

A new species of *Carinosquilla* (Crustacea, Stomatopoda, Squillidae) from the Seychelles with a cladistic analysis of the genus

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ABSTRACT

A new species of *Carinosquilla* Manning, 1968, *C. mclaughlinae* n. sp., is described from the Seychelles. It is readily distinguished from its congeners by the spinulose dorsal surface of the sixth abdominal somite, and telson. *Carinosquilla mclaughlinae* n. sp. is the tenth known species of the genus. Phylogenetic relationships within *Carinosquilla* are investigated by cladistic analysis. Results support monophyly of the genus, and the synonymy of *Keijia* Manning, 1995 with *Carinosquilla*.

RÉSUMÉ

Une nouvelle espèce de *Carinosquilla* (Crustacea, Stomatopoda, Squillidae) des Seychelles et une analyse cladistique du genre.

Une nouvelle espèce de *Carinosquilla* Manning, 1968, *C. mclaughlinae* n. sp., est décrite des Seychelles. Elle se distingue immédiatement des autres espèces du genre par la surface dorsale spinuleuse du sixième segment abdominal et du telson. *Carinosquilla mclaughlinae* n. sp. est la dixième espèce connue du genre. Les relations phylogénétiques dans le genre *Carinosquilla* sont recherchées par analyse cladistique. Les résultats obtenus appuient la monophylie du genre ainsi que la mise en synonymie de *Keijia* Manning, 1995 avec *Carinosquilla*.

KEY WORDS

Crustacea,
Stomatopoda,
Squillidae,
Carinosquilla,
Indian Ocean,
new species.

MOTS CLÉS

Crustacea,
Stomatopoda,
Squillidae,
Carinosquilla,
océan Indien,
espèce nouvelle.

INTRODUCTION

Species of the stomatopod crustacean genus *Carinosquilla* Manning, 1968 are distinctive for the possession of numerous longitudinal carinae covering the entire surface of the body. Until 1983, only three species of *Carinosquilla* were recognised: the type species, *Squilla multicaudata* (White, 1848) (type locality: Philippines), *C. carinata* (Serène, 1954) (type locality: Vietnam), and *C. lirata* (Kemp & Chopra, 1921) (type locality: Singapore). Naiyanetr (1983) added a fourth species, *C. thailandensis*, from the Gulf of Thailand. Moosa (1991) synonymised *C. thailandensis* with *C. carinata* based on apparent morphological overlap between specimens from New Caledonia, the Seychelles and Madagascar identified with *C. carinata* by Manning (1968) and Moosa & Cleva (1984). Manning (1995) subsequently placed *C. lirata* in a new genus *Keijia*, and therefore restricted *Carinosquilla* to *C. carinata* and *C. multicaudata*. Naiyanetr *et al.* (2000) showed that *C. thailandensis* is distinct from *C. carinata*. Ahyong (2001), in a revision of the Australian stomatopod fauna, described three new species of *Carinosquilla* (*C. redacta*, *C. australiensis*, and *C. carita*) and synonymised *Keijia* with *Carinosquilla*. Ahyong & Naiyanetr (2002) subsequently showed that most Indian Ocean records of *C. carinata* are referable to a new species, *C. spinosa*, bringing the number of recognised species of *Carinosquilla* to eight. A ninth species of *Carinosquilla*, *C. balicasag*, was described by Ahyong (2004) from the Philippines. In 2002 and 2004, all specimens of *Carinosquilla* in the Muséum national d'Histoire naturelle, Paris (MNHN) studied by Manning (1968), Moosa & Cleva (1984) and Moosa (1991) from New Caledonia and the western Indian Ocean were reexamined. As suspected by Ahyong (2001), the specimens from New Caledonia reported by Moosa (1991) as *C. carinata* comprised two species, *C. australiensis* and *C. redacta*. The Western Indian Ocean specimens also comprised two species: *C. spinosa*, and an undescribed species resembling *C. thailandensis* and *C. australiensis*. The new *Carinosquilla* is described below, and relationships within the genus are investigated by cladistic analysis.

