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New and poorly known Indo-Pacific species of *Pseudodiaptomus* (Copepoda:Calanoida), with a key to the species groups

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Abstract. Five new species of *Pseudodiaptomus* are described: *P. philippinensis* [Republic of the Philippines, (R.P.)], *P. trispinosus* (R.P.), *P. caritus* (R.P.), *P. diadelus* (R.P., Palau), and *P. pacificus* (Palau, Tonga, China and Australia). Redescriptions of seven species *P. galleti*, *P. clevei*, *P. ornatus*, *P. burckhardti*, *P. dauglishi*, *P. smithi*, and *P. annandalei* from Indonesia, Palau and the Philippines are also included. The genus is herein revised, seven species groups established, and a key for the species groups presented.

Introduction

The family Pseudodiaptomidae was established by Sars (1902), and comprised two genera *Pseudodiaptomus* Herrick, 1884 and *Calanipeda* Kritchagin, 1873 (=*Poppella* Richard, 1888). Apparently unaware of the genus *Pseudodiaptomus*, Poppe and Richard (1890) established a new genus *Schmackeria* from China, and noted its affinities to *Calanipeda*. Another genus *Mazellina* Rose, 1957a was reported by Walter (1984) to be a junior synonym of *Pseudodiaptomus*. Recently, the family was further expanded by Madhupratap and Haridas (1978) with the establishment of *Archidiaptomus* which possesses characteristics of both diaptomids and pseudodiaptomids.

Attempts to divide species of *Pseudodiaptomus* into distinct assemblages are present in the literature. Sewell (1924) proposed a division of the genus into two groups based upon the relative lengths of terminal spines (these spines are: Re2 spiniform process and Re3) of the female P5. This division did little to distinguish species, as the P5 of females are more uniform in structure than the P5 of males. In his review of the literature on the genus *Pseudodiaptomus*, Marsh (1933) removed nine Indo-Pacific species (without examining any of the specimens) and placed them in the genus *Schmackeria* based on: rounded Pdg5 corners on female Pr and presence in males of a long curved medial projection on B2 of the left P5. Most of the species transferred by March occur typically in freshwater habitats, although they are not restricted to them. The status of *Schmackeria* as a separate genus is still undecided as species that possess the above and other characteristics may in fact represent a separate genus. However, at present, many authors, including this one, consider *Schmackeria* a synonym of *Pseudodiaptomus* and consider Marsh's *Schmackeria* species as members of the former (Giesbrecht and Schmeil, 1898; Kikuchi, 1928; Burckhardt, 1913; Wright, 1928; Pillai, 1980; Walter, 1984). A new subgenus was established by Johnson (1939) to accommodate the species *P. (Pseudodiaptallous) euryhalinus*, in which the female has only two urosomal segments instead of the typical three to four.

Recent attempts to divide the genus led Pillai (1980) and Grindley (1984) to distinguish specific groups of species based primarily on male P5 morphology. Pillai's division

was incomplete as it was restricted to only those species found along the coasts of the Indian Ocean. Grindley's scheme, based on the arrangement of the endopods of the male P5 and geographical location, divided all the known species into five generic groups and six subgroups. The proposed division of *Pseudodiaptomus* included herein was devised after examination of 50 species representing all the species groups. These groups were created based on male and female P5, non-sex related characteristics, geographic considerations and 15 new species not known to previous authors.

At present, the revised genus *Pseudodiaptomus* consists of 72 species, including the five new species described herein and five new species to be described in a subsequent paper; 49 of these species are from the Indo-Pacific region (Table I). These demersal species live in shallow estuarine or coastal marine waters and have been reported to remain in, on or near the bottom during the day (Jacobs, 1961; Gonzalez and Bowman, 1965; Grindley, 1972; Bowman, 1978a; Jacoby and Youngbluth, 1983; Walter, 1984) and migrate into the water column at dusk.

This paper is the second in a series describing demersal calanoid copepods from the Indo-Pacific. Most species of *Pseudodiaptomus* reported herein, were obtained from studies on demersal zooplankton using emergence traps (Walter *et al.*, 1982; Alldredge, 1985). Several genera of calanoids occurred in association with these pseudodiaptomids: *Acartia, Calanopia, Centropages, Epacteriscus, Exumella, Pseudocyclops, Ridgewayia, Stephos* and *Tortanus*. In this paper, the word 'pseudodiaptomid' refers only to members of the genus *Pseudodiaptomus*.

Abbreviations

USNM, United States National Museum; AMS, Australian Museum of Sydney; SAM, South Australian Museum; A1, first antenna; A2, second antenna; Mnd, mandible; Mx1–Mx2, first and second maxilla; Mxp, maxilliped; P1–P5, first–fifth swimming legs; Pdg1–5, pedigers 1–5; Pr, prosome; Ur, urosome; Ur 1–5, urosome segments 1–5; CR, caudal rami; B1–B2, basipods 1–2; Re, exopod; Ri, endopod; Se, outer spine; St, terminal spine.

Appendage morphology

Throughout the literature, variation in the total number of male and female A1 segments appears to be the result of whether authors counted the partly fused 6–7 proximal segments as 1 or 2 segments (Figure 1A and B). Female A1 – symmetrical; usually with 22 segments; segments 6–7 partly fused, the former with small spine, and are counted separately. These segments correspond to the partly fused segments 8 and 9 on other calanoids (Bowman, 1978b) which are separated by a modified suture. Members of the Hyalinus species group possess only 21 segments with four segments proximal to the partly fused sgments (Walter, 1984). Segments 1–5, 7–17 and terminal two segments bear one esthete. Simple plumose setae are not drawn in the illustrations. Segment 20 with short 2-segmented plumose seta and usually a large modified recurved seta which is distally barbed at midlength on medial surface. The barbed seta is not present in *P. gracilis* and the Americanus, Hyalinus, and Lobus species groups (personal examination; Sewell, 1932; Ummerkutty, 1960; Grindley and Grice, 1969; Pillai, 1980; Reddy and Radhakrishna, 1982). Male A1 – asymmetrical; left A1 with

Table I. *Pseudodiaptomus* species groups and species subgroups assemblages.

	IP	A	B	F	S	U	X	O
Nudus								
1. *P. clevei* Scott, 1909	+	−	−	−	−	+	−	−
2. *P. gracilis* (Dahl, 1894)	−	−	+	+	−	+	−	−
Americanus								
'acutus-subgroup'								
3. *P. acutus* (Dahl, 1894)	−	−	+	−	−	+	−	−
4. *P. acutus leptopus* Loeffler, 1963	−	−	+	−	−	−	−	−
5. *P. galapagensis* Grice, 1964	−	−	+	−	−	+	−	−
6. *P. richardi* (Dahl, 1894)	−	−	+	+	−	+	−	−
7. *P. richardi inequalis* (Brian, 1926)	−	−	+	+	−	−	+	−
8. *P. wrighti* Johnson, 1964	−	−	+	−	−	+	+	−
'pelagicus-subgroup'								
9. *P. americanus* Wright, 1937	−	−	+	−	−	−	+	−
10. *P. cokeri* Gonzalez and Bowman, 1965	−	−	+	−	−	+	−	−
11. *P. cristobalensis* Marsh, 1913	−	−	+	−	−	−	−	−
12. *P. culebrensis* Marsh, 1913	−	−	+	−	−	−	−	−
13. *P. euryhalinus* Johnson, 1939	−	−	+	−	−	+	−	−
14. *P. marshi* Wright, 1936	−	−	+	−	−	+	+	−
15. *P. pelagicus* Herrick, 1884 [=*P. coronatus* Williams, 1906]	−	−	+	−	−	+	+	−
Burckhardti								
16. *P. burckhardti* Sewell, 1932	+	−	−	−	−	+	−	−
Improcerus								
17. *P. andamanensis* Pillai, 1980	+	−	−	−	−	−	−	−
18. *P. batillipes* Brehm, 1954	−	+	−	−	−	−	+	−
19. *P. hessei* (Mrazek, 1894)	−	+	−	−	−	+	−	−
20. *P. ornatus* (Rose, 1957)	+	−	−	−	−	+	−	+
21. *P. pauliani* Brehm, 1951	−	+	−	−	−	−	+	−
22. *P. stuhlmanni* (Poppe and Mrazek, 1895) [=*P. charteri* Grindley, 1963]	−	+	−	−	−	+	+	−
23. *P. trispinosus* n.sp.	+	−	−	−	−	+	−	−

Table I. (continued)

	IP	A	B	F	S	U	X	O
Lobus								
'forbesi-subgroup'								
24. *P. annandalei* Sewell, 1919	+	–	–	+	+	+	–	–
25. *P. binghami* Sewell, 1912	+	–	–	+	+	+	–	–
26. *P. binghami malayalus* Wellershaus, 1969	+	–	–	+	–	+	–	–
27. *P. brehmi* Keifer, 1938	+	–	–	+	–	–	+	–
28. *P. bulbosus* (Shen and Tai, 1964)	+	–	–	+	–	–	+	–
29. *P. forbesi* (Poppe and Richard, 1890)	+	–	–	+	+	+	–	–
30. *P. inflatus* (Shen and Tai, 1964)	+	–	–	+	–	–	+	–
31. *P. inopinus* Burckhardt, 1913	+	–	–	+	+	–	–	–
32. *P. inopinus saccupodus* (Shen and Tai, 1962)	+	–	–	+	–	+	+	–
33. *P. lobipes* Gurney, 1907	+	–	–	+	+	–	–	–
34. *P. poplesia* (Shen, 1955)	+	–	–	+	–	+	–	–
35. *P. spatulatus* (Shen and Tai, 1964)	+	–	–	+	–	–	+	–
'poppei-subgroup'								
36. *P. poppei* Stingelin, 1900	+	–	–	+	+	–	+	–
37. *P. smithi* Wright, 1928	+	–	–	+	+	+	+	–
38. *P. tollingerae* Sewell, 1919	+	–	–	+	+	+	–	–
Hyalinus								
'aurivilli-subgroup'								
39. *P. aurivilli* Cleve, 1901	+	–	–	–	–	+	–	–
40. *P. bowmani* Walter, 1984	+	–	–	–	–	+	–	–
41. *P. compactus* Walter, 1984	+	–	–	–	–	*	–	–
42. *P. mertoni* Früchtl, 1923	+	–	–	–	–	+	–	–
'trihamatus-subgroup'								
43. *P. baylyi* Walter, 1984	+	–	–	–	–	+	–	–
44. *P. bispinosus* Walter, 1984	+	–	–	–	–	+	–	–
45. *P. dauglishi* Sewell, 1932 [=*P. beieri* Brehm, 1951]	+	–	–	+	–	+	–	–
46. *P.* sp.1	+	–	–	–	–	+	–	–
47. *P. incisus* Shen and Lee, 1963	+	–	–	–	–	–	+	–
48. *P.* sp.2	+	–	–	–	–	+	–	–

Table I. (continued)

	IP	A	B	F	S	U	X	O
49. *P. sewelli* Walter, 1984	+	–	–	–	–	*	–	–
50. *P. trihamatus* Wright, 1937	+	–	–	–	–	+	–	–
Ramosus								
'hickmani-subgroup'								
51. *P. ardjuna* Brehm, 1953	+	–	–	–	–	–	–	–
52. *P. sp.3*	+	–	–	–	–	+	–	–
53. P. hickmani Sewell, 1912	+	–	–	+	–	+	–	–
54. *P.* sp.4	+	–	–	–	–	+	–	–
55. *P. ishigakiensis* Nishida, 1985	+	–	–	–	–	+	–	–
56. *P. jonesi* Pillai, 1970	+	–	–	–	–	+	–	–
57. *P. marinus* Sato, 1913	+	–	–	–	–	+	–	–
58. *P. philippinensis* n. sp.	+	–	–	–	–	+	–	–
'serricaudatus-subgroup'								
59. *P. caritus* n. sp.	+	–	–	–	–	+	–	–
60. *P. colefaxi* Bayly, 1966	+	–	–	–	–	+	–	–
61. *P. cornutus* Nicholls, 1944	+	–	–	–	–	+	–	–
62. *P. diadelus* n. sp.	+	–	–	–	–	+	–	–
63. *P. galleti* (Rose, 1957)	+	–	–	–	–	+	–	–
64. *P.* sp.5	+	–	–	–	–	+	–	–
65. *P. nihonkaiensis* Hirakawa, 1983	+	–	–	–	–	+	–	–
66. *P. pacificus* n. sp.	+	–	–	–	–	+	–	–
67. *P. salinus* (Giesbrecht, 1896)	+	–	–	–	–	–	–	–
68. *P. serricaudatus* (T. Scott, 1894) [=*P. nudus* Tanaka, 1960]	+	–	–	–	+	+	–	–
Unassigned species								
69. *P. bulbiferus* (Rose, 1957)	+	–	–	–	–	–	–	+
70. *P. heterothrix* Brehm, 1953	+	–	–	–	–	–	+	–
71. *P. masoni* Sewell, 1932	+	–	–	–	–	–	–	+
72. *P. nankauriensis* Roy, 1977	+	–	–	–	–	–	–	+

IP = Found in Indo-Pacific; A = Found around southern half of Africa; B = Found in North and/or South American waters; F = Reported from freshwater habitats; S = *Schmackeria* according to Marsh (1933); U = Specimens deposited at USNM; X = Previously reported only once in literature; O = Only female reported in the literature; * deposited at University of Kiel.

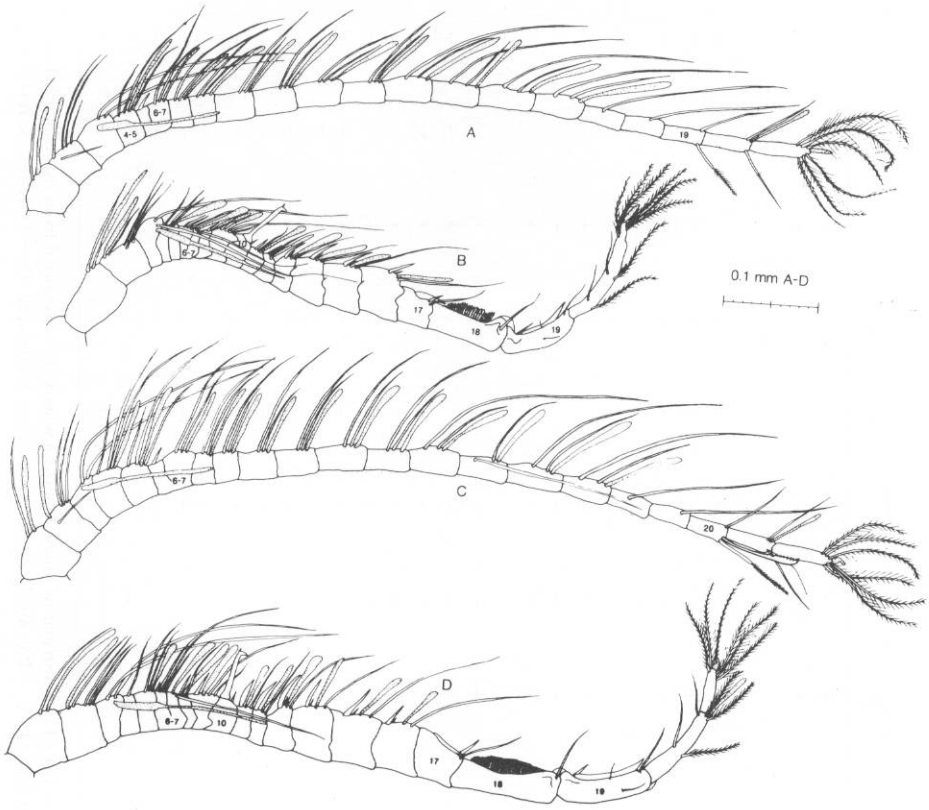

Fig. 1. *Pseudodiaptomus* first antennae, dorsal view. **A – B**, basic segmentation plan of A1 for *P. gracilis* and members of the Hyalinus, Americanus and Lobus species groups. **A**, female without modified barbed seta on antepenultimate segment; **B**, male. **C – D**, A1 for *P. clevei, P. burckhardti*, and members of the Improcerus and Ramosus species group. **C**, female with modified barbed seta on antepenultimate segment; **D**, male.

