

The Natantian Shrimps (Crustacea, Decapoda) Associated with Invertebrates in Hawaii¹

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NUMEROUS INSTANCES OF SYMBIOTIC ASSOCIATIONS between natantian shrimps and other invertebrates have been reported in the literature (see reviews by Balss, 1956 and Patton, 1967). These associations have generally been considered to be examples of commensalism on the basis that the host offers shelter to the smaller associate without being "harmed" by its presence. They are grouped here with other hetero-specific associations (parasitism, mutualism, etc.) under the term symbiosis.

This checklist is a summary of general information on the natantian shrimps found associated with marine invertebrates in the Hawaiian Islands. It is based mostly on collections and observations made by the author. The checklist is intended not only as a guide for the quick identification of the shrimps but, hopefully, as an incentive for studies on the ecological, behavioral, and physiological aspects of the symbioses.

All synonyms and the most important references are given for each of the shrimp species. The diagnoses have been prepared by stressing those characters which can be easily observed in the specimens. Hosts listed are those recorded from Hawaii. Most hosts are common littoral forms and an examination of invertebrates from deeper water will probably result in the finding of new hosts and additional symbionts.

Fourteen species from three families of Natantia were found to be always in close association with other invertebrates. The groups serving as hosts and the number of associates in each is given as follows: Madreporaria (4), Echinoidea (4), Porifera (2), Antipatharia (1), Gastropoda (1), Pelecypoda (1), and Asteroidea (1).

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LIST OF SPECIES

FAMILY PALAEMONIDAE

All species listed under this family are members of the subfamily Pontoniinae. Holthuis (1955) has given a key to most of the genera.

Periclimenes soror Nobili

Periclimenes soror Nobili, 1904, p. 232; Kemp, 1922, p. 165; Gordon, 1939, p. 395, figs. 1-3 (redescription); Holthuis, 1952, pp. 9, 51, fig. 17, table (complete references)

Periclimenes bicolor Edmondson, 1935, p. 10, fig. 3

Hosts

Hosts are *Acanthaster planci* (Linn.), *Culcita novaeguineae* *arenosa* Perrier, *Mithrodia bradleyi* Verrill, and *Linckia multifora* (Lamarck) (Asteroidea).

Diagnosis

Rostrum is compressed and armed with 10 to 13 dorsal teeth; ventral border without teeth. Body is red, light yellow, or orange (sometimes with a white stripe on each side), depending on the color of the host.

Remarks

Individuals are normally found on the oral surface of the host, sometimes entering into the ambulacral grooves. One to 24 individuals have

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been observed in single starfish. Largest specimens reach a total length of 13 mm.

Recorded from several Indo-West-Pacific locations in association with various species of asteroids and one holothuroid (Bruce, 1965).

Periclimenes imperator Bruce

Periclimenes imperator Bruce, 1967, p. 53, figs. 23–25.

Hosts

Hosts are *Hexabranhus aureomarginatus* Ostergaard, *Dendrodoris tuberculosa* (Quoy and Gaimard) (Gastropoda, Nudibranchia, Dorioidea).

Diagnosis

Rostrum is compressed and conspicuously convex, its dorsal border armed with 23 to 30 small teeth; ventral border without teeth. Body is orange to red, with a broad white band across the carapace immediately behind the rostrum and another along the dorsal surface of the abdomen.

Remarks

Single pairs are occasionally found on the surface of nudibranchs. Largest specimens reach a total length of 20 mm.

Recorded associated with nudibranchs from the Indian Ocean and the Red Sea.

Onycocaris quadratophthalma (Balss)

Pontonia quadratophthalma Balss, 1921, p. 15, fig. 7; Edmondson, 1946, p. 250, fig. 150 c

Onycocaris quadratophthalma Holthuis, 1952, pp. 15, 150, table (complete references); Holthuis, 1955, fig. 36; Fujino and Miyake, 1969, p. 435, figs. 16–18

Host

Host is *Toxadocia violacea* de Laubenfels (Porifera, Demospongia).

