

Documentation of the Symbiotic Emperor Shrimp, *Zenopontonia rex* (Kemp, 1922) from the Central Indian Ocean Islands

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Key Points:

- Animals show Symbiotic relationships for protection, reproduction, and nutrition, often switching their hosts or species over time.
- Suheli Island, an uninhabited atoll in the Lakshadweep archipelago, features a 17 km oval lagoon, supporting diverse marine habitats.
- This study records the first occurrence of the emperor shrimp (*Zenopontonia rex*) in association with sea cucumbers in Lakshadweep, Central Indian Ocean.

Abstract

During a faunal survey of the Lakshadweep Archipelago in the Central Indian Ocean Islands, two specimens of shrimps were observed on sea cucumbers, *Thelenota ananas* (Jaeger, 1833), from the north-west coast of Suheli Island, Lakshadweep. The Pontoniine shrimp, *Zenopontonia rex* (Kemp, 1922), is a common emperor shrimp of sea cucumber that was collected, identified and documented at the MTRLDST in Kavaratti, Lakshadweep. The present study reports the occurrence of a sea cucumber-associated emperor shrimp from Lakshadweep, Arabian Sea, India, for the first time. Here, we provide details on the morphology, distribution, and habitat of the species.

Keywords: Arabian Sea, Pontoniine, Symbionts, *Thelenota ananas*, Lakshadweep

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1. Introduction

Associations between tiny marine decapods and other larger marine animals are widespread globally, especially in coral reefs (Marin, 2012). Decapod crustaceans like Shrimps showed symbiotic association with different invertebrates and vertebrates, including sponges, cnidarians, molluscs, echinoderms, ascidians and fish (Bruce, 1976a; Bruce, 1976b; Castro, 1988; Li, 1993; Paramasivam et al., 2022a; Prakash et al., 2015; Ross et al., 1983; Thiel and

Baeza, 2001). Shrimps and their symbiotic relationship are typically commensalism (Paramasivam et al., 2022a). Symbionts benefit from such associations by using the hosts as a hiding place from predators or mating and moulting sites or as a source of food (Antokhina and Britayev, 2020; Bauer, 2004; Duffy, 2007; Fautin et al., 1995; Jons-son et al., 2001; Ory et al., 2013; Wirtz, 1997). More than 500 species belonging to the subfamily Pontoniinae were associated with all known large invertebrates in tropical marine waters (Li and Bruce, 2006; Marin, 2012). Fifty-

one species of shrimps are known to live in association with Indo-West Pacific echinoderms (Bruce, 1982). At present, 216 species belonging to 85 genera of Caridean shrimps has documented in Indian waters (Akash et al., 2020; Jose et al., 2020; Jose et al., 2021; Kemp, 1922; Madhavan et al., 2019; Paramasivam et al., 2022b; Paramasivam et al., 2022a; Prakash and Marimuthu, 2020; Prakash and Marimuthu, 2022; Radhakrishnan et al., 2012; Samuel et al., 2016). The degree of host specificity varies among symbiotic shrimps. Some of these species are opportunists and associated with various host species, whereas others are specialists inhabiting only one species (Antokhina and Britayev, 2020). Symbiotic invertebrates do not always stay on the same host during their lifespan but may switch from one individual or even species to another (Baeza and Thiel, 2007; Bell, 1984; Britayev, 1991; Castro, 1978; De Bruyn et al., 2011; Gray et al., 1968; Grove and Woodin, 1996; Mekhova et al., 2018; Prakash and Marimuthu, 2020).