22 segments. Right A1 with 20 – 21 segments, and geniculate at segments 18 – 19. Segment 3 with anterolateral lobe covering about 3/4 of 4; 6 – 7 partly fused, the former with small spine. Segment 10 usually with large hooked spine (straight spine in Lobus group or lacking in some species), 11 – 17 with strong spines, and 13 – 17 widened with musculature often visible. Segment 17 with variable, distally acute flange. Esthetes present on 1 – 3, 5, 7 – 9, 11 – 16 and terminal two segments. Segment 18 with comb-plate of fine spinules, 19 with elongate distally acute flange that lies parallel to segment and invariably overlaps next segment. All setae are plumose. Terminal esthete varies interspecifically not intraspecifically. Males with 20 segments in right A1 (terminal two segments fused), lack the modified barbed seta on antepenultimate segment of left male A1, and correspond to the species and species groups indicated above.

A2 – P4 (Figure 2A – L): in this genus, species division based on morphological differences of mouthparts and their setation patterns is not possible. Confusion in the literature exists on the reported number of seta per mouthpart segment and the correct referral of the Re and Ri on the A2 and Mnd. A2 with two segmented Ri, and longer

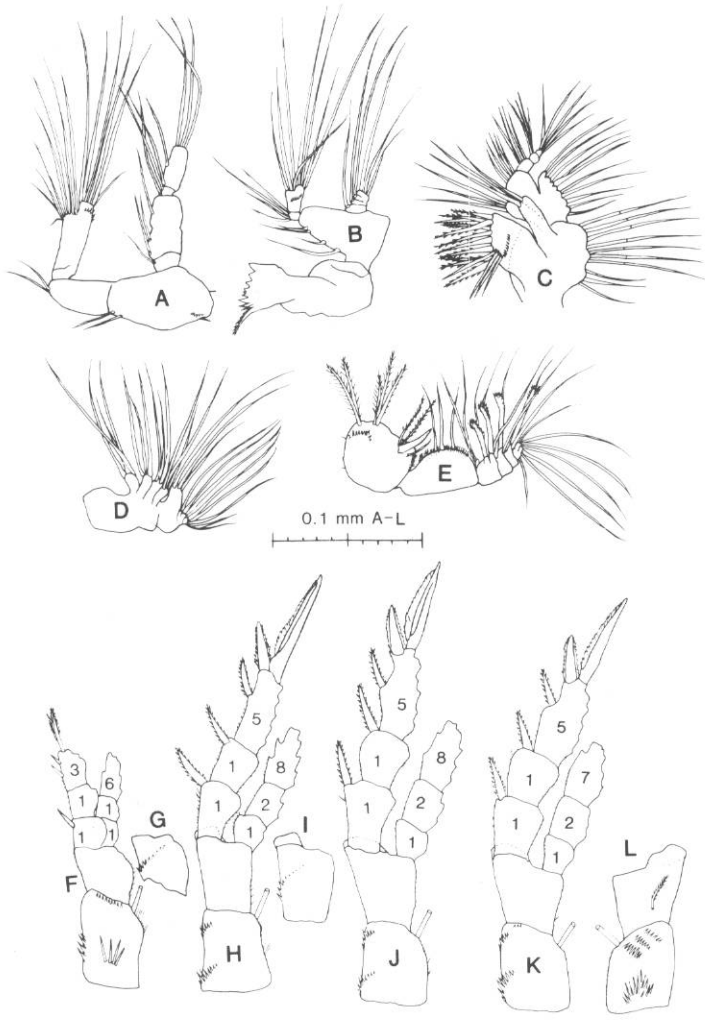

Fig. 2. Mouthparts of *Pseudodiaptomus*: **A**, A2; **B**, Mnd; **C**, Mx1; **D**, Mx2; **E**, Mxp; **F**–**L**, Swimming legs spinule arrangement on B1 and B2, the numbers on Re and Ri indicate number of setae per segment. Anterior view: **F**, P1 (*P. ornatus* and *P. trispinosus* without lateral spinules); **G**, P1, B2 with lateral spinule row present in Hyalinus group, **H**, P2; **I**, B2 with lateral spinule row present in *P. ornatus* and *P. trispinosus*; **J**, P3; **K**, P4; **L**, P4 posterior view (*P. ornatus* and *P. trispinosus* without proximal spinule patch).

multi-segmented Re. Mnd with two segmented Ri, and short Re composed of four indistinct segments. Mx1, Mx2 and Mxp with setation and segmentation as in figures. Of special note on the Mxp are the modified setiform bristles on Ri lobes 1–4. P1–4 of pseudodiaptomids are biramous with two basal, three exopodal and three endopodal segments; P1 Re2 lacks Se. Within certain species groups or individual species, patterns of spinulation vary on the anterior, posterior, and lateral surfaces of B1 and B2 (Figure 2G and I), with small spinules variably present on the anterior surface of the Re and or Ri segments. This variation is not used for species determination.

All previous reports indicate that the female P5 possesses only two Re segments, and referred to the third segment as a terminal or apical spine of variable length. After examination of the female P5 of species from each species group, in terms of morphology, size variation and internal muscle attachment of this alleged spine, I have concluded that it is not a spine, but a true segment.

The following P5 characters are common for all males and females studied and will not be repeated in the descriptions. Female P5 with three Re segments, posterior view: B2 with one large and one small surface seta. Re1 with distal Se and two surface setae. Re2 with one seta, medially produced into a spiniform process, and plumose or spinulose along both margins; Se small, naked or plumose. Re3 with proximomedial spiniform process, distally produced with both margins hirsute, and usually equal in length or longer than Re2 spiniform process.

Male P5, posterior view: right leg (three Re segments) B1 with subapical spinule row. B2 with one large plumose seta and at least one small surface seta. Re1 – Re3 each with at least one small surface seta; Re1 with Se, and Re3 with 1 – 2 setae, proximally thickened with medial basal swelling or process, concavely produced, and distal half of medial margin hirsute. Left leg (two Re segments) B1 same; B2 same with or without Ri. Re1 with at least one surface seta and variably shaped Se. Re2 with several surface setae, Se near midlength, and typically with a St. Anterior view: right leg, B1 with hair or spinule row. B2 possesses lateral spinule row that continues onto surface at midlength, and usually with Ri. Re2 with variably shaped Se. Left leg, B1 and B2 with same spinule ornamentation.

Measurements herein are in millimeters. Lengths of prosome and urosome were taken dorsally from anterior margin of head to posterior end of Pdg5, and from anterior margin of Ur1 to distal tip of CR. Since the Pdg5 usually overlaps Ur, total length may be less than combined lengths of Pr and Ur. The female Ur1 – 3 with posterdorsal spine rows that extend partly along lateral. The ventral surface of Ur1 usually with fringe of spinules anterior to genital boss which is protected by a pair of spines,flaps or valves. The male Ur2 – 4 typically with spine rows that are complete and in some species a partial spine row is present on Ur1. In the female the second medial CR seta is usually twice the length of the other setae; in the male the third medial CR seta is the longest. There are six CR setae of which one is laterally, and five are posteriorly placed. Not all the material examined was deposited in the National Museum of Natural History (NMNH), therefore, the number examined may not correspond to the number of specimens deposited.

Pseudodiaptomus galleti (Rose), new combination, Figure 3A – M.

Mazellina galleti (Rose, 1957a: 235 – 245, Figures 1 – 6).

Material examined. Philippines: Padre Burgos, Quezon Province, Long. 112° 47′E; Lat. 13° 53′N, coral reef, 3 m, S‰ = 34‰, 7 – 10 January 1981, 1 male, USNM 210658; 24 males and 10 females, USNM 210659, collected by T.C. Walter and L. Taluae.

Philippines: Calatagan, Batangas Province, eelgrass, 1 m, 32‰, 21 September 1984, 26 males, 98 females, USNM 216780, collected by M. Trinidad.

Japan: Aburatsubo Cove, Numazu, 15 October 1984, 7 males, 7 females, USNM 216778, collected by S. Nishida.

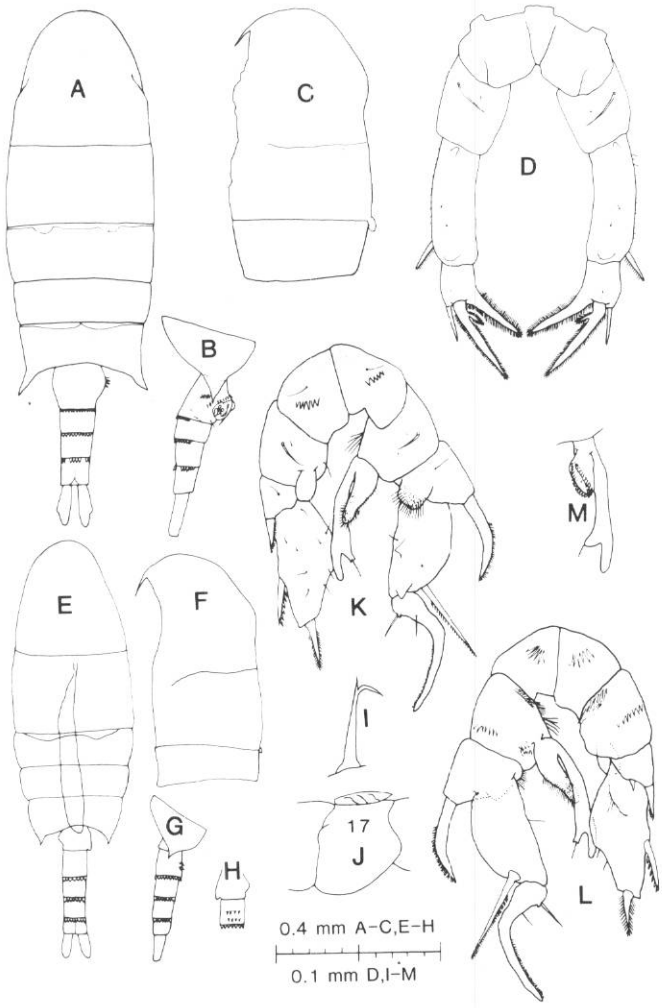

Fig. 3. *Pseudodiaptomus galleti* female: **A**, dorsal view; **B**, Ur right lateral view; **C**, Pr lateral view; **D**, P5 posterior view. Male: **E**, dorsal view; **F**, Pr lateral view; **G**, Ur right lateral view; **H**, Ur1–2 ventral view; **I**, A1 elongated hooked spine on segment 10; **J**, A1 segment 17 dorsal flange; **K**, P5 posterior view; **L**, P5 anterior view; **M**, *P. galleti* (Japan), right male Ri.

Australia: Sharks Bay, Western Australia, 17 June 1983, 2 males, 8 females, USNM 216855; 3 males, 3 females, AMS P35511; collected by D. McKinnon.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	26	1.22–1.30	1.24	0.88	0.40	2.2:1
Male	71	1.00–1.10	1.04	0.74	0.33	2.3:1

Description of female, new description. Figure 3A–D. Head with slight anterior constriction. Lateral view; prominent dorsal hump on head and pair of large posterdorsal fleshy hyaline protuberances on Pdg1. Pdg5 right posterolateral wing more laterally produced than left. Ur1 right side with slight proximolateral swelling and small patch

of fine spinules. Ventrally, genital boss with pair of very fine spines and anterior spinule fringe. Ur3 spine row with central four spines separated from others. CR 3.5 x longer than wide. Ur segments and CR with proportions 28: 14: 16: 18: 24 = 100. A1 as in Figure 1C.

P5 posterior view (Figure 3D), symmetrical; B1 distal corners rounded. B2 rectangular with rounded corners. Re1 elongate, with proximal and distal 'shoulders', outer margin lined with row of fine hairs. Re2 spiniform process plumose; Se naked. Re3 slightly longer than Re2 with short basal spine.

Description of male. Figure 3E – M. Head with prominent dorsal hump and reduced posterodorsal fleshy hyaline protruberances on Pdg1. Ur1 with proximal swelling on left and distal knob on right side. Ventrally Ur2 with two rows of fine spinules (Figure 3G – H). CR 2.5 x longer than wide. Ur segments and CR with proportions 18: 20: 16: 16: 12: 18 = 100. Right A1 with deeply curved hooked spine on segment 10, 17 with ovoid-elongate dorsal flange (Figure 1D,3I – J).

P5 posterior view (Figure 3K), right leg; B1 distomedial corner blunt with one seta. B2 with patch of hair on medial margin and two small surface setae. Re1 triangular, proximal inner corner with raised ridge covered with fine hairs, and Se thick, recurved, and plumose on outer margin. Re2 hemispherical with central and distal triangular knobs and two setae; Se simple. Re3 deeply recurved with small basal knob and spine. Left leg; B2 with small rounded Ri at distomedial corner. Re1 small with short thick Se. Re2 larger and broad with nine surface setae. Anterior view (Figure 3L), right leg; B2 with bifid Ri; long, narrow, medial branch distally widened and notched with seta on shorter outer wall of notch; shorter thumb-like lateral branch disally hirsute. Re2 with Se plumose on lateral margin. Left leg; B2 bearing one seta. Re1 with small medial spine. Re2 with one coarsely serrate Se and plumose St.

Remarks. Pseudodiaptomus galleti originally reported from Viet Nam (Rose, 1957a) is a member of the Ramosus species group (Table I) and *serricaudatus* subgroup. However, Rose's *P. galleti* female was not conspecific to the male and was shown to be a member of the Hyalinus group (Walter, 1984). His female lacked the dorsal hump on head and dorsal fleshy hyaline processes on Pdg1 that the male possessed. In addition, the female A1 had only 21 instead of 22 segments and lacked the barbed seta on antepenultimate segment, possession of which is characteristic for females of the Ramosus group. The following are amendments to Rose's original description of *P. galleti* male: (i) Head and Pdg1 not fused; (ii) head with dorsal hump, Pdg1 with small posterodorsal fleshy protuberances; (iii) left Re1 of P5 with small medial spine, and (iv) left Re2 broad with short St.