Diagnosis

Rostrum is minute, not reaching beyond the eyes, and without teeth. First pair of pereopods is very slender; second pair with enlarged and

compressed chelae. Adult females have a conspicuously swollen body. Color is transparent-white.

Remarks

Individuals are found in relative abundance inside the spongocoel of the host, a tubular sponge from shallow water. Largest specimens reach a total length of 14 mm.

The species is known from the Pacific Ocean and Northwestern Australia. Fujino and Miyake (1969) obtained specimens from "the base of branching corals" in the Ryukyu Islands.

Harpiliopsis depressus (Stimpson)

Harpilius depressus Stimpson, 1861, p. 38; Rathbun, 1906, p. 920, text fig. 68, pl. 24, fig. 12; Kemp, 1922, pp. 226, 228, 231, figs. 69, 70; Edmondson, 1946, p. 248, fig. 149

Anchistia spinigera Ortmann, 1890, p. 511, pl. 36, figs. 23, 23 a

Periclimenes spinigerus Borradaile, 1898, p. 1004

Harpiliopsis depressus Holthuis, 1951, p. 70, pls. 21, 22 (complete references); Holthuis, 1952, pp. 16, 182, fig. 90, table; Holthuis, 1955, fig. 40a

Hosts

Hosts are *Pocillopora meandrina* var. *nobilis* Verrill and *P. ligulata* Dana (Anthozoa, Madreporaria).

Diagnosis

Body is strongly depressed. Rostrum is compressed, its dorsal border armed with five to seven teeth and the ventral border with two to five teeth. Pleurae of the last two abdominal segments end in the form of acute teeth. Body almost transparent, with thin bluish stripes running along its dorsal surface.

Remarks

Individuals are commonly found on the branches of living *Pocillopora*, the number of shrimp in each colony depending on the size of the coral head. Barry (1965) analyzed the stomach contents of four individuals and found

coral mucus, zooxanthellae, and algal spores in two of them. Largest specimens reach a total length of 17 mm but females as long as 27 mm have been recorded (Holthuis, 1951).

The species is widely distributed throughout the Indo-West-Pacific region and the tropical eastern Pacific. It has been recorded from various species of the madreporarian corals *Pocillopora*, *Porites*, *Acropora*, *Seriatopora*, and *Stylophora*. Jacquotte (1964) found a pair between the spines of the echinoid *Echinometra mathaei* (de Blainville).

Conchodytes tridacnae Peters

Conchodytes tridacnae Peters, 1852, p. 594; Kemp, 1922, pp. 279, 283, fig. 105; Holthuis, 1952, pp. 17, 195, fig. 95, table (complete references); Miyake and Fujino, 1968, p. 426, fig. 8, table

Conchodytes meleagrinae Peters, 1852, p. 594; Edmondson, 1946, p. 250, fig. 151

Pontonia tridacnae Dana, 1852, p. 571, pl. 37, fig. 1

Pontonia meleagrinae Bate, 1888, p. 707, pl. 124, figs. 1, 2

Host

Host is Mollusca, Pelecypoda: *Pinctada margaritifera* (Linn.).

Diagnosis

Rostrum is depressed, curved downwards, and without teeth. Second pair of pereopods are greatly enlarged. Body color is transparent-pink, with darker spots on the dorsal surface of the body and pereopods.

Remarks

Single pairs have been found in the mantle cavity of the pearl oyster. Females may reach a total length of 30 mm.

The species is known throughout the Indo-West-Pacific region. It has been recorded from species of *Pinctada*, *Tridacna*, and *Pinna*, as well as from the cloaca of a holothurian (Chopra, 1931).

Stegopontonia commensalis Nobili

Stegopontonia commensalis Nobili, 1906, p. 258. Nobili, 1907, p. 360, pl. 1, fig. 2. Kemp, 1922, p. 268. Holthuis, 1952, p. 16, table. Holthuis, 1955, fig. 32a

Hosts

Hosts are *Echinothrix calamaris* (Pallas), *E. diadema* (Linn.), and *Diadema paucispinum* A. Agassiz (Echinoidea).