MATERIALS AND METHODS

Morphological terminology and size descriptors follow Ahyong (2001). Abbreviations used: abdominal somite (AS), thoracic somite (TS). Carapace length (CL) and total length (TL) are measured along the dorsal midline and are given in mm. Corneal Index (CI) is given as 100 times carapace length divided by cornea width.

Type material is deposited in the collections of the MNHN.

Relationships between the nine species of *Carinosquilla* were analysed via cladistic analysis of 28 characters (Appendix 1) and rooted to *Quollastria gonyptetes* (Kemp, 1911). *Lophosquilla costata* (de Haan, 1844) was included in the ingroup because of its close relationship to species of *Carinosquilla* (see Ahyong 2005) and to test the monophyly of the genus. Specimens examined are deposited in the collections of Australian Museum and MNHN. The data matrix (Appendix 2) was constructed in MacClade 4.0 (Maddison & Maddison 2000) and analysed in PAUP 4.0 (Swofford 2002) (50 heuristic searches, random input order, all characters unordered). Topological robustness was assessed via jackknifing using 1000 pseudoreplicates with 33% character deletion, implemented in PAUP 4.0.

SYSTEMATICS

Family SQUILLIDAE Latreille, 1802

Genus *Carinosquilla* Manning, 1968

Carinosquilla mclaughlinae n. sp.

(Figs 1; 2)

Carinosquilla carinata – Moosa & Cleva 1984: 427, 428 [part]. — Moosa 1991: 194–196 [part]. *Non* Serène 1954.

TYPE MATERIAL. — **Seychelles**. Holotype: REVES 2, stn 36, 4°40.7'S, 55°03.0'E, 62–55 m, sand, trawl, 10.IX.1980, ♂ TL 71 mm (MNHN-Sto 896).

Paratypes: REVES 2, stn 22, 5°16.3'S, 55°58.2'E, 60 m, sand and shell, dredge, 6.IX.1980, 1 ♀ TL 77 mm (MNHN-Sto 894). — REVES 2, stn 42, 4°31.6'S, 56°09.7'E, 55–60 m, sand and shell, trawl, 13.IX.1980, 1 ♀ TL 83 mm (MNHN-Sto 897).