This redescription of *P. galleti* associates the correct conspecific male and female pair of the species. According to Dr. R. Vaissière of the Musée Océanographique in Monaco, Rose's original material was left in Algiers and is probably no longer extant. The material examined from Australia and the Philippines appear identical, however, in the Japanese specimens the male P5 right Ri has a smaller more rounded lateral branch (Figure 3M).

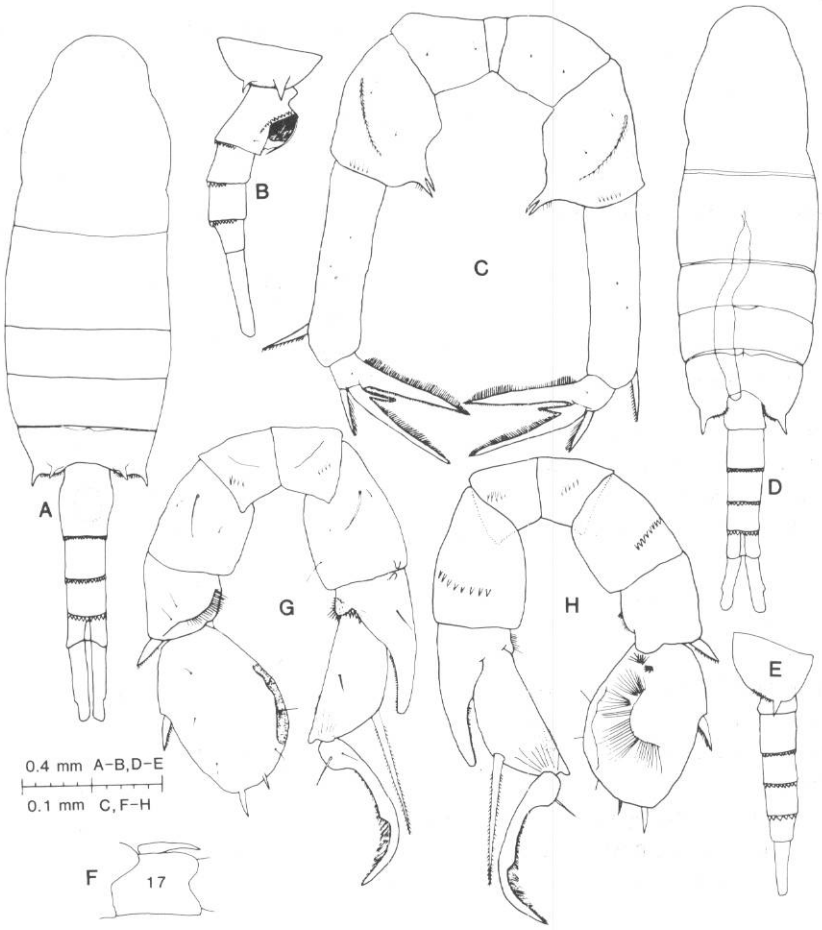

Fig. 4. *Pseudodiaptomus clevei* female: **A**, dorsal view; **B**, Ur right lateral view; **C**, P5 posterior view. Male: **D**, dorsal view; **E**, Ur right lateral view; **F**, A1 segment 17 dorsal flange; **G**, P5 posterior view; **H**, P5 anterior view.

Pseudodiaptomus clevei Scott, Figure 4A – H.

Pseudodiaptomus clevei (Scott, 1909: 116 – 117, pl. 37, Figures 1 – 8; Früchtl, 1924: 48 – 49, Figures 29 – 30; Sewell, 1932: 235; Marsh, 1933: 31, pl. 6, Figures 1 – 2; Mori, 1942: 553; Pillai, 1980: 246, 256, Figure 1o – s).

Material examined. Philippines: Padre Burgos, same locality as *P. galleti*, 25 males, 25 females, USNM 210655.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	63	1.86 – 2.22	2.02	1.36	0.78	1.7:1
Male	114	1.62 – 1.84	1.78	1.24	0.65	1.9:1

Description of female. Figure 4A – C. Head with anterior constrictions. Pdg5 with small recurved posterolateral wings, pair of dorsal spines, pair of very fine rows of hairs between wings and spines, and fine hairs along posterior margin. Right lateral margin of genital segment slightly swollen. Ventrally Ur1 with prominent dark genital boss fringed anteriorly with spinules and pair of small spines at genital opening. CR 6 x longer than wide. Ur segments and CR with proportions 28: 17: 14: 10: 31 = 100. A1 reaches proximal margin of Ur3, with 22 segments and barbed seta on antepenultimate segment (Figure 1C).

P5 posterior view (Figure 4C), symmetrical; B1 with two small surface setae. B2 with two small surface setae, 4 – 5 subapical spinules, and distomedial corner spiniform process bifid with a few hairs along lateral margin.Re2 spiniform process plumose; Se plumose on medial margin. Re3 equal in length to Re2.

Description of male. Figure 4E – H. Head with anterior constrictions. Pdg5 posterior margin deeply incised at Ur insertion and lined with fine hairs. CR 5 x longer than wide. Ur segments and CR with proportions 18: 19: 14: 12: 11: 26 = 100. A1 with segments 13 – 17 not as enlarged as in other species, 11 – 17 with inconspicuous thin whip-like spines, 10 with straight spine (not hooked as in other species), 17 dorsal flange elongate and distally pointed (Figures 1D and 4F).

P5 posterior view (Figure 4G), right leg; B1 distomedial corner triangular. B2 with three small surface setae. Re1 with patch of fine hairs, five spinules along medial corner, and distolateral corner produced into stout spiniform process plumose on medial margin. Re2 longitudinally striated at distal end. Re3 distally constricted with fine spine on proximomedial swelling. Left leg; B1 and B2 same as right. Re1 with two surface setae and short blunt Se. Re2 ovate with stout Se, two St (medial spine smaller), six setae and distomedial groove lined with fine hairs. Anterior view (Figure 4H), right leg; Re2 bearing fine hairs at distomedial margin and long plumose Se. Left leg; Re1 with knob-like protrusion at distomedial corner. Re2 with long hairs that radiate from proximal corner and along central semicircular groove.

Remarks. The Philippine material agrees with the descriptions of Scott (1909) and Früchtl (1924) with additional details presented. Scott noted the partly fused A1 segments 6 – 7, but reported only 21 and 19 segments for female and male A1, respectively. Scott did not indicate Ur1 ventral spines at female genital opening. Pillai (1980) noted the large dark genital boss, but did not report distal hairs on Pdg5 or the ventral spinule fringe anterior to the genital boss.

Two distinct size groups of adult males and females were observed from samples as follows: males, 1.62 – 1.68 mm and 1.74 – 1.84 mm; females, 1.86 – 1.92 mm and 2.12 – 2.22 mm. I have no explanation for this size variation as all animals appeared identical in body morphology and P5 features. This species and *P. gracilis* (Dahl) are the only two pseudodiaptomids so far reported without either a left or right Ri on the male P5, and both have been placed in the Nudus group. Besides geographical division, the lack of lateral head hooks on *P. clevei*, possession of the barbed seta on the A1 penultimate segment, and female P5 with pair of distomedial points on B2 further divide these two species.

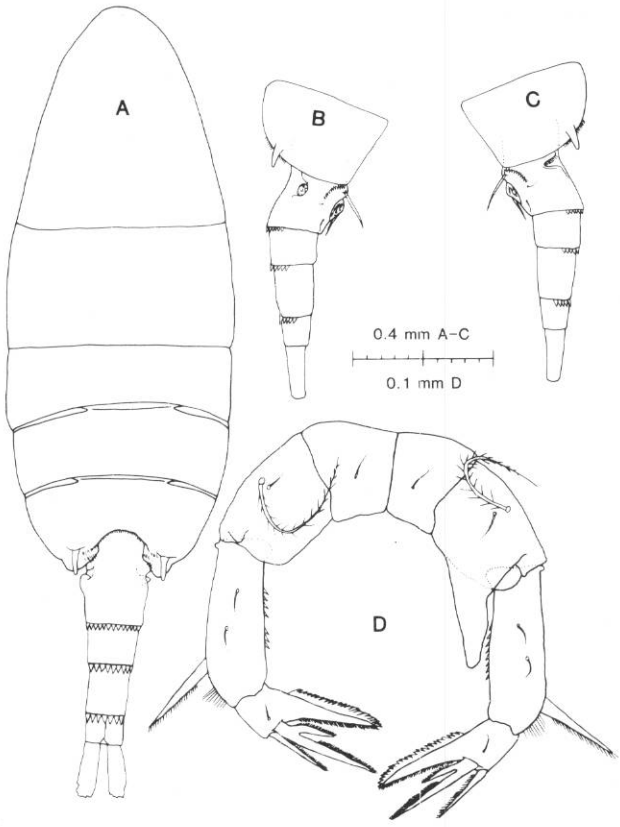

Fig. 5. *Pseudodiaptomus ornatus* female: **A**, dorsal view; **B**, Ur right lateral view; **C**, Ur left lateral view; **D**, P5 posterior view.

Pseudodiaptomus ornatus (Rose), Figure 5A – D.

Mazellina ornata (Rose, 1957b: 332 – 336, Figures 10 – 12).

Material examined. Philippines: Padre Burgos, same locality as *P. galleti*, 1 female, USNM 210656; 2 females, (P5 on slide), USNM 210657.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	3	2.10 – 2.32	2.20	1.58	0.76	2.1:1

Description of female. Pdg5 with rounded posterior corners, one pair of dorsally inserted spines, distomedial margin deeply incised and lined with fine hairs at Ur insertion. Ur1 left anterolateral margin swollen, with U-shaped cleft extending to dorsal surface and lined with fine hairs; right margin with ventral knob-like protrusion. Ventrally Ur1 possessing small genital boss, fringe of small spinules and pair of large spines anterior to boss, and pair of smaller spines at genital opening. CR 3 x longer than wide. Ur segments and CR with proportions 35: 15: 19: 11: 20 = 100. A1 with 22 segments

and reaches posterior margin of Ur1 when extended (Figure 1C).

P5 posterior view (Figure 5D), asymmetrical; B1 with one surface seta. B2 with large triangular process at distomedial corner of right leg and rounded distomedial corner on left leg. Re1 with spinule row on medial margin, large partly plumose Se and fine distolateral hairs. Re2 spiniform process strongly serrated on inner margin, equal in length to Re3; Se more than 1/2 the length of Re3.

Remarks. Rose (1957b) collected this species from Viet Nam, and his original description was based on only one female. To date no males have yet been recorded. Differences between present description and original description by Rose are as follows: (i) female A1 with 22 segments, not 21, as Rose apparently did not count the partly fused segments; (ii) fine hairs line inner distal margin of Pdg5; (iii) female Ur1 with prominent pair of anteroventral spines and fringe of spinules anterior to boss. The original material, according to Dr. R. Vaissière of the Musée Océanographique, Monaco, is probably no longer extant. Lack of a male prohibits assignment of *P. ornatus* to a species group. However, based on similarities of female P5 to *P. trispinosus* it has been tentatively placed in the Improcerus group.

Pseudodiaptomus trispinosus, new species, Figure 6A–I.

Material examined. Philippines; Padre Burgos, same locality as *P. galleti*, 1 male, holotype, USNM 210660; 1 female, allotype, (P5 on slide) USNM 210661; 3 males, paratypes, USNM 210662.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	1	2.38	2.38	1.59	0.81	2.0:1
Male	4	1.86–1.90	1.88	1.28	0.58	2.2:1

Description of female. Figure 6A–D. Pdg5 with one pair of dorsal spines in addition to large posteriorly directed Pdg5 wings, and lining of fine hair on posteromedial margin. Ur1 slightly asymmetrical with proximal swelling on left lateral margin and three spines on posterior part of right lateral surface. Ur1 ventral surface bearing one thick anterior brush-like spine, anterior spinule fringe, pair of spines with the right spine twice as long and bent 90° near midlength, and pair of thick lateral plumose setae (Figure 6C). Ur2 with row of ventral spinules. CR 3 x longer than wide. Ur segments and CR with proportions 32: 16: 18: 13: 21 = 100. A1 as in Figure 1C.

P5 posterior view (Figure 6D), asymmetrical; B1 with one surface seta. B2 left leg with right distomedial corner ending in a blunt triangular plate; right leg plate bifid. Re1 medial margin lined with three rows of spinules; laterally, fine spinules distal to naked stout Se. Re2 lateral margin with 6–7 fine hairs, spiniform process plumose; Se naked, stout. Re3 twice as large as Re2 with large coarse spinules on medial margin, fine hairs along lateral margin, and naked basal spine.

Description of male. Figure 6E–I. Pdg5 corners rounded with pair of dorsal spines, pair of hairs medial to spines and fine hairs lining medial margin. Ur1 slightly asymmetrical with small knob on right lateral margin and three small spines posterior to knob. Ur2–4 with spine rows, ventrally complete on Ur4 only. CR 2 x longer than

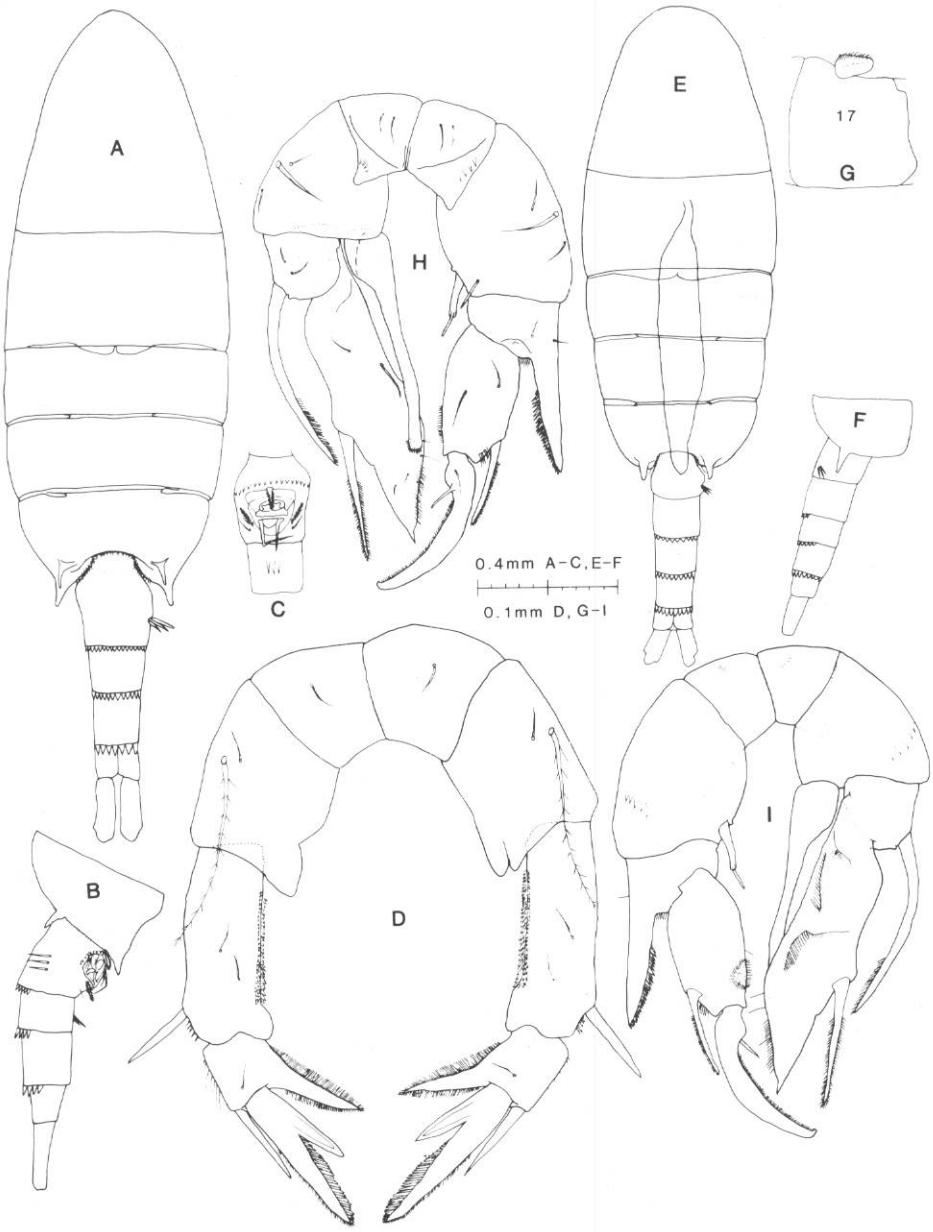

Fig. 6. *Pseudodiaptomus trispinosus*, new species: **A**, dorsal view; **B**, Ur right lateral view; **C**, Ur1 – 2 ventral view; **D**, P5 posterior view. Male: **E**, dorsal view; **F**, Ur right lateral view; **G**, A1 segment 17 dorsal flange; **H**, P5 posterior view; **I**, P5 anterior view.

wide. Ur segments and CR with proportions 24: 17: 17: 16: 10: 16 = 100. A1 segment 10 with straight small stout spine (not hooked), 14 with thin whip-like spine instead of stout spine as in 11 – 13 and 15 – 16, 17 with short blunt dorsal flange lined with fine hairs on surface (Figure 6G).