Diagnosis

Rostrum is broad, depressed (lanceolated in dorsal view), and with a longitudinal carina running along its ventral surface. Body is dark purple, almost black, with a thin white line running along each side.

Remarks

Single pairs of the shrimp are found living on the primary spines of the host. Not common. Largest specimens reach a total length of 35 mm.

Recorded associated with species of *Echinothrix* and *Diadema* from several Indo-Pacific locations.

Tuleariocaris holthuisi Hipeau-Jacquotte

Tuleariocaris holthuisi Hipeau-Jacquotte, 1965, p. 247, pls. 1–5; Bruce, 1967, p. 43

Hosts

Hosts are *Echinothrix diadema* (Linn.) and *Astropyga radiata* (Leske) (Echinoidea).

Diagnosis

Rostrum is compressed but provided with a supraocular midrib. Dorsal border is armed with six to eight teeth; ventral border without teeth. Three last pairs of pereopods are composed of only six segments, the ischium and merus being fused. Individuals from *Echinothrix* are dark purple, almost black, changing to red at night; those from *Astropyga* are reddish-pink.

Remarks

Individuals are found living on the primary spines of the host, orienting the anterior end toward the base of the spines. Not common.

Largest specimens reach a total length of 13 mm.

The species has also been recorded in association with the echinoids *Echinometra mathaei* (de Blainville) and *Stomopneustes variolaris* (Lamarck) from Madagascar (Hipeau-Jacquotte, 1965).

Pontonides sp.

Pontonia maldivensis Borradaile, 1915, p. 213

Pontonides maldivensis Borradaile, 1917, p. 387, pl. 57, fig. 28

?*Pontonides uncinger* Davis and Cohen, 1968, p. 749, figs. 1, 3

Host

Host is *Cirrhipathes* sp. (Anthozoa, Antipatharia).

Diagnosis

Body is depressed. Rostrum is compressed, slightly curved downward, and ending in a sharp point. It has a short and untoothed medial keel above and below. Yellow and greenish bands alternate across body.

Remarks

The only two specimens collected agree in most characters with Borradaile's description of *Pontonides maldivensis*. Nevertheless, his description is inadequate and the species needs redescription with a review of the genus (A. J. Bruce, personal communication). Hawaiian specimens collected by Davis and Cohen (1968) from the same host appear to represent the same species. This is also possibly true with the shrimp (referred to as *Pontonides* sp.) reported from *Antipathes grandis* Verrill by Grigg (1964).

The two individuals were observed between the polyps of the host, collected from a depth of 20 meters off Halona Blowhole, Oahu. *Pontonides maldivensis* was described from an unspecified habitat in the Maldive Islands.

FAMILY GNATHOPHYLLIDAE

Members of this family can be easily recognized by their expanded, leaflike third maxilli-

peds. A key to the genera has been given by Holthuis (1955).

Gnathophylloides mammillatus (Edmondson)

Coralliocaridius mammillatus Edmondson, 1931, p. 5, pl. 1, fig. 2; Edmondson, 1946, p. 249

Host

Host is *Heterocentrotus mammillatus* (Linn.) (Echinoidea).

Diagnosis

Rostrum is very broad, depressed, and armed with four minute dorsal teeth. Second maxillipeds with an elongated, leglike endopod. Eyes sharply pointed. Body and appendages brick-red in color. Thin, dark lines are present along the dorsal surface of the body.

Remarks

Individuals are found clinging to the large primary spines of the host. At least one pair was found among all occupied sea urchins. The shrimp orient the anterior end toward the tip of the spines. Females may reach a total length of 15 mm. Shorter and stouter individuals have been observed between the flat secondary spines.

The species is known only from the Hawaiian Islands.