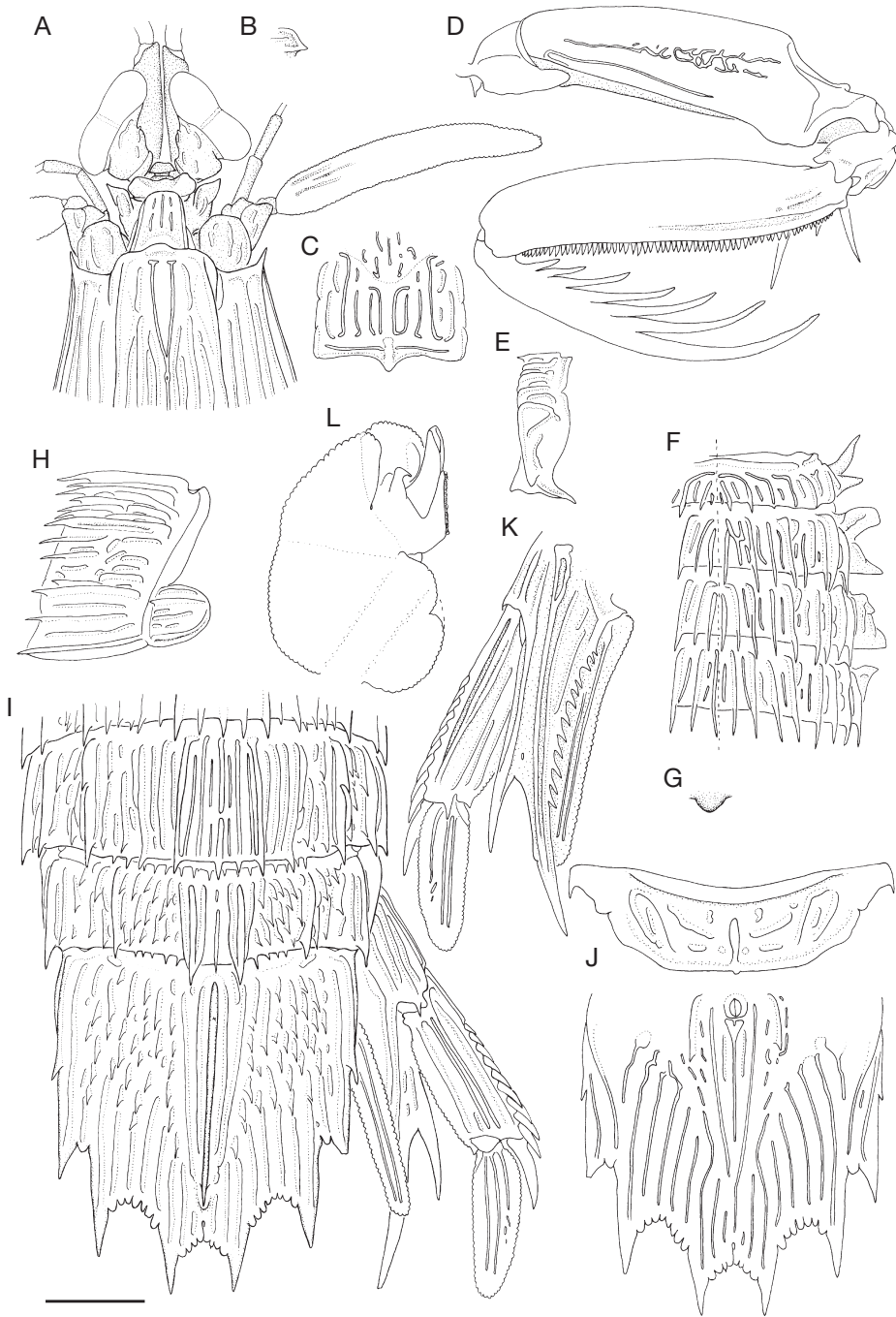


FIG. 1. — *Carinosquilla mclaughlinae* n. sp., ♂ holotype (TL 71 mm) (MNHN-Sto 896), Seychelles: **A**, anterior; **B**, dorsal process of antennular somite, right lateral view; **C**, posteromedian portion of carapace; **D**, right raptorial claw; **E**, TS5, right lateral view; **F**, TS5-8, right dorsal view; **G**, TS sternal keel, right lateral view; **H**, AS1, right lateral view; **I**, posterior abdomen, telson and uropod; **J**, AS6 and telson, ventral view; **K**, right uropod, ventral; **L**, pleopod 1 endopod, left anterior view. Abbreviations: **AS**, abdominal somite; **TS**, thoracic somite. Scale bar: A-K, 4 mm; L, 2 mm.

ETYMOLOGY. — This species is named in honour of Pat McLaughlin for her longstanding contributions to carcinology.

DISTRIBUTION. — Known only from the Seychelles at depths of 55-62 m.

MEASUREMENTS. — Male ($n = 1$) TL 71 mm, female ($n = 2$) TL 77-83 mm. Other measurements of holotype: CL 15.61 mm, anterior carapace width 7.48 mm, cornea width 4.10 mm, antennular peduncle length 16.48 mm, antennal scale length 11.10 mm.

DIAGNOSIS. — Eystalk with irregular dorsal carinae. Ocular scales with apices entire. Raptorial claw merus with vermiform sculpture on outer margin; dactylus with six or seven teeth. Dorsolateral carinae of AS6 and telson divided, forming field of spines.