P5 posterior view (Figure 6H), right leg; B1 with slightly pointed corners and two setae proximal to spinules. B2 with two small surface setae and one spine at distomedial corner. Re1 produced distally into large spiniform process with coarse spinules along medial margin, and fine hairs at its base. Re2 with two setae and fine hairs between Se and Re3. Re3 large with one seta and proximal spine. Left leg; B2 with elongate Ri thickened at base, extending about 3/4 length of Re2 and with fine hairs at apex. Rel with two setae and long curved distally plumose Se. Re2 very large, elongate, pointed apex, with seven setae, plumose Se at midlength and fine hairs at distomedial margin. Anterior view (Figure 6I), right leg; B2 with small distomedial Ri that appears spiniform at apex. Re2 with partly plumose Se and distomedial patch of fine hairs. Left leg; Re2 with three grooves lined with fine hairs.

Etymology. The specific name *trispinosus* refers to the three spines on the right margin of Ur1 on both males and females.

Remarks. The female of *P. trispinosus* is most similar to *P. andamanensis* from Indian waters (Pillai, 1980), however, the male P5 of the two species are different. The *P. trispinosus* female differs from the latter female in the following: (i) Ur1 lacks recurved peg-like structure at right lateral margin and cluster of 5 – 6 spines on posterolateral surface; (ii) left Pdg5 spine not significantly larger than right, and dorsal spines are slightly recurved; (iii) ventral surface of Ur1 with one pair of unequal spines, proximal brush-like spine and two plumose lateral setae which are lacking on *P. andamanensis*; (iv) Ur3 lacks two spines on mid-dorsal margin; (v) female P5 are almost identical in both, except that the two parts of the bifid plate on right B2 are not separated by a gap in *P. trispinosus*; (vi) female A1 has 22 segments, while Pillai reported only 21 segments for *P. andamanensis*, as he counted the partly fused segments 6 – 7 as one.

This species has been placed in the Improcerus species group based on: (i) female P5 B2 with triangular process at distomedial corner; (ii) male P5 right Ri simple and rudimentary.

Pseudodiaptomus philippinensis, new species, Figure 7A – K.

Material examined. Philippines: Calatagan, same location as *P. galleti*, 1 male, holotype, USNM 216768; 1 female, allotype, USNM 216769; 300 males, 460 females, paratypes, USNM 216770, collected by M. Trinidad.

Philippines: Padre Burgos, same location as *P. galleti*, 30 males, 30 females, USNM 210654.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	260	1.14 – 1.25	1.22	0.82	0.40	2 : 1
Male	320	0.94 – 1.00	0.98	0.66	0.32	2 : 1

Description of female. Figure 7A – E. Head and Pdg1 not fused. Pdg5 with small posterolateral wings; posterior margin lined with small fine hairs on each side of Ur insertion. Ur1 with patches of fine hairs along anterolateral and posterodorsal margin (Figure 7A – C), small genital flaps instead of spines, and small spinules on lateral surfaces. Ur2 with proximal patch of fine hairs on right lateral margin. Ur3 longest

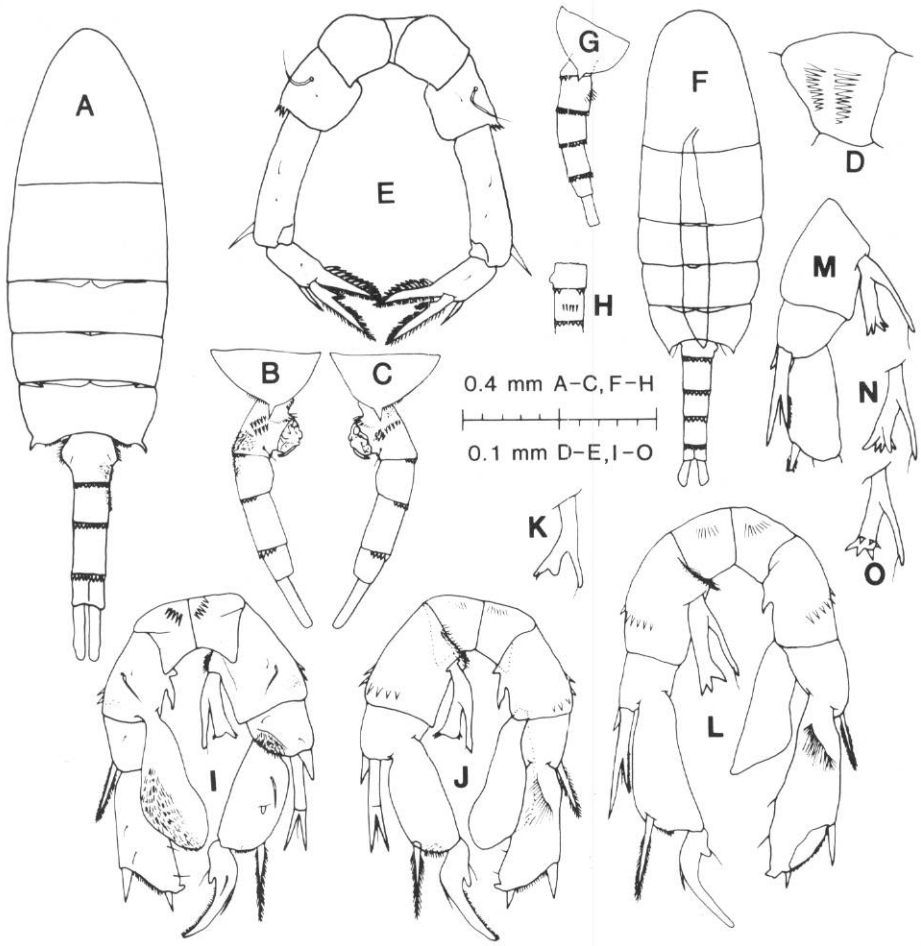

Fig. 7. *Pseudodiaptomus philippinensis*, new species female: **A**, dorsal view; **B**, Ur right lateral view; **C**, Ur left lateral view; **D**, A1 segment 1 with spinule rows on ventral surface; **E**, P5 posterior view. Male: **F**, dorsal view; **G**, Ur, right lateral view; **H**, Ur1 – 2 ventral view with ventral spinules; **I**, P5 posterior view; **J**, P5 anterior view; **K**, P5 variant form of right Ri. **L** – **O**, *P. marinus* male (Japan): **L**, P5 anterior view; **M** – **O**, P5 variant forms of right Ri collected from different localities.

segment. CR about 5 x longer than wide. Ur segments and CR with proportions 22: 18: 22: 13: 25 = 100. First segment of A1 with spinules on inner surface (Figures 1C and 7D). Live specimens tinted yellow-orange, especially on ventral surface; orange pigment spots noted throughout Pr, eyespot prominent, red.

P5 posterior view (Figure 7E), symmetrical; B1 distomedial corners pointed. B2 distolateral corner with 2 – 3 small spinules. Re2 spiniform process with row of large coarse spinules on medial margin, lateral margin plumose. Re3 equal in length to Re2.

Description of male. Figure 7F – J. Pdg5 with single fine hair (Figure 7F) lateral to Ur insertion rather than row of hairs as in female. Ur1 with small protrusion at right

proximolateral margin and with posterodorsal spine row, which is unusual in male pseudodiaptomids. Ur2 with five minute spinules on ventral surface (Figure 7G – H). CR 3 x longer than wide. Ur segments and CR with proportions 14: 21: 16: 21: 9: 19 = 100. Right A1 (Figure 1D) with elongate dorsal flange on segment 17; only left A1 with small spinules on inner surface of segment 1.

P5 posterior view (Figure 7I), right leg; B1 distomedial corners slightly pointed. B2 with small patch of fine surface hairs at distolateral corner. Re1 with two surface seta and fine hairs along medial margin; two distolateral Se, one short less than 1/3 the length of the narrow longer Se, which is bifid above midlength with branches equal in length and seta at base of bifurcation. Re2 with small triangular spine at midlength and plumose Se. Re3 with small lateral spine at midlength. Left leg; B2 with pointed proximomedial corner and distally directed acute process on medial margin; Ri clavate and large. Re1 with Se medially plumose. Re2 with four surface setae, hirsute margin between Se and St, and apex medially directed. Anterior view (Figure 7J), right leg; Ri bifid with lateral ramus shorter, forked and appears to have two points; but closer examination shows that each branch with two small points at apex (Figure 7K, variant form); medial fork slightly longer with seta at apex. Left leg; Ri set with fine hairs along distolateral margin. Re2 with proximal row of fine hairs.

Remarks. Pseudodiaptomus philippinensis, P. marinus and the following closely related species are members of the Ramosus species group and the *hickmani* subgroup. According to Dr. S. Nishida of the Ocean Research Institute, Japan, the type-material of *P. marinus* is no longer extant. However, he provided me with *P. marinus* from Nemuro Bay, Hokkaido (near the type locality of Oshoro Bay, Hokkaido) which is conspecific with Sato's species (Figure 7L). Examination of the Nemuro Bay material (USNM 216773), and specimens from Hawaii, Mauritius, Australia and other areas of Japan it was apparent that this Philippine material is a new closely related species. Morphological differences were only noted in the male and female P5. The male P5 of the Philippine material differs from *P. marinus* in that: (i) Ri appears bifid, not trifid, with each fork ending in two small points that usually overlap so as not to be readily visible, (ii) right Re1 Se is bifid above midlength with each branch equal in length; and (iii) left Ri more rounded at apex. Female P5 identical.

Previous descriptions of P. marinus. Pseudodiaptomus marinus has been described with a 3-pt right Ri and right Re1 Se with unequal forks (Sato, 1913; Brodsky, 1948, 1950; Chen and Zhang, 1965; Tanaka, 1965, 1967; Pillai, 1980). Sato's report of a 1.3 mm male was believed incorrect as males in this group rarely exceed 1.0 mm, but measurement of Nemuro Bay material confirms Sato's report. Pillai (1980) mistakenly reported the hooked spine of segment 10 of male right A1, as being on the twelfth segment. Variations on reported number of A1 segments exist, with Grindley and Grice (1969) and Pillai (1980) stating that both males and females have 21 segments, while Tanaka (1967) correctly reported 21 and 22 segments, respectively. No previous studies have noted the spinules on the inner surface on segment 1 of female and left male A1, however I have observed them in material from all localities.

Pillai (1980) presented a useful table comparing the male P5 diagnostic characters of previous *P. marinus* descriptions. Noted differences included the number of apical

points on right Ri, variation in bifid Se and length of subsidiary spine on right Re1. These differences were previously ascribed to ecophenotypes or geographical variants (Grindley and Grice, 1969). However, after examination of *P. marinus* from the Philippines, Japan, Australia and Hawaii, this author concludes that some of these closely related forms are in fact, distinct species as noted herein and Walter (in preparation). Previous studies, except Grindley and Grice (1969), failed to report the posterodorsal spine row on male Ur1 which I observed on all specimens.

In addition to the Nemuro Bay material, Dr. S. Nishida provided me with specimens from various locations around Japan. The type locality for *P. marinus* (3-pt Ri) appears to be the coastal waters of northern Japan and probably the USSR. Material examined from Tokyo Bay (USNM 216777, 216774), Seto Inland Sea (USNM 216775) and Ariabe Bay, Kyushu (USNM 216776) produced specimens with 4, 5 and 6 points (Figure 7M–O) on right Ri, Re1 Se branches unequal in length and smaller in size. I have tentatively placed these specimens as *Pseudodiaptomus* cf. *P. marinus*, though examination of additional material may prove these to be subspecies. Examination of *P. marinus* collected by Jones (1966) (USNM 112647) revealed that the right Ri possesses a 4-pt Ri instead of 3-pt and is herein placed as *Pseudodiaptomus* cf. *P. marinus* as it resembles the material of Tokyo Bay.

Grindley and Grice reported *P. marinus* from Mauritius with a 2-pt right Ri. This material was deposited at Woods Hole Oceanographic Institution (WHOI) and the South African Museum (SAM). Dr. G. Grice (WHOI) loaned me four females and informed me that the rest of the material (one male and five females) was deposited with SAM. However, Mrs. M.G. van der Merwe (Technical Officer, SAM) informed me this material cannot be found. The WHOI specimens were requested by Grice to be deposited at NMNH, and were deposited as *Pseudodiaptomus* cf. *P. marinus* (USNM 216772). Before one can definitely ascertain which species is present in Mauritius additional material, particularly males, needs to be collected.

Pillai's (1980) illustration of *P. marinus* from Andaman Islands lacks sufficient detail to confirm this assignment, though I suspect this species is more closely related to *P. philippinensis* than *P. marinus*. *Pseudodiaptomus marinus* has also been reported from Australia (Greenwood, 1977). However, examination of material from that area shows that a different species is present (Walter, in preparation). Another closely related species *Pseudodiaptomus ishigakiensis* from Japan is easily distinguishable from *P. marinus* (Nishida, 1985).

Pseudodiaptomus caritus, new species, Figure 8A–I.