Gnathophylloides mineri Schmitt

Gnathophylloides mineri Schmitt, 1933, p. 7, fig. 3; Holthuis, 1955, fig. 52; Lewis, 1956, p. 288, figs. 1, 2

Hosts

Hosts are *Pseudoboletia indiana* (Michelin) and *Tripneustes gratilla* (Linn.) (Echinoidea).

Diagnosis

Rostrum is short, compressed, and armed with three to four dorsal teeth and a minute ventral tooth near the tip. Second maxillipeds with an endopod not longer than the exopod. Eyes are stout but not sharply pointed. Dorsal surface of the body is pink with thin and dark longitudinal lines. A broad, white band runs along each side of the carapace and abdomen; its in-

ferior border is whitish (as in individuals found on *Tripneustes gratilla* or on white *Pseudoboletia indiana*) or purple on *P. indiana* with purple spines).

Remarks

Species is commonly found on the spines of the oral surface *P. indiana*. Rare on *Tripneustes gratilla*. As on *Heterocentrotus mammillatus*, individuals orient their anterior end to the tip of the sea urchin's spines. Maximum length recorded is 8 mm.

This is the first time the species is reported from the Indo-Pacific region. Schmitt (1933) described it from specimens collected from "coral reefs" in Puerto Rico. It has also been recorded associated with the echinoids *Tripneustes ventricosus* (Lamarck) and *Lytechinus variegatus* (Lamarck) from the Caribbean Sea and Florida (Lewis, 1956).

FAMILY ALPHEIDAE

In addition to the four species listed below, two alpheids have been recorded as apparent associates of invertebrates. *Salmonus mauiensis* (Edmondson) was observed by Edmondson (1946) as being usually associated with a large polychaete (*Eurythoe* sp.). The shrimp, however, has apparently never been found again. Some specimens of *Alpheus paracentipes* Coutière have been collected from sponges (Banner, 1953).

Keys to most of the Hawaiian alpheids have been given by Banner (1953).

Synalpheus charon (Heller)

Alpheus charon Heller, 1861, p. 272, pl. 3, figs. 21, 22

Synalpheus charon Coutière, 1899, p. 264, figs. 331, 332; Banner, 1953, p. 37, fig. 11; Patton, 1966, p. 281, table I; Banner and Banner, 1967, p. 262

Synalpheus charon charon Banner, 1956, p. 331

Synalpheus charon obscurus Banner, 1956, p. 329, fig. 5

Synalpheus helleri de Man, 1911, p. 246, pl. 8, fig. 37

Hosts

Hosts are *Pocillopora meandrina* var. *nobilis* Verrill, *P. ligulata* Dana, and *P. cespitosa* Dana (Anthozoa, Madrepuraria).

Diagnosis

Inferior hook of dactylus of third pereopods has an expanded base, a spoonlike depression on inferior margin, and a broad, blunt tip. Superior hook is slightly longer and acute. Body is dark orange-red.

Remarks

Shrimps are very common in crevices at the base of living colonies of *P. meandrina* and *P. ligulata*. One pair is usually found in each colony. Individuals may reach a total length of 20 mm.

The species is known from several locations across the Indo-West-Pacific region and the Gulf of California. It appears to be an obligate associate of corals, especially of *Pocillopora*. Patton (1966) recorded it from the coral, *Stylophora*.

Synalpheus streptodactylus streptodactylus Coutière

Synalpheus neomeris streptodactylus Coutière, 1905, p. 870, pl. 70, fig. 1

Synalpheus streptodactylus de Man, 1911, p. 226, pl. 7, fig. 29

Synalpheus metaneomeris streptodactylus Coutière, 1921, p. 414, pl. 60, fig. 4

Synalpheus streptodactylus streptodactylus Banner and Banner, 1966 a, p. 157; Banner and Banner, 1966 b, p. 50, fig. 14, table I

Host

Host is *Zygomycale parishii* (Bowerbank) (Porifera, Demospongia).

Diagnosis

Inferior hook of dactylus of third pereopods has base twice the diameter of superior hook, almost equal in length, and has an acute tip. Inferior margin of merus of third pereopods armed with two to five movable spinules near its middle portion. Body is tannish-brown in color (D. M. Banner, personal communication).