DESCRIPTION

Eystalk with short, irregular dorsal carinae; CI 380-409. Ocular scales entire, apices truncate, not bifurcate.

Antennular peduncle 1.02-1.06 CL. Antennular somite dorsal processes with acute, triangular apices; directed anterolaterally. Antennal scale length 0.65-0.72 CL.

Rostral plate trapezoid, about as long as broad; apex truncate to rounded; lateral margins carinate; with long, distinct, median carina flanked by longitudinal supplementary carina (interrupted distally in male specimen).

Carapace anterior width 0.47-0.50 CL; anterior bifurcation of median carina opening anterior to dorsal pit; dorsum covered with numerous closely spaced longitudinal carinae; anterolateral spines reaching anteriorly approximately to level of base of rostral plate.

Raptorial claw dactylus with six or seven teeth; outer surface of propodus with short oblique carina and longitudinal carina subparallel to occlusal margin; carpus with undivided dorsal carina; outer surface of merus with vermiform sculpture.

Mandibular palp 3-segmented. Maxillipeds 1-4 each with epipod.

TS5 lateral process bilobed; anterior lobe a slender spine directed anterolaterally; posterior lobe short, slender, directed laterally. TS6 lateral process bilobed; anterior lobe broad, quadrate, apex truncate; posterior lobe broad, triangular. TS7 lateral

process bilobed; anterior lobe triangular, blunt; posterior lobe larger than anterior lobe, broad, triangular, anterior margin convex, apex blunt. TS8 with sharp, triangular, lateral process; sternal keel rounded.

TS5 dorsal carinae longitudinal or oblique, none transverse; supplementary carinae between submedian carinae posteriorly spined. TS6-8 and AS1-5 with most or all supplementary dorsal carinae posteriorly armed above level of lateral carinae. AS1-5 with one to three (usually two) supplementary carinae armed between lateral and marginal carinae. Surface of AS1-5 between intermediate and lateral carinae with some shorter carinae also spined. Articular membrane between AS5 and 6 lined with small spines. AS5 with three or four spinules on posterior margin between submedian and lateral carinae. AS6 submedian carina tricarinate, usually with median spine on posterior margin between submedian spines; with three to six spinules on posterior margin lateral to submedian spines; with short dorsal carinae usually posteriorly spined; sternum with anterior and posterior transverse carina, median carina flanked by four or five sinuous transverse carinae, some uniting laterally; with small ventrolateral spine anterior to uropodal articulation. Abdominal somites with normal complement of carinae spined as follows: submedian 1-6, intermediate 1-6, lateral 1-6, marginal 1-5.

Telson about as long as broad; prelateral lobe longer than margin of lateral tooth, terminating in sharp spine; dorsolateral surface with numerous supplementary longitudinal carinae; proximal supplementary carinae subdivided and posteriorly spined forming field of spines; denticles submedian 4, intermediate 7 or 8, lateral 1; ventral surface with long postanal carina, numerous long supplementary carinae and several short carina and tubercles proximomedially.

Uropodal protopod with smooth outer margin; inner margin with 10-13 slender spines; with short ventral tubercle anterior to endopod articulation; protopod terminal spines with lobe on outer margin of inner spine rounded, narrower than adjacent spine, proximal margin slightly concave. Exopod proximal segment outer margin with 10 or 11 movable spines, distalmost not exceeding mid-length

of distal segment; distal margin 2 ventral spines, outer longest. Exopod distal segment slightly longer than proximal segment; unpigmented; dorsally and ventrally carinate. Endopod dorsally and ventrally carinate.

Colour in alcohol

Faded to pale brown. Carinae of carapace dark brown. Posterior margins of thoracic and abdominal somites dark brown. AS2 with dark transverse bar across submedian carinae. AS5 with diffuse pigmentation dorsally between intermediate carinae, and with large black patch below intermediate carinae. Telson with apices of primary teeth and apex of median carina dark brown. Uropodal protopod dark at articulation with exopod; distal half of endopod dark; exopod unpigmented except on articular membrane separating distal and proximal segments.