Studies have brought crucial new findings on the decapod crustacean shrimp fauna in the waters of Lakshadweep Islands (Akash et al., 2020; Baby et al., 2015; Baby et al., 2019; Bharathi et al., 2019; Jose et al., 2020; Jose et al., 2021; Kuberan et al., 2019; Madhavan et al., 2019; Paramasivam et al., 2022b; Paramasivam et al., 2022a; Prakash and Ajithkumar, 2013; Prakash and Marimuthu, 2020; Prakash and Marimuthu, 2022; Prakash et al., 2011; Prakash et al., 2015; Radhakrishnan et al., 2012; Samuel et al., 2016). Many more shrimp-echinoderm associations remain to be hidden, and much more needs to be explored for the type of symbiotic relationships involved. This paper aims to provide a new report and association involving Pontonine shrimps and sea cucumber, based on recently collected extensive material from the Lakshadweep.

2. Materials and methods

2.1. Area of collection

North-west coast of Suheli Island in the Lakshadweep archipelago, Arabian Sea of the Indian Ocean (Figure 1). Suheli Par is an uninhabited atoll island within the Lakshadweep archipelago (10° 05' N, 72° 17' E), India, with an oval-shaped lagoon of about 17 km long with 78.6 SqKm area, this lagoon include two islands (Valiyakara

and Cheriyakara) and one sand bar (Indira-Shastri), one of the potential fishing ground in Lakshadweep island, fishermen of Agatti and Kavaratti depend on this reef and lagoon for their livelihood.

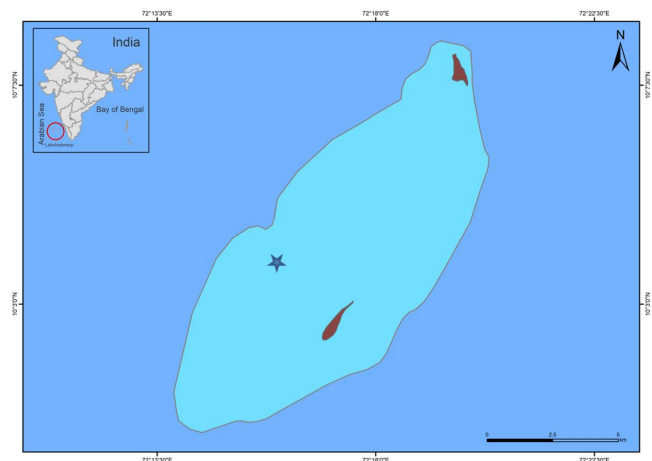


Figure 1: Map showing Suheli Island and ★ showing sample collected site in Lakshadweep archipelago.

2.2. Collection

Holothuria Thelenota ananas (Jaeger, 1833) were collected from a depth of 4m by SCUBA diving. Five specimens of *Thelenota ananas* (Jaeger, 1833) were observed for the occurrence of associated epibionts. The holothuria were collected gently by hand picking without harming the body parts and immediately placed in zip-lock bags. On reaching the boat, symbiotic organisms were separated from the host using forceps and brushes. The host sea cucumbers were released back to the original site after photographing and recording the morphometrics.

2.3. Measurements

Body measurements of the shrimp, such as carapace length (CL), carapace width (CW), rostrum length (RL) and telson length (TL), were measured using a digital calliper.

2.4. Identification and documentation

Shrimp were identified following (Bruce, 1967) and (Marin, 2012). Specimens examined in the present study are preserved in 70% ethanol and deposited in the Marine Taxonomy Reference Laboratory of the Department of Science and Technology (MTRLDST), Lakshadweep, India.

3. Results

Two specimens of shrimp associated with the Holothurian were collected and identified, using standard references, as *Zenopontonia rex* (Figure 2).