Remarks

In Hawaii the species has been reported as occurring in abundant numbers in the spongocoel of *Z. parishii*, a large sponge (Banner and Banner, 1966a). This appears not to be the case in the other locations of the Pacific and Indian Oceans where the species has been recorded. Barry (1965) collected it from dead coral in Hawaii.

Alpheus lottini Guérin

Alpheus lottini Guérin-Ménéville, 1830, p. 38, pl. 3, fig. 3; Banner and Banner, 1964, p. 88 (notes on nomenclature); Banner and Banner, 1966b, p. 91, fig. 31, table I

Alpheus ventrosus H. Milne Edwards, 1837, p. 352; Banner, 1958, p. 164, fig. 4; Patton, 1966, p. 282, tables I-III

Alpheus laevis Randall, 1839, p. 141

Alpheoides laevis Paulson, 1875, p. 106, pl. 14, fig. 3

Crangon laevis Urita, 1921, p. 217

Crangon ventrosus Edmondson, 1923, p. 29; Edmondson, 1946, p. 255, fig. 155

Crangon ventrosa Banner, 1953, p. 88, fig. 28

Crangon latipes Banner, 1953, p. 82, fig. 27

Hosts

Hosts are Anthozoa, Madreporaria: *Pocillopora menadrina* var. *nobilis* Verrill, *P. ligulata* Dana, and *P. cespitosa* Dana.

Diagnosis

Carina of rostrum is separated from orbital hoods by deep, narrow grooves. Dactylus of third pereopods is blunt and compressed, with a longitudinal ridge on the inner side and a hooflike ridge on the tip. Body bright orange-red, darker on dorsal surface (usually in the form of stripes or spots).

Remarks

Species is a common and conspicuous associate of *Pocillopora*. It is found in pairs in the spaces between the coral branches. Barry (1965)

found that the shrimp feed mostly on small invertebrates and algae from the coral branches, but that coral mucus and tissue are also ingested. Maximum total length recorded is approximately 40 mm.

The species is an apparent obligate associate of corals throughout its wide range. It is known from across the entire Indo-West-Pacific region and from the Gulf of California to the Galápagos Islands. It has been recorded from *Pocillopora*, *Seriatopora*, and *Stylophora*.

Alpheus deuteropus Hilgendorf

Alpheus deuteropus Hilgendorf, 1878, p. 834, pl. 4, figs. 8-10; Banner and Banner, 1964, p. 88; Banner and Banner, 1966b, p. 80, fig. 26, table I

Crangon deuteropus Banner, 1953, p. 70, fig. 22

Host

Host is *Porites lobata* Dana (Anthozoa, Madreporaria).

Diagnosis

Large and small chelae have dense hair along the inner surface. Merus of third pereopods has a strong tooth on distal inferior border; dactylus is simple. Body is mostly transparent; carapace has sparsely scattered red chromatophores (D. M. Banner, personal communication).

Remarks

Single pairs are found living inside fissures on the surface of living coral colonies. The branching fissures are usually lined with short filamentous algae.

The species is known from locations across the Indo-West-Pacific region. It has been recorded from fissures on *Porites*, *Acropora*, and *Astreopora*.

LITERATURE CITED

- BALSS, H. 1921. Stomatopoda, Macrura, Paguridea und Galatheidea. Results of Dr. E. Mjöberg's Swedish Scientific Expedition to Australia, 1910-13. Kungliga Svenska Ve-