Material examined. Philippines: Padre Burgos, same locality as *P. galleti*, 1 male, holotype USNM 210666; 1 female, allotype USNM 210667; 3 males, 10 females, paratypes (P5 of male and female on slides), USNM 210668.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	11	1.24–1.28	1.26	0.86	0.41	2.1:1
Male	5	1.04–1.10	1.08	0.76	0.34	2.2:1

Description of female. Figure 8A–C. Red eyespot present after 2 years in ethanol. Pdg5 wings asymmetrical, left wing larger and more laterally directed. Ur1 unusual

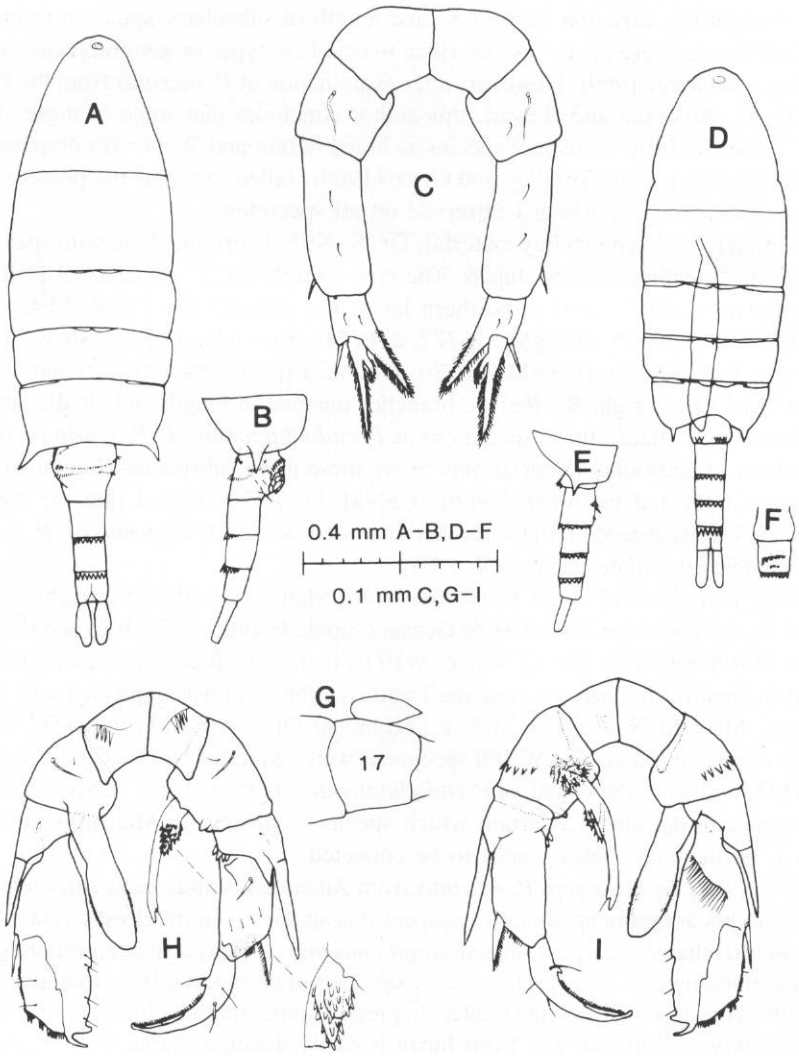

Fig. 8. *Pseudodiaptomus caritus*, new species female: **A**, dorsal view; **B**, Ur right lateral view; **C**, P5 posterior view. Male: **D**, dorsal view; **E**, Ur right lateral view; **F**, Ur1 – 2 ventral view; **G**, A1 segment 17 dorsal flange; **H**, P5 posterior view; **I**, P5 anterior view.

in lacking posterodorsal spine row; anterior swelling on left side with small anterolateral patch of hairs; dorsal surface with two rows of fine hairs. Ventral surface of Ur1 with fringe of stiff spinules anterior to genital boss, and small genital valves at opening. Ur2 – 3 with normal spine rows on posterodorsal margin. CR 3 x longer than wide. Ur segments and CR with proportions 29: 17: 17: 15: 22 = 100. A1 reaches proximal margin of Ur2, small spinules on inner surface of segment 1 similar to those of *P. philippinensis* (Figures 1C and 7D).

P5 posterior view (Figure 8C), symmetrical; B1 with slightly produced distomedial

corners. Re1 with short naked Se. Re2 with two small surface setae, spiniform process margin with fine serrate membrane; Se small, naked. Re3 slightly longer than Re2.

Description of male. Figure 8D–I. Pdg5 wings small, posteriorly directed. Ur1 with interrupted posterodorsal spine row. Ur2 with two ventral spinule rows. CR 3.5 x longer than wide. Ur segments and CR with proportions 16: 18: 16: 14: 14: 22 = 100. Left A1 same as female, right A1 segment 10 with strong hooked spine and 17 with ovoid dorsal flange pointed at apex (Figures 1D and 8G).

P5 posterior view (Figure 8H), right leg; B1 distal corners bluntly pointed. B2 medial margin with two small knobs. Re1 distolateral corner drawn out into large naked blade with small triangular process at base, distomedial corner with four spinules. Re2 with proximal surface knob, one small spine, four setae and patch of fine hairs at base of Re3. Re3 with two surface setae, small medial knob and seta. Left leg; B2 with large spatulate Ri, about 2/3 length of Re2, lined with fine hairs along distal part of lateral and medial margins. Re1 with stout naked Se. Re2 large, oblong, with six setae, naked Se at midlength and small spinules along distal outer margin which grade into fine hairs near Se, lateral section of segment somewhat hyaline in appearance, and terminal spiniform process inwardly curved. Anterior view (Figure 8I), right leg; B2 with one seta, patch of hairs at base of Ri which is long, digitiform, apex incised with seta; base bifid with outer process pointed, inner rounded, both processes covered with small papilla. Re2 with partly plumose Se.

Etymology. The specific name *caritus* is derived from Latin 'careo', meaning to be without; referring to the absence of the typical posterodorsal spine row on Ur1 of females.

Remarks. This species is a member of the *serricaudatus* subgroup of the Ramosus species group as the right Re1 of male P5 lacks the bifid Se. Although in a different subgroup, *P. caritus* possess the following similarities to *P. marinus* and *P. philippinensis* (of the *hickmani* subgroup): (i) spinules on inner surface on A1 of female and left A1 of male; (ii) male with spine row present on Ur1. Only the males of *P. caritus, P. marinus, P. philippinensis*, and *P.* sp. 3 have a spine row on Ur1, which is unusual for male pseudodiaptomids; (iii) red eyespot persistent in ethanol-preserved specimens over time; (iv) P5 of males with large, spatulate left Ri; and (v) female with small genital valves instead of spines at genital opening.

Pseudodiaptomus diadelus, new species, Figure 9A–K.

Material examined. Philippines: Padre Burgos, same locality as *P. galleti*, 1 male, holotype, USNM 210663; 1 female, allotype (P5 on slide, habitus lost), USNM 210664; 1 male, paratype (P5 on slide), USNM 210665.

Palau: Koror, coral reef, 3 m, emergence trap, 6 November 1978, 8 males, 1 female, paratypes, USNM 213438; collected by A.L. Alldredge.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	2	1.38–1.62	1.50	1.16	0.48	2.4:1
Male	11	1.00–1.28	1.16	0.88	0.36	2.4:1

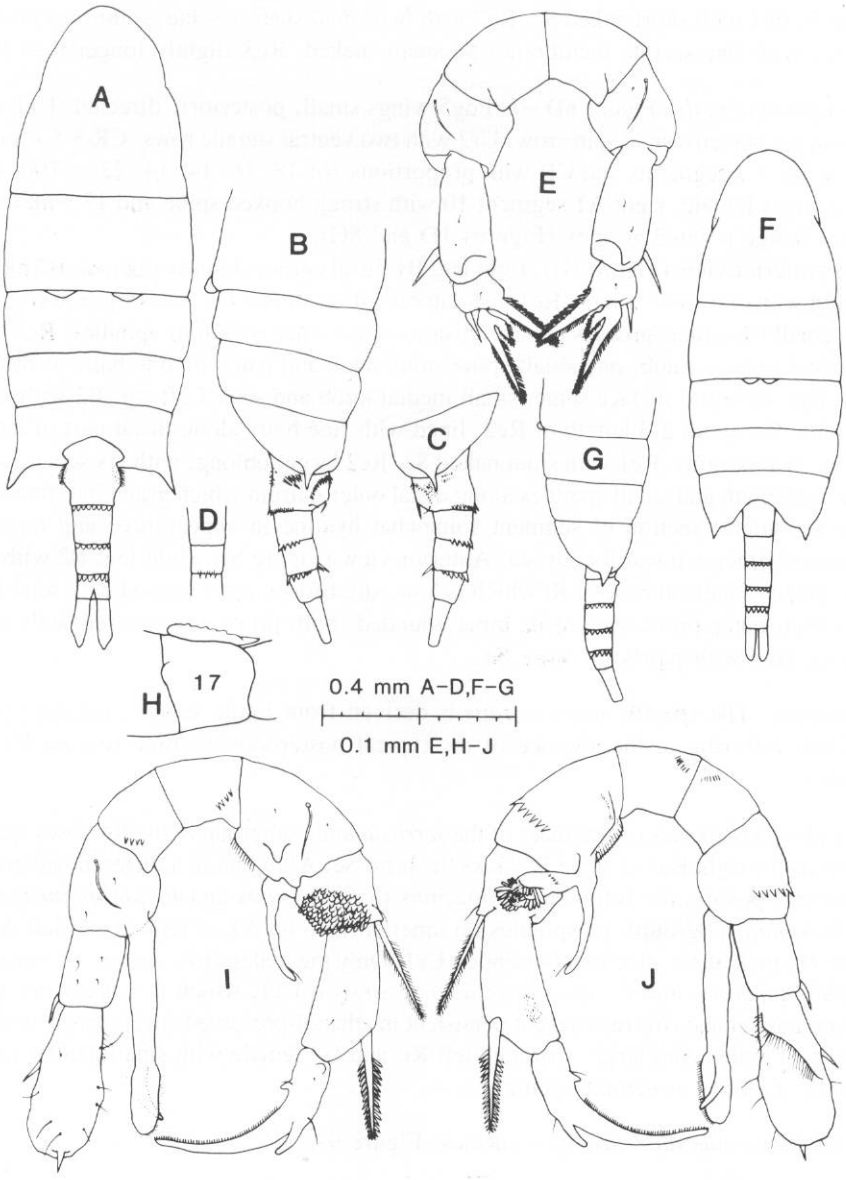

Fig. 9. *Pseudodiaptomus diadelus*, new species female: **A**, dorsal view; **B**, Pr and Ur right lateral view; **C**, Ur left lateral view; **D**, Ur2–4 ventral view; **E**, P5 posterior view. Male: **F**, dorsal view; **G**, Pr and Ur right lateral view; **H**, A1 segment 17 dorsal flange; **I**, P5 posterior view; **J**, P5 anterior view.

Description of female. Figure 9A–E. Head with slight anterodorsal indentation. Pdg1 with pair of large dorsal hyaline protuberances. Pdg5 with large posterolateral wings. Ur1 large, deeply indented into Pdg5 with patches of fine hair on anterolateral surface, pair of small ventral spines at genital opening and spinule fringe proximal to genital boss. Ur3 with posteroventral spinule row. CR 4 x longer than wide. Ur segments and

CR with proportions 32: 19: 14: 11: 24 = 100. Body color of Palau specimens, both sexes, rusty-orange which faded rapidly in ethanol. A1 as in Figure 1C.

P5 posterior view (Figure 9E), symmetrical; B1 distomedial corners rounded. B2 with large rounded proximomedial corners. Re1 with naked Se. Re2 spiniform process with medial margin serrate, lateral margin plumose and equal in length to Re3; Se naked.

Description of male. Figure 9F–J. Head indented as in female, with small dorsal hyaline protuberances on Pdg1. Pdg5 with small posteriorly directed wings. Ur1 deeply indented into Pdg5. Ur2 with small ventral protrusion (Figure 9G). CR ~3.5 x longer than wide. Ur segments and CR with proportions 21: 17: 15: 13: 13: 21 = 100. Right A1 segment 17 elongate flange with crenulate anterior margin (Figures 1D and 9H).

P5 posterior view (Figure 9I), right leg; B1 distomedial corners slightly pointed.B2 with two small surface seta and medial hump. Re1 with one seta, large distomedial patch of small blunt scales and long plumose Se. Re3 with two surface setae, small proximolateral basal knob; lateral margin with pronounced digitiform process near midlength. Left leg; B2 with two setae, Ri elongate with distal digitiform process on anterior surface and medial hairs. Re1 with four setae and small naked distal Se. Re2 large, oblong with small naked medial Se, small St, eight setae, and oblique groove lined with fine long hairs; apex with acute spine. Anterior view (Figure 9J), right leg; B2 with patch of fine hairs in groove at base of Ri. Ri bifid with inner branch clavate, lined with small spatulate spinules at apex and small spinules at midlength; outer branch narrow, digitiform, with subapical seta. Re1 with spinules at distolateral corner. Re2 with stout coarsely serrate Se and surface patch of fine hairs.

Etymology. The specific name *diadelus* is derived from the Greek 'diadelos' meaning distinctive, referring to the unusual digitiform process on the lateral margin of right Re3 on P5 of male.

Remarks. This species obviously belongs to the Ramosus group and the *serricaudatus*-subgroup as it possesses a branched right Ri, large spatulate left Ri and lacks the forked Se on right Re1. The densely scaled distal surface of right Ri and the thumb-like process on lateral margin of right Re3 separate *P. diadelus* from other members of the group. Female P5 is unusually stout in appearance.

Pseudodiaptomus burckhardti Sewell, Figure 10A–H.

Pseudodiaptomus burckhardti [Sewell, 1932: 235, Figure 83a–e (Female only); Pillai, 1980: 253–256, Figures 2w–z, a1–h1 (Male)].