REMARKS

Carinosquilla mclaughlinae n. sp. is unique in the genus in having the supplementary carinae of AS6 and proximomedial supplementary carinae of the telson broken into short posteriorly spined carinae forming a field of spines. In bearing carinate ocular peduncles and entire, non-bifurcate ocular scales, *Carinosquilla mclaughlinae* n. sp. resembles *C. thailandensis*, *C. australiensis* and *C. balicasag*. *Carinosquilla mclaughlinae* n. sp. further resembles *C. thailandensis* in the vermiform sculpture on the outer surface of the merus of the raptorial claw, but differs by having six or seven instead of five teeth on the dactylus of the claw, and in having the posterior spines of the supplementary abdominal carinae that continue below the level of the intermediate carinae. In having six or seven teeth

on the dactylus of the raptorial claw and spined supplementary carinae between the abdominal intermediate and lateral carinae, *C. mclaughlinae* n. sp. resembles *C. australiensis* and *C. balicasag*. *Carinosquilla mclaughlinae* n. sp., however, differs from *C. australiensis* and *C. balicasag* in having vermiform sculpture on the outer surface of the merus of the claw, and in having armed supplementary abdominal carinae not only between the intermediate and lateral carinae, but also between the lateral and marginal carinae. It further differs from both *C. australiensis*, *C. balicasag* and *C. thailandensis* in having many of the supplementary carinae on the lateral surfaces of the abdomen broken into several short posteriorly spined carinae, in having the prelateral lobe of the telson terminating in a sharp spine, in having a carinate outer margin of the propodus of the claw, and in colour pattern. In *C. mclaughlinae* n. sp., a black patch is present laterally on AS5 (absent in *C. australiensis* and *C. thailandensis*) and the segments of the uropodal exopod appear to be unpigmented (entirely or partially dark in other species).

The three specimens of the type series are morphologically uniform but vary in the following features: 1) the male bears seven teeth on the dactylus of the raptorial claw, whereas the two females bear six dactylar teeth; and 2) the carina lateral to the median carina of the rostral plate is interrupted distally in the male, whereas the carina is entire in the two females. These differences are likely to represent individual variation instead of sexual dimorphism. Variation in the number of dactylar teeth on the raptorial claw is present also in *C. reducta*, and similar variation in the development of the rostral plate carinae is occasionally evident in all species of *Carinosquilla*.

KEY TO SPECIES OF *CARINOSQUILLA* MANNING, 1968

1. Eyestalk with irregular dorsal carinae 4
- Eyestalk without dorsal carinae 2
2. Dorsal carinae on either side of midline of TS5 transverse. Inner margin of uropodal protopod spinose 3
- Dorsal carinae on either side of midline of TS5 longitudinal or oblique, not transverse. Inner margin of uropodal protopod crenulate *C. lirata*

3. Mandibular palp present. Telson prelateral lobe with sharp apex *C. multicarinata*
— Mandibular palp absent. Telson prelateral lobe with blunt apex *C. carita*
4. Ocular scales with bifurcate apices 5
— Ocular scales with apices entire, not bifurcate 7
5. Posterior margin of AS1-4 between submedian carinae lined with spines *C. spinosa*
— Posterior margin of AS1-4 between submedian carinae unarmed 6
6. AS1-2 with unarmed submedian and intermediate carinae *C. redacta*
— AS1-2 with armed submedian and intermediate carinae *C. carinata*
7. Merus of raptorial claw with single longitudinal carina on outer margin 8
— Merus of raptorial claw with vermiform sculpture on outer margin 9
8. AS6 without posteriorly armed supplementary carinae between submedian and intermediate carinae. Distal segment of uropodal exopod entirely dark *C. australiensis*
— AS6 with one or two posteriorly armed supplementary carinae between submedian and intermediate carinae. Uropodal exopod distal segment dark on proximal third
..... *C. balicasag*
9. Dactylus of raptorial claw with five teeth. Dorsal carinae of AS6 and telson entire, not forming field of spines *C. thailandensis*
— Dactylus of raptorial claw with six or seven teeth. Dorsolateral carinae of AS6 and telson divided, forming field of spines *C. mclaughlinae* n. sp.