- tenskapsakademiens Handlingar, vol. 61, no. 10, pp. 1-24.
- 1956. Decapoda. VI. Ökologie (Fortsetzung). In: Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs, vol. 5, Buch 7, pp. 1369-1476.
- BANNER, A. H. 1953. The Crangonidae, or snapping shrimp, of Hawaii. Pacific Science, vol. 7, no. 1, pp. 1-147.
- 1956. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part I. Collections from the Mariana Archipelago. Pacific Science, vol. 10, no. 3, pp. 318-373.
- 1958. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part III. On a small collection from Onotoa, Gilbert Islands. Pacific Science, vol. 12, no. 2, pp. 157-169.
- BANNER, A. H., and D. M. BANNER. 1964. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part IX. Collections from the Phoenix and Line Islands. Pacific Science, vol. 18, no. 1, pp. 83-100.
- 1966 a. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part X. Collections from Fiji, Tonga, and Samoa. Pacific Science, vol. 20, no. 2, pp. 145-188.
- 1966 b. The alpheid shrimp of Thailand. The Siam Society, Monograph Series, no. 3, pp. 1-168.
- 1967. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. XI. Collections from the Cook and Society Islands. Occasional Papers of the Bernice P. Bishop Museum, vol. 23, no. 12, pp. 253-286.
- BARRY, C. K. 1965. Ecological study of the decapod crustaceans commensal with branching coral *Pocillopora meandrina* var. *nobilis* Verrill. M.S. Thesis, University of Hawaii, Honolulu.
- BATE, C. S. 1888. Report on the Crustacea Macrura dredged by H.M.S. *Challenger* during the years 1873-76. Report on the scientific results of the voyage of H.M.S. *Challenger* during the years 1873-76, Zoology, vol. 24, pp. 1-942.
- BORRADAILE, L. A. 1898. On some crustaceans from the South Pacific. III. Macrura. Proceedings of the Zoological Society of London, 1898, pp. 1000-1015.
- 1915. Notes on carides. Annals and Magazine of Natural History, ser. 8, vol. 15, pp. 205-213.
- 1917. On the Pontoniinae. The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. J. Stanley Gardiner, M.A. Transactions of the Linnean Society of London, Zoology, ser. 2, vol. 17, pt. 3, pp. 323-396.
- BRUCE, A. J. 1965. Notes on Indo-Pacific Pontoniinae. X. *Periclimenes cristimanus* sp. nov. A new pontoniid shrimp from Singapore. Annals and Magazine of Natural History, ser. 13, vol. 8, no. 92, pp. 487-493.
- 1967. Notes on Indo-Pacific Pontoniinae. III-IX. Descriptions of some new genera and species from the Western Indian Ocean and the South China Sea. Zoologische Verhandelingen, no. 87, pp. 1-73.
- CHOPRA, B. 1931. Further notes on Crustacea Decapoda in the Indian Museum. II. On some decapod Crustacea found in the cloaca of holothurians. Record of the Indian Museum, vol. 33, pp. 303-324.
- COUTIÈRE, H. 1899. Les Alpheidae, morphologie externe et interne, formes larvaires, biologie. Thèses présentées à la Faculté des Sciences de Paris. Masson et Cie., Paris. 599 pp. (Also in: Annales des Sciences Naturelles, Zoologie, vol. 9, pp. 1-590.)
- 1905. Les Alpheidae. In: J. S. Gardiner, ed., Fauna and geography of the Maldives and Laccadive Archipelagoes, vol. 2, no. 4, pp. 852-921.
- 1921. Les espèces d'Alpheidae rapportées de l'Océan Indien par M. J. Stanley Gardiner. The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. J. Stanley Gardiner, M.A., vol. 6, no. 10. Transactions of the Linnean Society of London, Zoology, ser. 2, vol. 17, no. 4, pp. 413-428.
- DANA, J. D. 1852. Crustacea. In: United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N., vol. 13, pp. 1-685. (Atlas folio published in 1855.)
- DAVIS, W. P., and D. M. COHEN. 1968. A