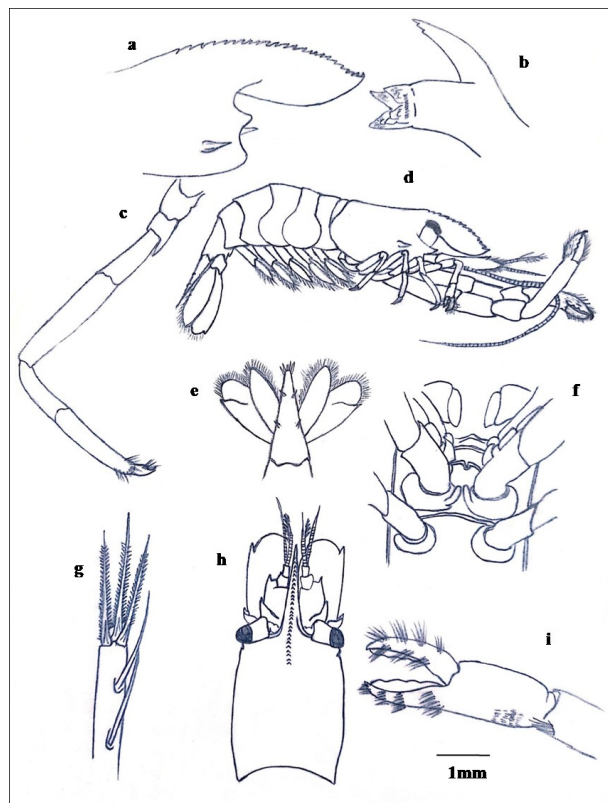


Figure 2: Image of *Zenopontonia rex* (Kemp, 1922) - (a). lateral view of the rostrum; (b). mandible; (c). pereopod III (d). whole animal, lateral view (e). Telson dorsal view showing posterior spines; (f) ventral view showing thoracic sternites; (g). appendix masculine; (h). Dorsal view of carapace with antennula and antenna; (i). major chela of pereopod II.

3.1. Taxonomy

Classification:

- **Class:** Malacostraca Latreille, 1802
- **Order:** Decapoda Latreille, 1802
- **Family:** Palaemonidae Rafinesque, 1815
- **Genus:** *Zenopontonia* Bruce, 1975
- **Species:** *Zenopontonia rex* (Kemp, 1922)

Synonyms:

- *Periclimenes imperator* Bruce, 1967
- *Periclimenes rex* Kemp, 1922

Periclimenes rex Kemp, 1922: 158, fig. 25, pl. 5 (type locality – Port Blair, Andaman Islands); Barnard 1955: 47; Macnae and Kalk 1962: 95; Bruce 1982: 203.

Periclimenes imperator Bruce, 1967: 53, figs. 23–25 (type locality: Zanzibar); 1968: 1166, fig. 10; 1971: 10; 1973: 135; 1976 a: 16; 1976 b: 16; 1977: 170; 1978: 230; 1982: 204; 1991: 237; 1996: 234; Bruce and Svoboda 1993: 9, fig. 2; Stack 1994: 55, 61, pl. 3, fig. 1; Fransen 1994: 123, pl. 3 E; Li 2000: 191, fig. 242.

3.2. Materials Examined

Two male specimens (MTRL DST S001) CL 3.82mm, CW 2.64mm, RL 3.97mm, and TL 2.55mm (MTRL DST S002), CL 2.30mm, CW 1.54, RL 1.72mm and TL 0.80mm, north-west coast of Suheli Island, Lakshadweep Archipelago, India (10°4'6.87"N, 72°15'46.37"E), 4m depth, Coll. KK Idrees Babu, 10 March 2021.

3.3. Diagnosis

Carapace smooth, with antennal and hepatic teeth; hepatic teeth are well developed, epigastric teeth absent; rostrum is deep and strongly depressed; dorsal carina convex bears numerous (up to 24) teeth; ventral margin is convex, ventral teeth are absent. Antennal spine is acute and slender. Scaphocerite exceeds the tip of the rostrum; flagellum is well developed. Mandibles are robust without palp. Eyes have a globular cornea; the inferior orbital angle is bluntly produced. Abdominal somites are smooth, with rounded pleura. Pleuron of the first abdominal segment is bluntly angled anteriorly. Telson has two pairs of dorsal submarginal spines and three pairs of posterior spines. Pereiopod I has robust segments; fingers are broad, shovel-like, with spatulate cutting edges. Pereiopod II are equal and symmetrical, with robust segments; palm is slender; fingers are subcylindrical, with well-developed smooth cutting edges and densely covered with long setae; fixed finger has two large teeth in the proximal half. Pereiopod III has robust segments; dactylus has sharply curved unguis without accessory spine. Propodus is robust; posterior margin



