshore.

C. japonica was found only on Vanua Levu, the second largest and second oldest

island. This island also had the second largest number of species (ten). The least number of species were found on: (i) smaller and (ii) geologically younger (e.g. Taveuni) or more isolated (e.g. Koro and Gau) islands. However, it could also reflect the lower sampling intensities in these areas.

In general, the number of species found on any island within Fiji seem to be a result of one or more of the following factors: the age of the island, its size, its proximity to another island that has a greater number of species, habitat availability and the biology of the species in question.

C. brevicarpalis seems to have only S. E. Asian and western Pacific distribution. *Caridina devaneyi* spec. nov., *C. fijiana* and *C. nudirostris* are endemic to Fiji and perhaps to Viti Levu only.

Edmondson's (1935) subspecies and varieties of *C. nilotica* (i.e. *C. n. wyckii*, *C. n. brachydactyla* and *C. n. b.* var. *penisularis*) are all of dubious status. Most of his specimens that were re-examined (Cat. Nos. BPBM S3904, S3941, S3447) belonged to either *C. nilotica* senso stricto or *C. longirostris*. De Silva (1983) citing Bouvier (1904, 1925) and Johnson (1963) reported the presence of *C. simoni* Bouvier, 1904 in Fiji. Its presence is very doubtful. Borradaile's (1898) *C. wyckii* (Hickson, 1888) from Tamavua River, Viti Levu, Fiji was relegated to the *C. nilotica* complex by De Man (1908).

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Table 1. List of sampling stations and the species of atyid shrimps collected at each of these stations.

Station no.	Locality/Grid reference	Altitude (m)	Date of collection	Species collected
	Gau Island (18°01'S 179°16'E)			
1	Naivilali Creek (near Nawaikama Village)	17	15.iv.1983	*Caridina typus, Atyoida pilipes*
	Koro Island (17°04'S 179°18'E)			
2	Waitabu Creek	15	14.iv.1983	*Caridina typus*
	Ovalau Island (17°39'S 178°40'E)			
3	Bureta River and tributaries	0-35	26.vii.1980	*Atyoida pilipes, Ayopsis spinipes, Caridina longirostris, C. nilotica,C. typus,C. weberi*
4	Waitovu Creek	30	30.viii.1980	*A. pilipes, A. spinipes, C. weberi*
5	Waganivuakau Creek	10-40	31.viii.1980	*Caridina typus*
	Taveuni Island (16°58'S 179°56'E)			
6	Creek near Lake Tagimaucia	800	18.ii.1983	*C. typus*
7	Creek near Somosomo Village	5-10	19.viii.1983	*A. pilipes*
	Vanua Levu (16°37'S 179°10'E)			
8	Kuludrusi Creek	80	16.vii.1980	*A. spinipes, C. nilotica*
9	Naweni anchialine ponds	0	19.vii.1983	*Antecaridina lauensis*
10	Qelemumu Creek, Cogeloa	0-10	3.viii.1980	*C. longirostris, C. serratirostris, C. typus*
11	Saivou Creek	250-350	29.x.1980	*C. japonica, C. longirostris, C. typus*
12	Seaqaqa Creek	30	18.vii.1980	*C. longirostris, C. typus*
13	Tacilevu Creek	3-7	29-30.x.1980	*C. longirostris, C. serratirostris, C. typus*
14	Tributary of Bagasau Creek	100	30.x.1980	*A. pilipes, A. spinipes, C. japonica, C. longirostris, C. nilotica, C. weberi, C. vitiensis*
15	Waqativikei Creek	30	30.x.1980	*A. spinipes, C. nilotica*
	Viti Levu (17°38'S 177°59'E)			
16	Nabukavesi Creek	10	25.xi.1980	*C. longirostris*
17	Nadala Creek, Nadarivatu	690	2-3.vi.1980	*A. pilipes, A. spinipes, C. fijiana*
18	Nanuku Creek, Nadrau Plateau above Monasavu Falls	700	2.vi.1980	*A. spinipes, C. nudirostris*
19	Naqali Creek, Serea	40	5.viii.1980	*C. longirostris, C. nilotica*
20	Nukunuku Creek, Nadarivatu	640	3.vii.1980	*A. pilipes, A. spini-*

				pes, C. fijiana
21	Rewa River, Sawani	2-5	26.xi.1980	*C. longirostris*
22	Stream near Mt. Korobaba	110	19.vi.1980	*C. weberi*
23	Vaqo Creek, Wailoku	20-50	6.vi.1980	*A. pilipes, A. spinipes, C. nilotica, C. typus*
24	Vunidawa River, Naitasiri	15-30	1933 (Edmondson)	*C. serratirostris C. vitiensis*
25	Wailoa Creek, Nadrau	160	7.vii.1980	*A. spinipes*
26	Waimanu River, Sawani	35	8.vi.1980	*C. nilotica, C. typus*
27	Wainikubukubu Creek	155	17.vii.1979	*A. pilipes, A. spinipes*
28	Wainisavulevu Creek, below Monasavu Falls	160	7.vi.1979	*A. pilipes, A. spinipes, C. typus, C. nudirostris*
29	Wainivodi Creek	150	17.vii.1979	*A. spinipes*