- gobiid fish and a palaemonid shrimp living on an antipatharian sea whip in the tropical Pacific. *Bulletin of Marine Science*, vol. 18, no. 4, pp. 749-761.
- EDMONDSON, C. H. 1923. Crustacea from Palmyra and Fanning Islands. With descriptions of new species of crabs from Palmyra Island by Mary J. Rathbun. *Bulletin of the Bernice P. Bishop Museum*, no. 5, pp. 1-43.
- 1931. New crustaceans from Kauai, Oahu and Maui. *Occasional Papers of the Bernice P. Bishop Museum*, vol. 9, no. 17, pp. 1-18.
- 1935. New and rare Polynesian Crustacea. *Occasional Papers of the Bernice P. Bishop Museum*, vol. 10, no. 24, pp. 1-40.
- 1946. Reef and shore fauna of Hawaii. Special Publication, Bernice P. Bishop Museum, no. 22, pp. 1-381.
- FUJINO, T., and S. MIYAKE. 1969. Studies on the genus *Onycocaris* with descriptions of five new species (Crustacea, Decapoda, Palaemonidae). *Journal of the Faculty of Agriculture, Kyushu University*, vol. 15, no. 4, pp. 403-448.
- GORDON, I. 1939. Redescription of *Periclimenes soror* Nobili (Crustacea, Decapoda). *Annals and Magazine of Natural History*, ser. 11, vol. 4, pp. 395-400.
- GRIGG, R. W. 1964. A contribution to the biology and ecology of the black coral, *Antipathes grandis*, in Hawaii. M. S. Thesis, University of Hawaii, Honolulu.
- GUÉRIN-MÉNEVILLE, F. E. 1830. Crustacés, arachnides et insectes. In: L. I. Duperrey, Voyage autour du monde, exécuté par ordre du roi, sur la corvette de sa majesté, *La Coquille*, pendant les années 1822, 1823 et 1825. *Zoologie*, vol. 2, pt. 2, pp. 1-319.
- HELLER, C. 1861. Beiträge zur Crustaceen-Fauna des Rothen Meeres. II Theil. Sitzungsberichte der Mathematisch-naturwissenschaftlichen Classe du Kaiserlichen Akademie der Wissenschaften, Wien, vol. 44, pp. 241-295.
- HILGENDORF, F. M. 1878. Die von Herrn W. Peters in Moçambique gesammelten Crustaceen. *Monatsberichte der K. Preuss. Akademie der Wissenschaften zu Berlin*, 1878, pp. 782-851.
- HIPEAU-JACQUOTTE, R. 1965. Notes de faunistique et de biologie marines de Madagascar.
- III. Un nouveau décapode nageur (Pontoniinae) associé aux oursins dans la région de Tuléar: *Tuleariocaris holthuisi* nov. gen. et nov. sp. *Recueil des Travaux de la Station Marine d'Endoume*, bull. 37, fasc. 53, pp. 247-259.
- HOLTHUIS, L. B. 1951. A general revision of the Palaemonidae (Crustacea Decapoda Natantia) of the Americas. II. The subfamilies Euryrhynchinae and Pontoniinae. *Occasional Paper, Allan Hancock Foundation Publications*, no. 11, pp. 1-332.
- 1952. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. II. Subfamily Pontoniinae. The Decapoda of the Siboga Expedition. Part XI. Siboga Expeditie, mon. 39a¹⁰, pp. 1-253, 1 table.
- 1955. The recent genera of the caridean and stenopodidean shrimps (class Crustacea, order Decapoda, supersection Natantia) with keys for their determination. *Zoologische Verhandelingen*, no. 26, pp. 1-157.
- JACQUOTTE, R. 1964. Notes de faunistique et de biologie marines de Madagascar. II. Décapodes nageurs associés aux échinodermes dans la région de Tuléar (sud-ouest de Madagascar). *Recueil des Travaux de la Station Marine d'Endoume*, bull. 32, fasc. 48, pp. 179-182.
- KEMP, S. 1922. Pontoniinae. Notes on Crustacea Decapoda in the Indian Museum. XV. *Records of the Indian Museum*, vol. 24, pp. 113-288.
- LEWIS, J. B. 1956. The occurrence of the macruran *Gnathophylloides mineri* Schmitt on the spines of the edible sea urchin *Tripneustes esculentus* Leske in Barbados. *Bulletin of Marine Science, Gulf and Caribbean Fisheries Institute*, vol. 6, no. 4, pp. 288-291.
- MAN, J. G. de. 1911. Family Alpheidae. The Decapoda of the Siboga Expedition. II. Siboga Expeditie, mon. 39a¹, pp. 133-465. (Supplement with plates and explanations published in 1915.)
- MILNE EDWARDS, H. 1837. Histoire naturelle des crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux. Tome II. Roret, Paris, 532 pp.
- MIYAKE, S., and T. FUJINO. 1968. Pontoniid shrimps from the Palau Islands (Crustacea,