Figure 3: *Zenopontonia rex* (Kemp, 1922) with host *Thelenota ananas* (Jaeger, 1833) original colour before preservation.

with terminal and subterminal spines. Pleopod are of normal shape; the endopod of pleopod I have a subterminal triangular lobe on the distal half at the median border; proximal half bears some hook-like setae with long simple setae. Appendix masculina has four terminal setae. Uropods are normal, exopod with disto-lateral spine; well developed di-aeresis is present.

3.4. Colour in Life

The basic colour of this shrimp is orange-yellow to orange-red, with purple antennal plates, claws and walking legs, and white chromatophores in the skin covering much of the dorsal surface and tail fan. The colour of the shrimp varies depending on their host (Figure 3).

3.5. Distribution

Zenopontonia rex is native to the tropical Indo-West Pacific region. Its range extends from the Red Sea, Réunion and Mayotte to Hawaii, French Polynesia, southern Japan, New Caledonia and northern Australia (Bruce, 1967; Fransen

and Goud, 2000; Marin, 2012) Andaman Islands (Barnard, 1955; Bruce, 1982; Macnae and Kalk, 1962) and Vietnam (Bruce, 1993). Now, the occurrence is reported from Lakshadweep, Arabian Sea, India.

4. Discussion

This study provides the first record of a symbiotic shrimp *Z. rex* associated with sea cucumbers in the Arabian Sea, Lakshadweep. Sea cucumbers can be hosts for many commensal organisms, both ecto- and endo-commensals. The impact of symbionts on hosts determines the type of their interactions, and many of these associations are poorly understood (Britayev and Lyskin, 2002). The specimen collected from sea cucumbers during the present study matches the characteristics of *Periclimenes imperator* (Bruce, 1967), which is now considered a junior synonym of *Zenopontonia rex* (Kemp, 1922). Emperor shrimp, *Z. rex*, was recorded in association with more than 29 species of various invertebrates from different phyla (Antokhina et al., 2012; Fransen and Goud, 2000; Marin, 2012).

Studies on the Symbiotic association with sea cucumbers in Lakshadweep with special reference to Shrimps, crabs and polychaetes are scanty except for a few studies (Alcock, 1899; Dev Roy and Nand, 2005; Marudhupandi et al., 2014; Prakash et al., 2011; Thomas, 1969).

The present collection was made from the lagoon at 4 meters depth. Published reports on the distribution of this species show that the distribution depth of this species ranges up to 40 meters (130 feet). Living in association with large sea cucumbers, the study confirms the distribution of *Z. rex* in the Arabian Sea. This present distribution record fills the gap in the occurrence of *Z. rex* in the Central Indian Ocean islands. The earlier studies (Barnard, 1955; Bruce, 1967; Bruce, 1982; Fransen and Goud, 2000; Macnae and Kalk, 1962; Marin, 2012) recorded the distribution of the species in the Indo-West Pacific region of Red Sea, Réunion and Mayotte to Hawaii, French Polynesia, southern Japan, New Caledonia and northern Australia, Vietnam and the Andaman Islands.

5. Conclusion

This species has not been previously recorded from the Lakshadweep Islands. The morphometric characteristics of *Zenopontonia rex* agree well with the description by Bruce, 1967 and Marin, 2012 with the following features: number of rostrum teeth and number of telson spines. Previous records have reported the association of this species with the large nudibranch, sea stars and sea cucumbers. The present paper suggests that detailed studies be carried out to understand the distribution of this associated shrimp in Lakshadweep water.

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Author Contributions

IB collected the specimens; MPC conceived the study, identified the specimens and drafted the manuscript; IB and SK participated in the identification of species, design and coordination of the survey and preparation of this article. All authors read and approved the final manuscript.