Material examined. Palau: Koror, coral reef, rubble, and sand, 3 m, emergence traps, 6 November 1978, 11 males, 5 females, USNM 213439; collected by A.L. Alldredge.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	5	1.47–1.53	1.51	1.06	0.53	2.0:1
Male	11	1.10–1.16	1.13	0.82	0.35	2.3:1

Description of female. Figure 10A–C. The following notes amend descriptions of Sewell (1932) and Pillai (1980). Ur1 with anterolateral patches of fine hairs; ventral surface

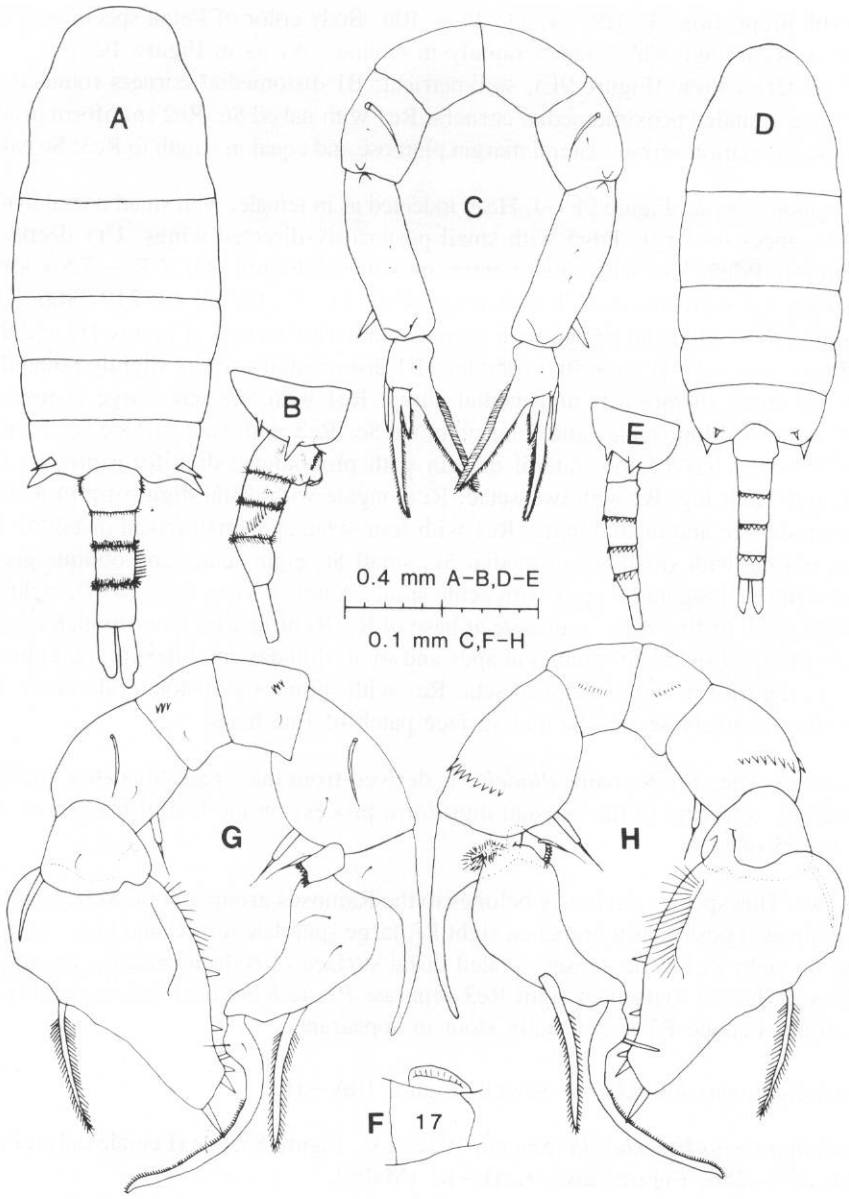

Fig. 10. *Pseudodiaptomus burckhardti* female: **A**, dorsal view; **B**, Ur right lateral view; **C**, P5 posterior view. Male: **D**, dorsal view; **E**, Ur right lateral view; **F**, A1 segment 17 dorsal flange; **G**, P5 posterior view; **H**, P5 anterior view.

with spinule fringe proximal to genital boss that bears small pair of genital flaps. Ur1 – 3 without spine rows, instead a profusion of fine hairs completely encircle the posterior margins. Ur2 right lateral surface with few hairs at midlength. Ur3 with oblique row of fine spines on right lateral surface. CR unusual in that left ramus is distinctly shorter

than right. CR with left ramus 3.7 x and right 4.5 x longer than wide. Ur segments and right CR with proportions 21: 15: 17: 20: 27 = 100. A1 as in Figure 1C.

P5 posterior view (Figure 10C), symmetrical; B2 and Re1 with small juxtaposed knobs; Re1 with subapical ridge. Re2 spiniform process with medial lamellar fringe of hair, laterally plumose, equal in length to Re3; Se naked.

Description of male. Figure 10D–H. Male Pdg5 with pair of small posterodorsal spines, which is unusual for pseudodiaptomids. Ur1 with right posterolateral swelling. Ur2 with anteroventral protrusion. CR 3 x longer than wide. Ur segments and CR with proportions 20: 16: 16: 16: 14: 18 = 100. Right A1 segment 17 with small dorsally rounded flange (Figures 1D and 10F).

P5 posterior view (Figure 10G). Amendment to Pillai's description as follows: Right leg; B2 with digitiform Ri, and cylindrical distomedial process with seta on medial margin and corona of spinules at apex. Re2 with two setae and concave medial margin. Re3 with robust spine at basal knob. Left leg; B2 with digitiform Ri. Re1 with naked Se. Re2 with enlarged proximal end and plumose Se at midlength. Anterior view (Figure 10H), right leg; Re1 with medial patch of hairs. Re2 with plumose Se. Left leg; Re2 with medial groove lined with long hairs.

Remarks. Sewell (1932) described the species from the female only and the male was first described by Pillai (1980), both from the Andaman Islands. The present specimens from Palau now extend the range of the species east through Malaysia, Indonesia, and probably the Philippines. Neither study reported the hairs in lieu of spinules or spine row that encircle female Ur1–3 or the asymmetrical female CR. Pillai (1980) did not indicate the characteristic row of fine spines on right lateral surface of female Ur3 as Sewell (1932) illustrated. I have placed *P. burckhardti* in its own monotypic species group. The unusual structure of the male P5, in particular, the possession of a rudimentary left and right Ri set this species off from the rest of the members in the genus.

Pseudodiaptomus pacificus, new species, Figure 11A–J.

Material examined. Palau: same locality as *P. burckhardti*, 1 male, holotype, USNM 213440; 1 female, allotype, USNM 213441; 15 males, 10 females, paratypes, USNM 213442.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	15	0.98–1.00	0.99	0.72	0.33	2.2:1
Male	10	0.80–0.84	0.82	0.61	0.26	2.3:1

Australia: One Tree Island lagoon, Great Barrier Reef, emergence trap, 24 November 1978, 6 males, 5 females, USNM 216328; 5 males, 7 females, AMS P35509; collected by P.S. McWilliam.

Tonga: Tongatapu Island, lagoon, night net tow, 7 March 1964, 27 males, 25 females, USNM 111310; collected by L.J. Lancaster.

China: Zhanjian District, estuary, 17 November 1983, 1 male, 1 female, USNM 216329; collected by Chen Qing-chao.

Description of female. Figure 11A–D. Pdg1 with large pair of dorsal fleshy hyaline protuberances. Pdg5 wings posteriorly directed. Ur1 deeply inserted into Pdg5, with

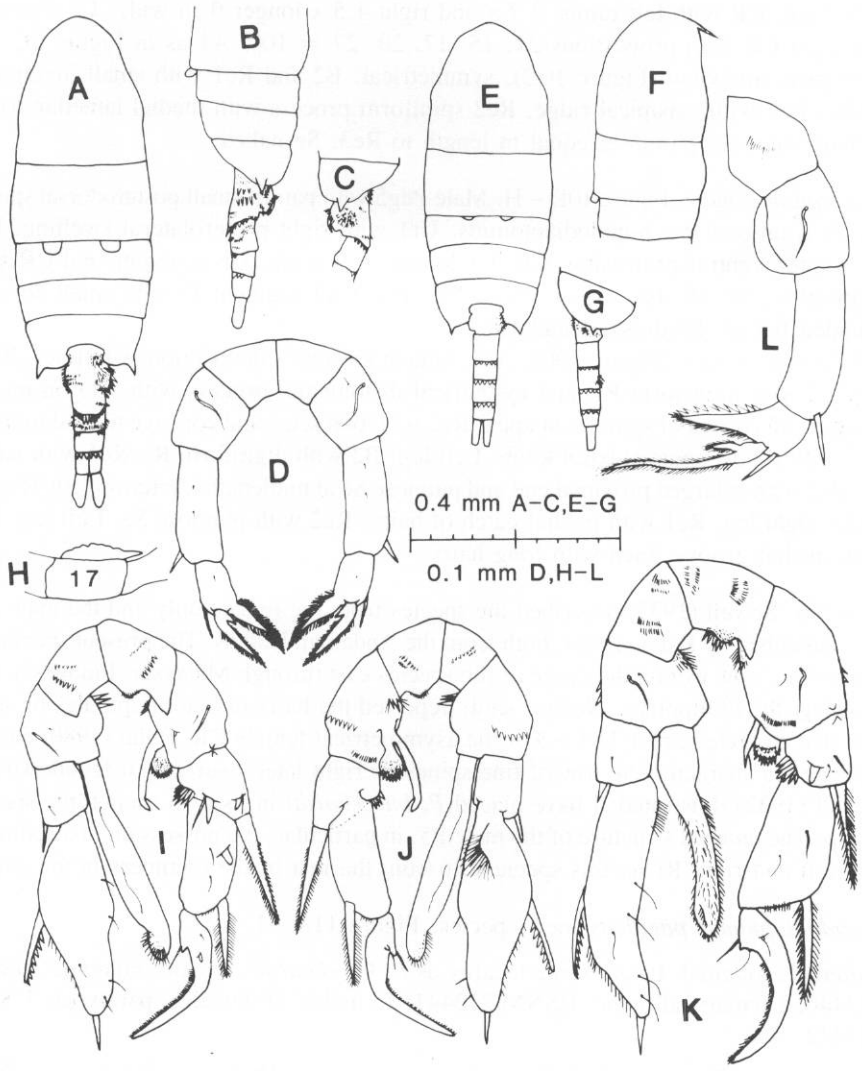

Fig. 11. *Pseudodiaptomus pacificus*, new species female: **A**, dorsal view; **B**, Pr and Ur right lateral view; **C**, Ur left lateral view; **D**, P5 posterior view. Male: **E**, dorsal view; **F–G**, Pr and Ur right lateral view; **H**, A1 segment 17 dorsal flange; **I**, P5 posterior view; **J**, P5 anterior view. *P. cornutus* (Australia): **K**, male P5 posterior view; **L**, female P5 posterior view.

patches of hairs on dorsal and lateral surfaces; right lateral margin with ridge and spinule cluster at midlength, posterodorsal spine row with larger central spines; ventrally genital boss with small genital valves and anterior spinule fringe. Ur2 with dorsal and lateral fine hairs and interrupted spine row. CR 3 x longer than wide. Ur segments and CR with proportions 41: 12: 12: 14: 21 = 100. A1 as in Figure 1C.

P5 posterior view (Figure 11D), symmetrical; B1 with triangular distomedial cor-

ners. Re2 with plumose spiniform process about equal in length to plumose Re3; Se small, naked.

Description of male. Figure 11E–J. Pdg1 with small pair of dorsal hyaline protuberances. Pdg5 with small posteriorly directed points. Ur1 deeply inserted into Pdg5 with right anterolateral hair patch. Ur3 with ventral spinule row. CR ~3 x longer than wide. Ur segments and CR with proportions 21: 21: 13: 16: 11: 18 = 100. Right A1 segment 17 with crenulate dorsal flange (Figures 1D and 11H).

P5 posterior view (Figure 11I), right leg; B1 with medial hump lined with very fine hairs, two spinule rows, and pointed distomedial corner. B2 with one raised surface seta, and distal shoulder juxtaposed to Re1 shoulder. Re1 with two short setae and triangular surface spines, medial spinule cluster, and large plumose Se. Re2 with two setae and spatulate spine near midlength. Re3 with one seta, small spatulate spine, and small basal knob with seta. Left leg; B2 with three large proximomedial spinules and elongate, slightly curved Ri with distolateral fine hairs at apex. Re1 with small naked Se. Re2 elongate with heavily serrate Se, lateral hairs distal to Se and small naked St, and five surface setae. Anterior view (Figure 11J), right leg; B1 with two spinule B2 with proximal spinules, distal hair row and bifid Ri; small branch broadly round, apex covered with small spinules, other branch narrow, 2 x longer, with subapical seta. Re2 with stout plumose Se. Left leg; Re2 with proximal hair patch.

Etymology. The specific name *pacificus* refers to the wide geographic Pacific range of the species, as it is recorded from China, Palau, Tonga and Australia.

Remarks. This species first recorded from the Palau Islands was the smallest pseudodiaptomid ever observed. Larger specimens of *P. pacificus* are known from the Tonga Islands (USNM 111310) female $\bar{x}$ = 1.20 mm, male $\bar{x}$ = 0.98 mm; Australia (USNM 216328), female $\bar{x}$ = 1.23 mm, male $\bar{x}$ = 0.97 mm; China (USNM 216329), female $\bar{x}$ = 1.20 mm, male $\bar{x}$ = 0.98 mm. *Pseudodiaptomus pacificus* is similar to *P. cornutus* Nicholls (1944) (Australia) and *P. nihonkaiensis* Hirakawa (1983) (Japan) in possessing the Pdg1 dorsal protuberances, morphology of female P5, and particularly the right Ri of male P5. The male of *P. salinus* (Giesbrecht, 1896) (Red Sea) is also similar in male P5 structure, but was not reported to have the Pdg1 protuberances. Possession of dorsal protuberances on Pdg1 is also shared with *P. galleti* and *P. diadelus*. Hirakawa (1983) amended the original description of *P. cornutus*, to which *P. pacificus* is most similar. Study of the *P. cornutus* type-material (South Australian Museum, C3957-C3960, slides), revealed that the head and Pdg1 are not fused. Differences in the female and male P5 morphology of *P. cornutus* (USNM 213981; Figure 11K–L) distinguish it from *P. pacificus* in that in the former the: (i) female P5, B2 with large rounded medial margins and Re2 spiniform process shorter than Re3; (ii) male P5, right Ri digitiform process only slightly longer than the plate-like (rather than rounded) process, left Ri proximally thickened and hirsute along distal half, and left Re2 narrow with medial suture. Differences in the left and right Ri of the male P5 easily distinguish *P. nihonkaiensis* from *P. pacificus*. This species belongs to the Ramosus species group and the *serricaudatus* subgroup.

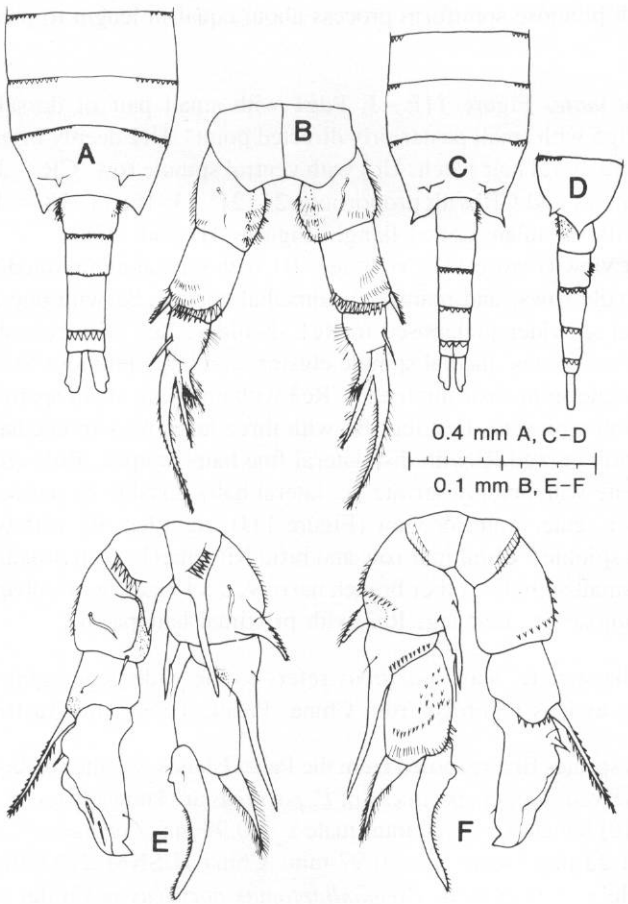

Fig. 12. *Pseudodiaptomus dauglishi* female: **A**. dorsal view; **B**. P5 posterior view. Male: **C**. dorsal view; **D**. Ur right lateral view; **E**. P5 posterior view; **F**. P5 anterior view.