RELATIONSHIPS IN *CARINOSQUILLA*

Analysis of the dataset resulted in five most parsimonious trees (length 50, consistency index 0.73, retention index 0.83). The strict consensus is shown in Figure 2. Jackknife proportions indicate a robust topology. Monophyly of *Carinosquilla* is strongly supported with a 100% jackknife proportion.

Carinosquilla falls broadly into four groups. The first group comprises *C. carita* and *C. multicarinata*, and is the sister to all other species of the genus. It is united by the presence of transverse carinae on TS5 and long, straight, carinae flanking the posterior bifurcation of the carapace that reach the posterior margin of the carapace.

The second group includes *C. lirata*, differing from other species of *Carinosquilla* in having a crenulate instead of spinose inner margin on the uropodal protopod. Manning (1995) placed *C. lirata* in a monotypic genus *Keijia*, chiefly on the basis of the suppression of the mandibular palp in contrast to the species of *Carinosquilla* known at the time. The position of *C. lirata*, nested within other species of

the genus, corroborates Ahyong's (2001) synonymy of *Keijia* with *Carinosquilla*.

The third and fourth groups are united by having carinate eyestalks, numerous supplementary carinae on the sternum of AS6 and tricarinate submedian carinae on AS6.

The third group comprising *C. carinata*, *C. spinosa* and *C. redacta* is united principally by the possession of bifurcate ocular scales.

The fourth group comprises *C. australiensis*, *C. balicasag*, *C. mclaughlinae* n. sp. and *C. thailandensis* and is united by the presence of carinae on the proximal portion of the antennal scales and tricarinate submedian carinae on AS5.

The geographical ranges of many species overlap, but within the aforementioned groups, species have discrete or near discrete ranges. In group 1, *C. multicarinata* ranges from Japan to the Southern India, whereas *C. carita* has an adjacent but discrete range along the coast of northern Australia (Ahyong 2001). The single species of group 2 ranges from the South China Sea to Madras, India (Shanbogue 1986). In group 3, *C. redacta* is known only from northern Aus-

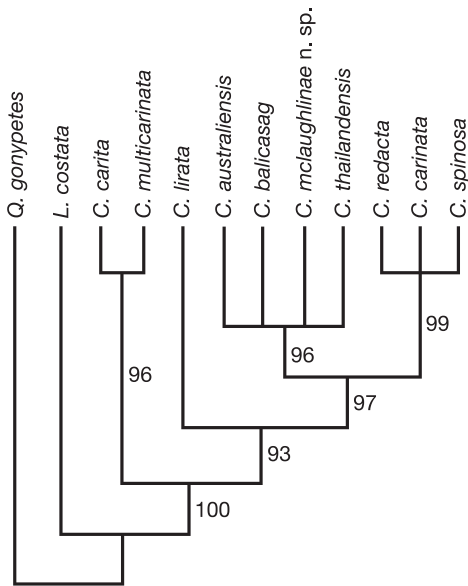


FIG. 2. — Phylogeny of *Carinosquilla* Manning, 1968, strict consensus of five most parsimonious topologies (length 50, consistency index 0.73, retention index 0.83). Jackknife proportions indicated on branches. Characters are listed in Appendix 1; data matrix is presented in Appendix 2. Abbreviations: *L.*, *Lophosquilla*; *Q.*, *Quollastria*.

tralia, *C. carinata* occurs in the South China Sea from Vietnam to the Gulf of Thailand, south to Indonesia, and *C. spinosa* ranges from the western Indian Ocean to the Andaman Sea. In group 4, *C. mclaughlinae* n. sp. is known only from the western Indian Ocean, *C. balicasag* is known only from Balicasag Island (Philippines) and *C. thailandensis* ranges from the Gulf of Thailand to northern Australia, where it overlaps with *C. australiensis* (see Ah Yong 2001).