Declaration of competing interest

We declare that we have no known competition for financial interests or personal relationships that could have appeared to influence the work reported in this article, and there is no conflict of interest between us or with other researchers in our institution or with any other institutions working in the same region and topic.

Data Availability Statement

The specimen used in the study is deposited in the reference collection, and the material is available for examination. All data collected during this study are included in the manuscript.

Ethical Approval

Since no animal experiments were conducted for this study, all applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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References

- Akash, S., Purushothaman, P., Madhavan, M., Ravi, C., Hisham, T., Sudhakar, M., & Kuldeep, L. (2020). *Urocaridella arabianensis* n. sp., a new palaemonid shrimp (crustacea, decapoda, palaemonidae) from lakshadweep islands, india with taxonomic comparison on the genus *urocaridella* borradale 1915. *Zootaxa*, 4816, 49–66. DOI: 10.11646/zootaxa.4816.1.2.
- Alcock, A. (1899). Materials for a carcinological fauna of India. No. 4. The Brachyura Cyclometopa. Part II. A revision of the Cyclometopa with an account of the families Portunidae, Cancridae and Corystidae. *Journal of the Asiatic Society of Bengal*, 68, 1–104.
- Antokhina, T., & Britayev, T. (2020). Host recognition behaviour and its specificity in Pontonine shrimp *Zenopontonia soror* (Nobili 1904) (Decapoda: Caridea: Palaemonidae) associated with shallow-water sea stars. *Journal of Experimental Marine Biology and Ecology*, 524, 151302.