Pseudodiaptomus dauglishi Sewell Figure 12A – F.

Pseudodiaptomus dauglishi (Sewell, 1932: 241 – 244, Figure 86a – h, 1933: 27; Lai and Fernando, 1978: 122 – 124, Figures 41 – 45, 1980: 62, 1981: 172, Figure 23b – d).

Pseudodiaptomus beieri (Brehm, 1951a: 97 – 99, Figures 1 – 7, 1951b: 79 – 80).

Material examined. Indonesia: Palembang and Musir Rivers, Sumatra, 2 – 9 July 1974, 1 male, 1 female, USNM 216295 (on slides); collected by C.H. Fernando and H.C. Lai.

Description of female. Figure 12A – B. Head narrows anteriorly. Pdg1 – 3 with small posterodorsal spines. Pdg4 – 5 fused with one pair of dorsal spines in addition to posteriorly directed Pdg5 wings. Ur1 with patches of hairs on lateral margins and small genital boss with pair of stout spines at genital opening. Ur2 lacks posterodorsal spine row, but has row of fine hairs. Ur3 longest segment. CR 4 x longer than wide. Ur

segment and CR with proportions 20: 20: 28: 10: 22 = 100. A1 with 21 segments and no barbed seta on antepenultimate segment (Figure 1A).

P5 posterior view (Figure 12B), symmetrical; B1 with slightly rounded distomedial corners. B2 with hair row along lateral margin and three rows of hairs on swollen medial margin. Re1 with two rows of distal surface hairs and distomedial row of large spinules. Re2 with proximomedial patch of fine hairs and short distomedial process. Re3 >3 x longer than Re2 with basal spine 2 x longer than Re2.

Description of male. Figure 12C – F. Pdg1 – 3 with few small posterodorsal spines. Pdg4 – 5 with pair of dorsal spines in addition to posterolaterally directed wings. Ur1 with fine hairs on left anterolateral margin. Ur2 with ventral spinule row. CR 2 x longer than wide. Ur segments and CR with proportions 20: 18: 20: 17: 8: 17 = 100. Right A1 with 20 segments, 19 – 20 fused (Figure 1B).

P5 posterior view (Figure 12E), right leg; B1 distal corner produced into long spiniform process. B2 medially enlarged with seta at base of small stout Se. Re1 with medial fine hair patch and distolateral corner produced into long spiniform process. Re2 with stout plumose Se. Re3 with small proximomedial knob. Left leg; B1 with distomedial corner produced into short spiniform process. B2 medial surface raised with fine hairs along groove and small distomedial spine. Re1 with fine hair patch at base of long serrate Se. Re2 with medially directed distomedial corner, and two large spinules along hyaline portion of lateral margin. Anterior view (Figure 12F), right leg; B2 Ri spiniform with one apical point and seta. Re1 with medial spinule row. Re2 with array of surface spinules and hairs. Left leg; Re1 with spinule row at distolateral corner. Re2 with proximolateral spine.

Remarks. Whole specimens were not available for study, therefore complete illustrations of male and female habitus are not presented. This species was collected by Sewell (1932) from Kuala Kuran, West Malaysia, and Lai and Fernando (1978, 1980, 1981) from freshwater habitats in Thailand and Indonesia. Brehm (1951a) apparently unaware of *P. dauglishi*, described as a new species, *P. beieri* from Phnom-Penh, Cambodia. Brehm's illustrations clearly indicate that the material he had was *P. dauglishi*, though in his illustration of the male P5 (p.118, Figure 7), he mistakenly placed the left Re1 Se on B2. Therefore, I place *P. beieri* in synonmy with *P. dauglishi*.

Pseudodiaptomus dauglishi is herein placed in the Hyalinus species group (Walter, 1984) based on the following morphological features: (i) female A1 with only 21 segments and no barbed seta on antepenultimate; (ii) right male A1 with 20 segments, terminal two fused; (iii) P1 with lateral spinule row on B2; (iv) female P5 with Re3 much longer than Re2; and (v) male P5 left Re2 with hyaline lateral margin, B2 posterior surface with medial raised margin lined with fine hairs, and right Ri spiniform. Though this species possesses characters of both subgroups, I place it in the *trihamatus*-subgroup. Among male pseudodiaptomids, *P. dauglishi* is one of only a few species that possess an additional pair of dorsal spines on male Pdg5.

Pseudodiaptomus smithi Wright, Figure 13A – I.

Pseudodiaptomus smithi (Wright, 1928: 592 – 596, pl.12, Figures 1 – 3, 5 – 8).

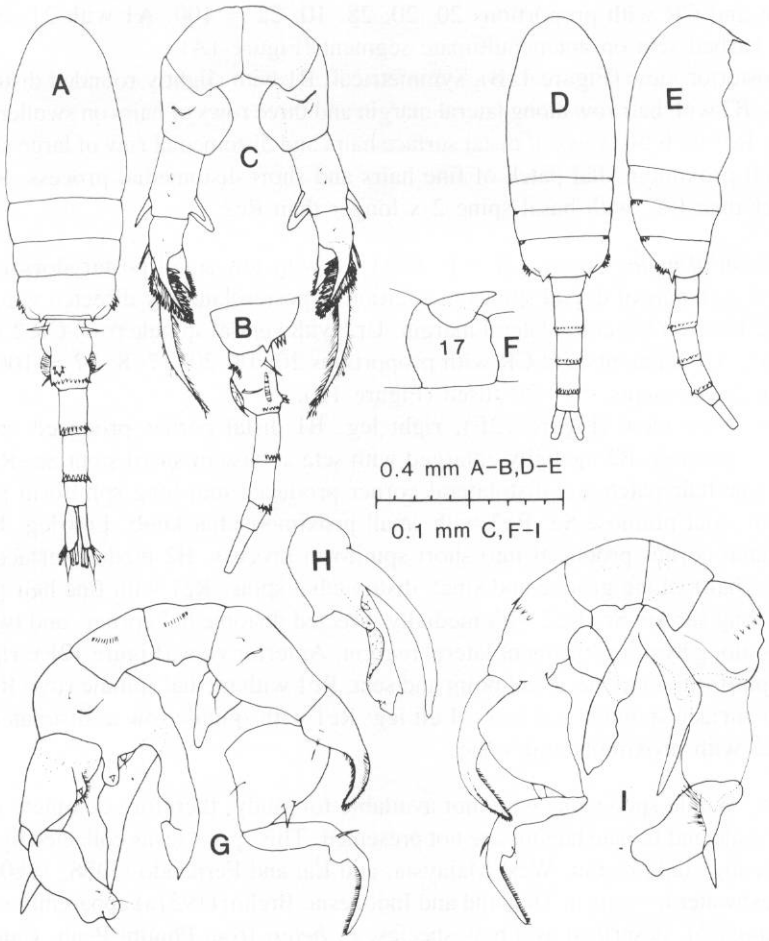

Fig. 13. *Pseudodiaptomus smithi* female: **A**, dorsal view; **B**, Ur left lateral view; **C**, P5 posterior view. Male: **D**, dorsal view; **E**, lateral view; **F**, A1 segment 17 dorsal flange; **G**, P5 posterior view; **H**, P5 left Ri medial view; **I**, P5 anterior view.

Material examined. Philippines: Manila, no locality data, 1 male, holotype, USNM 60597; 1 female, paratype, USNM 60598 (male and female P5 on slides); collected by W.D. Smith.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	1	1.12	1.12	0.64	0.48	1.3:1
Male	1	0.90	0.90	0.55	0.34	1.6:1

Description of female. Figure 13A–C. Head and Pdg1 fused. Pdg4–5 fused with spinules along lateral surfaces; Pdg4 produced posteriorly into two small spines and Pdg5 posterior corners rounded. Ur1 with pair of large anterodorsal spines, small posterolateral spines, anterolateral swellings and posterolateral striated lamellar sacs on both sides and posterodorsal cluster of three spinules left of midline. Egg sacs paired,

each 0.4 mm in length, with 11 eggs, and extend to Ur4. Ventral surface of Ur1 with anterior spinule fringe and pair of small spines at genital opening. CR 6 x longer than wide, left CR distinctly wider; third medial CR seta distinctly enlarged. Ur segments and CR with proportions 31: 20: 20: 11: 18 = 100. A1 with 22 segments (not 21) and lacks barbed seta as in Figure 1A.

P5 posterior view (Figure 13C), symmetrical; B2 with large rounded proximomedial corners. Re1 distomedial corners pointed, with hyaline membrane covering. Re2 spiniform process small with heavily serrate margins; Se naked, short. Re3 plumose, >2 x longer than Re2, with thickened plumose basal spine.

Description of male. Figure 13D–I. Head and Pdg1 fused, Pdg4–5 fused. Pdg2–5 with few posterolateral spinules on both sides. Pdg5 with rounded posterolateral corners and pair of small dorsal spines. CR 3 x longer than wide. Ur segments and CR with proportions 12: 22: 20: 18: 10: 18 = 100. Right A1 with only 20 segments, segment 17 with dorsal flange distally produced into blunt point (Figures 1B and 13F). Left A1 with 22 segments.

P5 posterior view (Figure 13G), right leg; B1 with small medial knob. B2 with small spiniform process at base of Ri. Re1 distolateral corner spiniform, recurved and plumose with small spine at base. Re2 medially truncate with lateral spine. Re3 with lateral spine and medial knob with seta at midlength. Left leg; B2 produced medially into large bifid process; broader medial branch with subapical notch and pointed apex, lateral branch elongate, distally pointed (Figure 13H). Distal to base of process, medial thumb-like knob with distal spine and seta between knob and process. Re1 with medial hirsute hump, large medial seta, and distally pointed. Re2 with large naked Se and three setae. Anterior view (Figure 13I), right leg; B2 with triangular stout Ri. Left leg; Re2 with fine hairs along groove.

Remarks. Collection data was not available, though Wright assumed this species was collected from freshwater. The original description specifies a small spine on either side of the head; I did not observe this in either sex. The striated sacs on each side of female Ur1 are probably part of the male spermatophore coupling device. Wright (1928) proposed placing *P. smithi* in his *lobipes*-group with six other species. I have divided these species under the Lobus group into two types, and placed this species in the *poppei*-subgroup as it possesses a large fused bifid process on left B2. *Pseudodiaptomus smithi* is most similar to *P. poppei* Stingelin (1900) from the Celebes. Another Philippine species, *P. brehmi* (Kiefer, 1938) collected from Naujan on the island of Mindoro (~250 km distance) is similar, however, the left B2 process in male P5 is not bifid.

Pseudodiaptomus annandalei Sewell, Figure 14A–I.

Pseudodiaptomus annandalei (Sewell, 1919: 5–7, pl.10, Figure 9, 1924: 787, pl.44, Figure 2a–c, 1932: 240; Früchtl, 1924: 48; Brehm, 1934: 88–92, Figures 3–4, 1953: 306–308, Figures 68–71; Kasturirangan, 1963: 39, Figure 35a–d; Saraswathy, 1967: 79; Wellershaus, 1969: 263, Figures 25–26; Pillai, 1970: 78, 1972: 164, 169, 171, Figures 2,3a, 1980: 248–250, Figure 1g–i; Grigg, 1972: 84–86, Figures 34a–b,

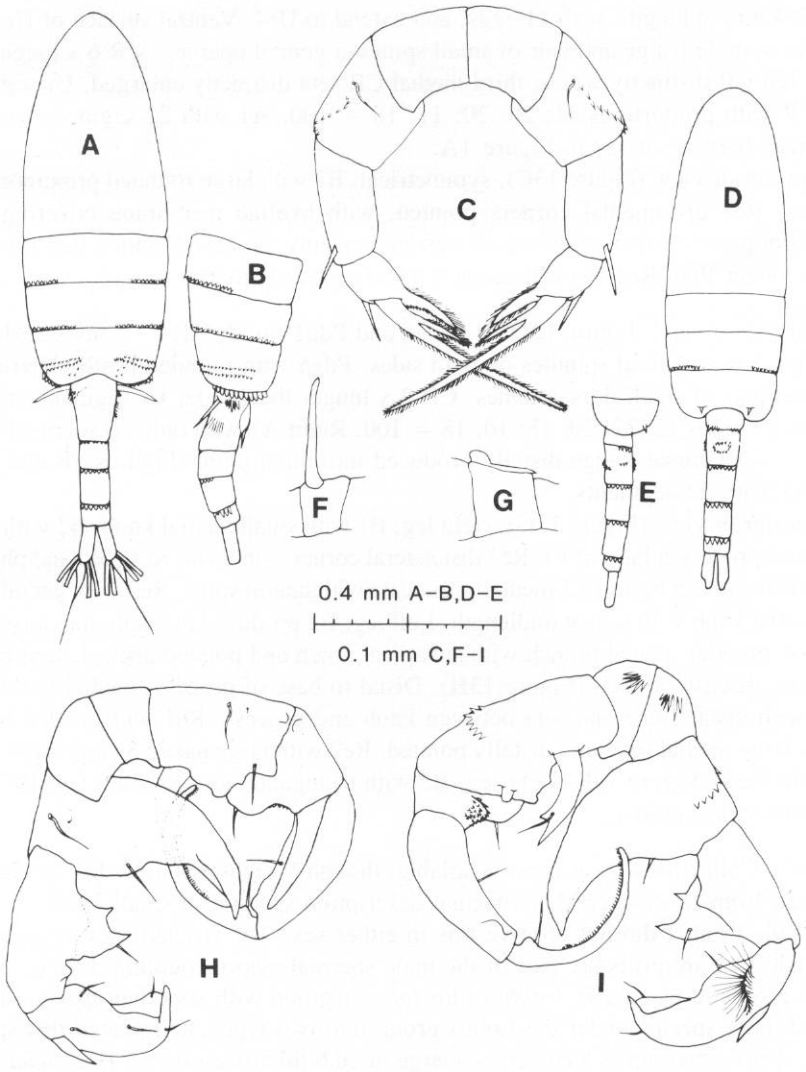

Fig. 14. *Pseudodiaptomus annandalei* female: **A**, dorsal view; **B**, Ur right lateral view; **C**, P5 posterior view. Male: **D**, dorsal view; **E**, Ur left lateral view; **F**, A1 segment 10 with straight spine; **G**, A1 segment 17 dorsal flange; **H**, P5 posterior view; **I**, P5 anterior view.