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APPENDIX 1

Morphological characters used for cladistic analysis of *Carinosquilla* Manning, 1968.

1. Ocular peduncles: smooth (0); with short dorsal carinae (1).
2. Ocular scales: entire (0); divided (1).
3. Dorsal processes of antennular somite: non-carinate (0); carinate (1).
4. Distal portion of antennal protopod: non-carinate (0); carinate (1).
5. Carapace carinae density: few, widely spaced (0); numerous, closely spaced (1).
6. Anterior bifurcation length: normal, distant from dorsal pit (0); long, base close to dorsal pit (1).
7. Anterior bifurcation: interrupted basally (0); uninterrupted basally (1).
8. Surface flanking posterior bifurcation of carapace: smooth (0); with straight carina, reaching posterior margin (1); with inward curving carina (2); tuberculate (3).
9. Carapace posteromedian projection: angular, pointed (0); stubby, blunt (1).
10. Raptorial claw dactylar teeth: five (0); six or seven (1).
11. Mandibular palp: present (0); absent (1).
12. Raptorial claw merus lateral: smooth (0); carina (1); sculpture (2).
13. AS1-5 posterior margin between submedian and intermediate carinae: at most with short teeth (0); long spines (1).
14. Posterior margin of AS1-4 below intermediate carinae: unarmed (0); spinous (1).
15. TS5 dorsolateral carinae: longitudinal (0); transverse (1).
16. AS6 sternal carinae: normal (0); few (1); numerous (2).
17. Antennal scale proximal surface: smooth (0); carinate (1).
18. Dorsal abdominal carinae: absent (0); few (1); numerous (2).
19. AS5 submedian carinae: single (0); tricarinate (1).
20. AS6 submedian carina: unicarinate (0); tricarinate (1).
21. AS6 surface between submedian and intermediate carinae: smooth (0); with numerous short carinae (1); long carinae (2).
22. Mid-dorsal telson carinae: short and broken (0); entire (1); spinose (2).
23. Telson lateral denticles: one (0); two (1).
24. Uropodal protopod inner margin: crenulate (0); spinose (1).
25. Uropodal protopod ventral carina of inner terminal spine: unicarinate (0); bifurcate (1).
26. Uropodal endopod dorsal surface: smooth (0); with two carinae (1); with four carinae (2).
27. Uropodal endopod ventral surface: smooth (0); with two carinae (1); with four carinae (2).
28. Multiple short carinae on uropodal exopod distal segment: absent (0); present (1).

APPENDIX 2

Data matrix used for cladistic analysis of *Carinosquilla* Manning, 1968. For characters descriptions see Appendix 1. Abbreviations: *L.*, *Lophosquilla*; *Q.*, *Quollastria*.

	1	2	2
	1	0	8
<i>C. carinata</i>	1111101201010002020110111111		
<i>C. redacta</i>	1111101201010002020110111111		
<i>C. spinosa</i>	1111101201010002020110111111		
<i>C. lirata</i>	0010111301110001020010001110		
<i>C. australiensis</i>	1010111200011102121121011111		
<i>C. balicasag</i>	1011111200011102121121011111		
<i>C. mclaughlinae</i> n. sp.	1011111211021102121112011110		
<i>C. thailandensis</i>	1011111210021002121121011221		
<i>C. carita</i>	0000111100111011020021010000		
<i>C. multicarinata</i>	0000111100011011020021010000		
<i>L. costata</i>	0000000300100000010010000000		
<i>Q. gonypetes</i>	0000000000000000000000000000		