- Decapoda, Palaemonidae). *Journal of the Faculty of Agriculture, Kyushu University*, vol. 14, no. 3, pp. 399–431.
- NOBILI, G. 1904. Diagnoses préliminaires de vingt-huit espèces nouvelles de stomatopodes et décapodes macroures de la Mer Rouge. *Bulletin du Musée d'Histoire Naturelle, Paris*, vol. 10, pp. 228–238.
- . 1906. Diagnoses préliminaires de crustacés, décapodes et isopodes nouveaux recueillis par M. le Dr. G. Seurat aux îles Tuamotou. *Bulletin du Musée d'Histoire Naturelle, Paris*, vol. 12, 256–270.
- . 1907. Ricerche sui crostacei della Polinesia. Decapodi, stomatopodi, anisopodi e isopodi. *Memorie dell'Accademia delle Scienze di Torino*, ser. 2, vol. 57, pp. 1–430.
- ORTMANN, A. E. 1890. Die Unterordnung Natantia Boas. Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und z.Z. im Strassburger Museum aufbewahrten Formen. I. Theil. *Zoologische Jahrbücher, Systematik, Ökologie und Geographie der Tiere*, vol. 5, pp. 437–542.
- PATTON, W. K. 1966. Decapod Crustacea commensal with Queensland branching corals. *Crustaceana*, vol. 10, no. 3, pp. 271–295.
- . 1967. Commensal Crustacea. *Proceedings of the symposium on Crustacea. Marine Biological Association of India. Part III*, pp. 1228–1243.
- PAULSON, O. 1875. Investigations of the Red Sea with notes on Crustacea of the adjacent seas. I. Podophthalmata and Edriophthalmata (Cumacea). Kiev, 144 pp. (English translation, Israel Program for Scientific Translation, 1961.)
- PETERS, W. 1852. Conchodytes, eine neue in Muscheln lebende Gattung von Garneelen. Bericht über die zur Bekanntmachung geeigneten Verhandlungen der K. Preuss. Akademie der Wissenschaften zu Berlin, 1852, pp. 588–595.
- RANDALL, J. W. 1839. Catalogue of the Crustacea brought by Thomas Nuttall and J. K. Townsend, from the West Coast of North America and the Sandwich Islands, with descriptions of such species as are apparently new, among which are included several species of different localities, previously existing in the collection of the Academy. *Journal of the Academy of Natural Sciences of Philadelphia*, vol. 8, no. 1, pp. 106–147.
- RATHBUN, M. J. 1906. The Brachyura and Macrura of the Hawaiian Islands. *Bulletin of the United States Fish Commission*, vol. 23, no. 3, pp. 827–930.
- SCHMITT, W. L. 1933. Four new species of decapod crustaceans from Porto Rico. *American Museum Novitates*, no. 662, pp. 1–9.
- STIMPSON, W. 1861. *Prodromus descriptionis animalium evertibratorum, quae in expeditione ad Oceanum Pacificum septentrionalem, a Republica Federata missa, C. Ringgold et J. Rodgers Ducibus, observati et descripti*. *Proceedings of the Academy of Natural Sciences of Philadelphia*, vol. 12, pp. 22–47.
- URITA, T. 1921. Species and distribution of Natantia found in Kagoshima Bay [in Japanese]. *Zoological Magazine, Tokyo*, vol. 33, 214–220.