36a–e; Bayly, 1975: 47; Reddy and Radhakrishna, 1982: 268–270, pl.6, Figures 1–12; Goswami, 1983: 254–257).

Pseudodiaptomus nostradamus (Brehm, 1933: 137–142, Figures 8–12, 1934: 84–92, Figures 5–6; Kiefer, 1938: 81–91, Figures 9–17).

Pseudodiaptomus dubius (Kiefer, 1936: 231–235, Figures 9–12; Kiefer, 1938: 86–91, Figures 18–24; Grindley, 1981: 124, tbl.8.3, 1984: 219, 226, Figure 1).

Schmackeria annandalei Sewell (Marsh, 1933: 42 – 43, pl.20, Figure 8, pl.21, Figure 1).

Schmackeria dubia Kiefer (Chen and Zhang, 1965: 23, pl.32, Figures 1 – 6; Shen, 1979: 77 – 78, Figure 34a – e).

Material examined. Philippines: Calatagan, same location as *P. galleti*, 2 males, 2 females, USNM 216781, collected by M. Trinidad.

India: Lake Kolleru, Andhra Pradesh State, July 1974, 2 males, 6 females, USNM 216573, gift of R. Reddy.

India: Cochin Backwater, surface, 22 – 23 November 1968, 9 males, 30 females, USNM 210671, collected by T.E. Bowman.

India: Cochin Backwater, surface, March 1972, 11 males, 16 females, USNM 213189, collected by M. Madhupratap.

Sex	No.	Length	$\bar{x}$	Pr $\bar{x}$	Ur $\bar{x}$	Pr:Ur
Female	13	1.22 – 1.26	1.24	0.85	0.43	1.9:1
Male	20	1.05 – 1.13	1.07	0.70	0.39	1.8:1

Description of female. Figure 14A – C. This species was recently redescribed by Reddy and Radhakrishna (1982) to which I refer the reader. The following are additional morphological details noted from examination of the above material. Pdg2 – 5 with posterior spine rows along dorsal and lateral margins. Pdg4 – 5 fused with a double spine row and larger posterolateral spines along rounded Pdg5 corner. P1 – 4 with lateral spinule row on B2. Ur1 – 2 with reduced posterodorsal spine rows. Ur1 with proximolateral spinules and hairs; ventrally with anterior spinule fringe and small genital flaps. CR 2.7 x longer than wide. Ur segments and CR with proportions 37: 15: 19: 10: 19 = 100. A1 with 22 (not 21) segments and lacks barbed seta on antepenultimate segment as in Figure 1A.

P5 posterior view (Figure 14C), symmetrical; B2 with spinule row that extends to distolateral corner. Re3 almost 4 x longer than Re2, with basal plumose spine slightly longer than Re2.

Description of male. Figure 14D – I. Pdg4 – 5 with pair of small dorsal spines and round Pdg5 corners. Ur1 with partial posterodorsal spine row. Ur2 with dorsal circular spinule patch, few spinules on left lateral margin and ventral spinule row. CR 2.5 x longer than wide. Ur segments and CR with proportions 13: 20: 20: 20: 7: 20 = 100. Right A1 with 20 segments, segment 10 with elongate straight spine, 17 with proximal knob on dorsal flange (Figures 1B and 14F – G).

P5 posterior view (Figure 14H), right leg; B2 with distomedial seta. Re1 with proximomedial seta, and large distal stout spine almost as long as Re2. Re2 with medial seta. Re3 elongate with small proximal swelling and spine. Left leg: B2 large medially projecting process with medial seta and laterally curved pointed apex. Re1 medially produced with two points. Re2 with five seta, large proximal Se and medially curved distal tip. Anterior view (Figure 14I), right leg; B1 with proximal spinules. B2 with distomedial knob; Ri simple and knotched at apex with seta. Re1 with raised surface covered with scales. Left leg; Re1 with seta on larger point. Re2 with hairs along medial groove.

Remarks. The only amendments to previous descriptions are that the female A1 and right male A1 have 22 and 20 segments, respectively. Reddy and Radhakrishna (1982) reported 21 segments for both male and female A1. Posterodorsal spine rows present on female Ur1 – 3, though reduced on Ur1 – 2, and on male Ur1.

Pseudodiaptomus annandalei is in the Lobus species group and *forbesi*-subgroup. The enlarged female third CR seta, paired egg sacs, lack of barbed seta on antepenultimate segment of male and female A1, and 20 segmented male A1 with non-hooked elongate spine on segment 10 are all characteristics of the Lobus group. One outstanding feature of this species is the lack on the female P5 Re2 of the distomedial triangular processes which all other females in the Lobus group possess. This species was reported from North Queensland, Australia (Grigg, 1972) and with the present material, the known range now extends from India, west to China, and south to Australia.

Species groups of Pseudodiaptomus

From a review of the literature and examination of about 50 species at the National Museum of Natural History, I have divided the species of *Pseudodiaptomus* into seven species groups (Table I), eight subgroups, and one unassigned group consisting of either inadequately described species or species based on females only. These distinct assemblages are based on the structure of male and female P5, and are supported by secondary morphological features and geographical distributions. This division of the genus into species groups incorporates the work of Pillai (1980), but is expanded to include all known species of the genus worldwide. Grindley's (1984) interpretation of species group division, based on Ri arrangement of the male P5, is similar to the views of Walter (in press) of how the genus should be divided. However, the present division of *Pseudodiaptomus* is based on several other characteristics, in addition to male P5 Ri arrangement, and includes over 15 species unknown to Grindley. Four species, *P. beieri, P. charteri, P. nudus* and *P. coronatus* are herein noted as junior synonyms of *P. dauglishi, P. stuhlmanni, P. serricaudatus* and *P. pelagicus*, respectively. In the following key, division of species groups is based on morphological distinctions of the male P5, primarily with respect to possession of either a left and or right Ri and complexity of the Ri. This key and Table I differs from that presented by Walter (in press) in that the *serricaudatus* and *salinus* subgroups of the Ramosus species group have been herein changed to the *hickmani* and *serricaudatus* subgroups, respectively.

Key to the species groups and subgroups of Pseudodiaptomus (L. = definition of Latin root for species group name):

1. P5 male B2 with right Ri absent 2
   P5 male B2 with right Ri present 3
2. Left Ri absent; (L. = bare, naked) . . . . . Nudus
   Left Ri small and digitiform; (all species from the Americas) . . . . . Americanus
   (a) left Re2 rounded . . . . '*acutus*-subgroup'
   (b) left Re2 spatulate . . . . '*pelagicus*-subgroup'
3. Right Ri rudimentary or small and simple 4
   Right Ri forked 6
4. Left Ri rudimentary . . . . . Burckhardti

Left Ri large and variably shaped, or sometimes fused to B2 to form a large, variably pointed medial process 5

5. Left Ri simple, large, and variably spatulate; female P5 B2 with small bluntly triangular process at distomedial corners; (L. = undersized, refers to the rudimentary right Ri of male P5) . . . . . Improcerus

Left Ri large, elongate, medially curved process that is fused to B2; female P5 Re1 with small triangular process and hyaline covering at distomedial corners; (L. = elongated projection, refers to large, fused left medial process) . . . . . Lobus

(a) left Ri apex hook-like . . . . '*forbesi*-subgroup'

(b) left Ri apex hook-like but bifid . . . . '*poppei*-subgroup'

6. Left Ri absent; female P5 with Re3 more than 2 x longer than Re2 (L. = transparent, hyaline; refers to the membrane at lateral margin of left Re2) . . . . . Hyalinus

(a) convexly curved hyaline . . . . '*aurivilli*-subgroup'

(b) incised hyaline . . . . '*trihamatus*-subgroup'

Left Ri present, variable in size; (L. = branched; refers to variably forked right Ri) . . . . . Ramosus

(a) right Re1, Se bifid . . . . '*hickmani*-subgroup'

(b) right Re1, Se not bifid . . . . '*serricaudatus*-subgroup'

Distinct similarities in female P5 morphology are characteristic for species within three of the species groups. In the Hyalinus species group the Re3 is >2 x longer than Re2, the Lobus group possesses a small hyaline process (except for *P. annandalei*) on the distomedial corners of Re1, and in the Improcerus group the B2 distomedial corners are produced into triangular processes.

The two species of the Nudus group are *P. gracilis* (Brazil) and *P. clevei* (Indo-Pacific) and are geographically isolated (Table I). These species appear closely related in that the male P5 of both species lacks both right and left Ri. However, the female P5 of *P. clevei* differs from the former in possessing a pair of distomedial points at each distomedial corner. At present these species appear to be allopatric species, though future studies may prove that they belong to separate species groups. All species in the Americanus group are, as the name indicates, from the Americas with species representing the two subgroups found in both Atlantic and Pacific waters (Walter, in preparation). Members of the Lobus species group are typically freshwater-brackish-water in habitat, with all females in this group possessing paired egg sacs (the other Indo-Pacific groups have only a single egg sac), and with the third CR seta noticeably wider and larger. Species in this group occur mainly around China, Japan and Southeast Asia, though some members inhabit waters from India to Australia (Walter, in press). Species of the Improcerus group predominately occur along the southern coastal waters of Africa, however three species tentatively placed in this group *P. andamanensis, P. ornatus*, and *P. trispinosus* are reported from the Sino-Malay region. Both the Hyalinus and Ramosus groups are brackishwater-marine species and have the most geographically widespread distribution (Figure 15).

Discussion

Most of the Philippine material was collected from a coral reef during 4 days of continuous 24-h sampling with emergence plankton traps (Walter *et al.*, 1982). Sampling

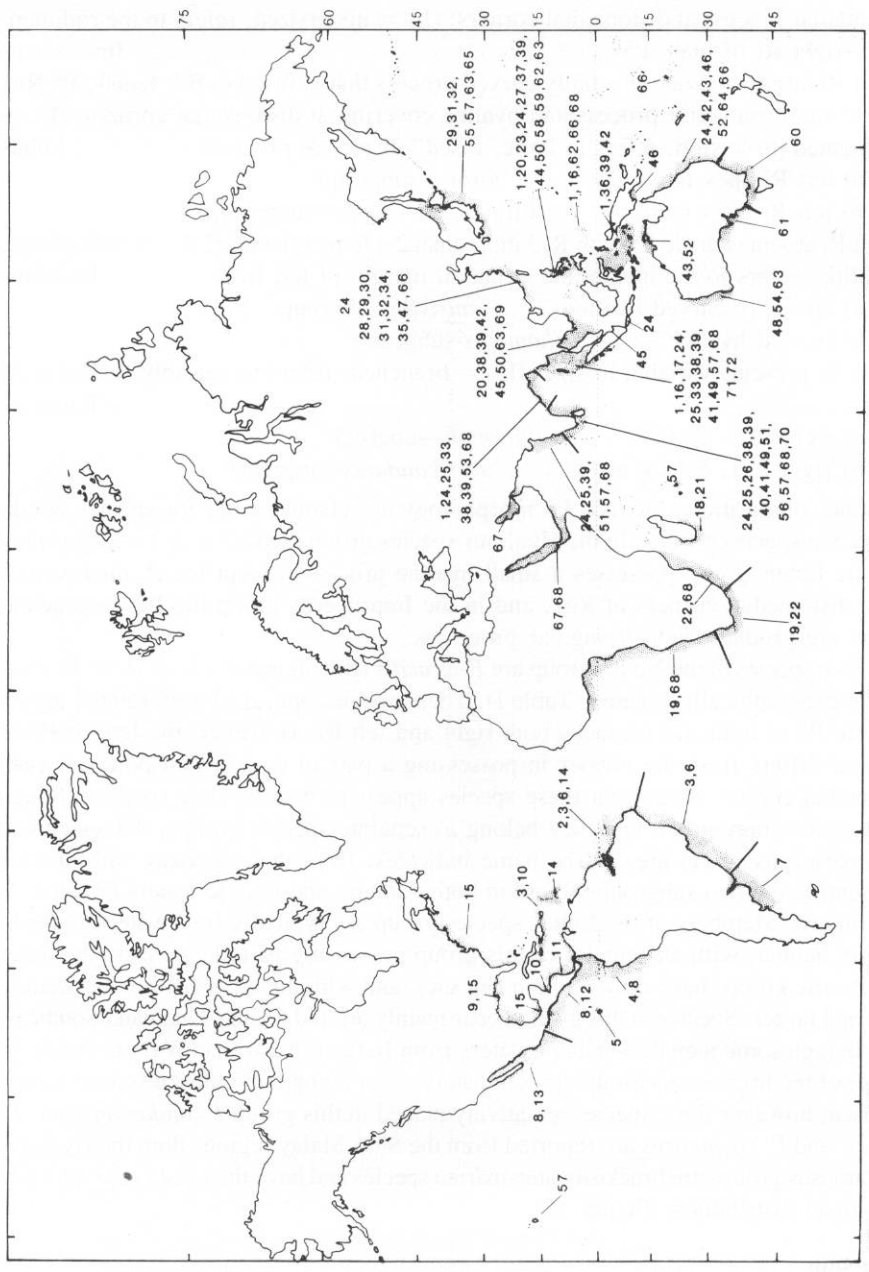

Fig. 15. Map showing the worldwide distribution of *Pseudodiaptomus*. The numbers correspond to species names as indicated on Table I.

the emerging zooplankton allowed for the collection of demersal species that are normally not collected by traditional net tows. Unfortunately, after the study the samples collected during different time periods were combined. Therefore, no statement as to time of emergence for the different species is possible. It was observed however, that maximum numbers of *Pseudodiaptomus* migrated into the water column just before dusk and dawn. In this study and Walter (1984), a total of 10 species of *Pseudodiaptomus* were presented, all of which were collected during the reef-associated zooplankton study. These species represent four species groups and are numerically ranked below in order of abundance.

Species	Female	Male
P. aurivilli	412	241
P. bispinosus	276	69
P. clevei	63	114
P. philippinensis	74	65
P. galleti	26	71
P. caritus	11	5
P. trihamatus	7	3
P. trispinosus	1	4
P. diadelus	1	2
P. ornatus	3	0

The occurrence of 10 congeneric species in one locale is unusual, but not unprecendented as Goswami (1983) reported six pseudodiaptomids from an Indian estuary. Another group of Indo-Pacific calanoids typically associated with pseudodiaptomids are species of *Acartia*. From the Cochin Backwaters (Kerala State) India, 9 – 11 species of *Acartia* were reported (Abraham, 1969; Tranter and Abraham, 1971; Goswami, 1983). Both genera have been reported to co-occur in Australian Waters (Greenwood, 1981) and African waters (Wooldridge and Melville-Smith, 1979), though with much reduced species diversity.

Species once thought to enjoy widespread distribution are now found to be biogeographically isolated. An example is *P. marinus* which reportedly occurred from Japan to Australia along the north-south axis and from India to Hawaii on the east-west axis. The results of this study and Walter (in preparation) show that not one, but several species closely related to *P. marinus* are present. Further studies on demersal zooplankton from the Indo-Pacific region are needed to determine the exact zoogeographical ranges and phylogenetic relationships of pseudodiaptomids. This paper is a starting point for such future research.

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