Table 2. Length (L) and width (W) in mm, of pereiopod segments of primary type specimens of *Caridina devaneyi*. P1 - P5, pereiopods 1 - 5.

	Dactylus		Propodus		Hand	
	L	W	L	W	L	W
P1	0.45-0.50	0.21-0.23	0.60-0.80	0.55-0.65	1.10-1.25	0.55-0.65
P2	0.65-0.75	0.13-0.20	0.50-0.71	0.50-0.62	1.31-1.39	0.46-0.59
P3	0.27-0.35	0.09-0.12	1.41-1.80	0.10-0.13	-	-
P5	0.48-0.52	0.10-0.13	1.80-2.25	0.12-0.15	-	-

	Carpus		Merus		Ischium	
	L	W	L	W	L	W
P1	0.60-0.70	0.46-0.49	0.68-0.80	0.30-0.35	0.30-0.52	0.26-0.32
P2	1.35-1.45	0.32-0.41	1.20-1.30	0.25-0.35	0.75-0.85	0.21-0.29
P3	0.90-1.00	0.15-0.18	1.20-1.80	0.22-0.28	0.43-0.55	0.21-0.26
P5	0.90-1.15	0.18-0.21	1.45-1.65	0.18-0.20	0.50-0.60	0.17-0.23

Table 3. Morphometric and meristic characteristics of *Caridina* species; n = 10 for each species. Abbreviations: am/ai, ratio of appendix masculina and appendix interna lengths on the second pleopod of adult males; c, post-orbital carapace length; r, rostrum length; 6s, dorsal length of sixth abdominal segment; C1, carpus of first pereiopod; C2, carpus of second pereiopod; C3, carpus of third pereiopod; C5, carpus of fifth pereiopod; D5, dactylus of fifth pereiopod; M3, merus of third pereiopod; P5, propodus of fifth pereiopod; L, length; W, width; Z, shape of the distal end of the endopod on the first pleopod of males.

	Caridina japonica		*Caridina weberi*		*Caridina vitiensis*		*Caridina devaneyi*	
	range	$\bar{x} \pm$ s.e.	range	$\bar{x} \pm$ s.e.	range	$\bar{x} \pm$ s.e.	range	$\bar{x} \pm$ s.e.
6s/c	0.45-0.63	0.51±0.03	0.39-0.66	0.49±0.05	0.67-0.71	0.69±0.02	0.60-0.93	0.74±0.04
C1L/C1W	1.69-2.10	1.88±0.08	1.55-1.93	1.79±0.08	2.00-2.53	2.27±0.08	1.30-1.45	1.37±0.04
C2L/C2W	4.04-5.45	4.89±0.21	4.86-5.60	5.13±0.13	4.65-4.71	4.67±0.02	4.02-4.79	4.52±0.03
M3L/C3L	1.78-2.05	1.91±0.05	1.19-1.88	1.54±0.10	1.79-2.03	1.91±0.06	1.90-2.05	2.01±0.05
r/c	0.33-0.67	0.48±0.03	0.32-0.66	0.52±0.03	0.86-1.04	0.94±0.03	0.67-1.03	0.82±0.05
Spinules on Diaresis	18-23	20±1	17-21	18±1	9-12	10±2	12-14	13±1
Rostral teeth	0-1)12-22/4-12		0-3)11-25/2-7		1-3)19-26/0-9		1-4)10-19/6-7	
Post rostral carina	not to tip of rostrum		to tip of rostrum		to tip of rostrum		may or may not reach tip of rostrum	
D5 spines	40-55		46-69		26-35		40-50	
P5 spines	15-18		11-12		13-15		10-11	
C5 spines	4-6		3-6		0-2		3-4	
am/ai	> 2		approx. 2		approx. 2		approx. 2	
Egg diameter (in mm)	0.24±0.02 × 0.42±0.03		0.26±0.03 × 0.44±0.03		0.27±0.02 × 0.46±0.04		0.6-0.8 × 1.0-1.2	

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