- Antokhina, T., Savinkin, O., & Britayev, T. (2012). Asteroidea of Vietnam with some notes on their symbionts. In T. Britayev & D. Pavlov (Eds.), *Benthic fauna of the bay of nhatrang, southern vietnam* (pp. 406–446). KMK Scientific Press.
- Baby, S., Ghosh, S., Mohan, G., Cubelio, S., & Sudhakar, M. (2015). Occurrence of marbled shrimp *Saron marmoratus* Olivier 1811 (Decapoda: Caridea: Hippolytidae) in Lakshadweep Archipelago, India. *Proceedings of the Zoological Society*, 69(1), 157–160. DOI: 10.1007/s12595-015-0136-9.
- Baby, S., Ghosh, S., Rithin Raj, M., Prabhakaran, M., Gopi, M., Sumod, K., & Cubelio, S. (2019). Alpheid shrimp *Arete dorsalis* and its association with the slate pencil sea urchin *Heterocentrotus mamillatus* in Lakshadweep waters. *Proceedings of the Zoological Society*, 73(2), 201–204. DOI: 10.1007/s12595-019-00318-1.
- Baeza, J., & Thiel, M. (2007). The mating system of symbiotic crustaceans: A conceptual model based on optimality and ecological constraints. In J. Duffy & M. Thiel (Eds.), *Evolutionary ecology of social and sexual systems: Crustaceans as model organisms* (pp. 250–267). Oxford University Press.
- Barnard, K. (1955). Additions to the fauna list of South African Crustacea and Pycnogonida. *Annals of the South African Museum*, 43, 1–107.
- Bauer, R. (2004). *Remarkable Shrimps: Adaptations and Natural History of the Carideans*. University of Oklahoma Press.
- Bell, J. (1984). Changing residence: Dynamics of the symbiotic relationship between *Dissodactylus mellitae* Rathbun (Pinnotheridae) and *Mellita quinquiesperforata* (Leske) (Echinodermata). *Journal of Experimental Marine Biology and Ecology*, 82, 101–115.
- Bharathi, S., Purushothaman, P., Akash, S., Jose, S., Madhavan, M., Dhinakaran, A., Saravanane, N., Ajith Kumar, T., & Lal, K. (2019). *Periclimenella agattii* sp. nov., a new palaemonid shrimp (crustacea, decapoda, palaemonidae) from lakshadweep islands, india. *Zootaxa*, 4706, 483–493. DOI: 10.11646/zootaxa.4706.3.9.
- Britayev, T. (1991). Life cycle of the symbiotic scaleworm *Arctonoe vittata*. *Ophelia, Supplement*, 5, 305–312.
- Britayev, T., & Lyskin, S. (2002). Feeding of the symbiotic polychaete *Gastrolepidia clavigera* (Polynoidae) and its interactions with its hosts. *Doklady Biological Sciences*, 385, 352–356.
- Bruce, A. J. (1975). Further observations upon periclimenes noverca kemp, 1922, with the designation of a new genus *Zenopontonia*, and some remarks upon *Periclimenes parasiticus* borradale (decapoda natantia, palaemonidae). *Crustaceana*, 28(1), 275–285.
- Bruce, A. (1967). Notes on some Indo-Pacific Pontoniinae III–IX: Descriptions of some new genera and species from the western Indian Ocean and the South China Sea. *Zoologische Verhandelingen*, 87, 1–73.
- Bruce, A. (1976a). Coral reef Caridea and "commensalism". *Micronesica*, 12, 83–98.
- Bruce, A. (1976b). Shrimps and prawns of coral reefs with special reference to commensalism. In O. Jones & R. Endean (Eds.), *Biology and geology of coral reefs, volume iii, biology 2* (pp. 37–94). Academic Press.
- Bruce, A. (1982). The shrimps associated with Indo-West Pacific Echinoderms, with the description of a new species in the genus *Periclimenes* Costa, 1844 (Crustacea: Pontoniinae). *Australian Museum Memoirs*, 16, 191–216.
- Bruce, A. (1993). Some coral reef Pontoniine shrimps from Vietnam. *Asian Marine Biology*, 10, 55–75.
- Castro, P. (1978). Settlement and habitat selection in the larvae of *Echinoecus pentagonus* (Milne Edwards A), a brachyuran crab symbiotic with sea urchins. *Journal of Experimental Marine Biology and Ecology*, 34, 259–270.
- Castro, P. (1988). Animal symbioses in coral reef communities: A review. *Symbiosis*, 5, 161–184.
- De Bruyn, C., De Ridder, C., Rigaud, T., & David, B. (2011). Chemical host detection and differential attraction in a parasitic pea crab infecting two echinoids. *Journal of Experimental Marine Biology and Ecology*, 397, 173–178. DOI: 10.1016/j.jembe.2010.12.005.
- Dev Roy, M., & Nand, N. (2005). Brachyuran diversity of coral reef ecosystems in India. *Proceedings of National Seminar on Reef Ecosystem Remediation, SDMRI Research Publication 9*, 220–231.
- Duffy, J. (2007). Ecology and evolution of eusociality in sponge-dwelling shrimp. In J. Duffy & M. Thiel (Eds.), *Evolutionary ecology of social and sexual systems: Crustaceans as model organisms* (pp. 387–409). Oxford University Press.
- Fautin, D., Guo, C., & Hwang, J. (1995). Costs and benefits of the symbiosis between the anemone shrimp *Periclimenes brevicarpalis* and its host *Entacmaea quadricolor*. *Marine Ecology Progress Series*, 129, 77–84.
- Fransen, C., & Goud, J. (2000). *Chromodoris magnifica* (quoy and gaimard 1832), a new nudibranch host for the shrimp *Periclimenes imperator* bruce, 1967 (pontoniinae). *Zool Meded*, 73, 273–283.
- Gray, I., McCloskey, L., & Weihe, S. (1968). The commensal crab, *Dissodactylus mellitae* and its reaction to sand dollar host-factor. *J Elisha Mitchell Sci Soc*, 472–481.
- Grove, M., & Woodin, S. (1996). Conspecific recognition and host choice in a pea crab, *Pinnixa chaetopterana* (brachyura: Pinnotheridae). *Biol Bull*, 190, 359–366.
- Jaeger, G. (1833). *De holothuriis* [3 pls]. Gessner.

- Jonsson, L., Lundälv, T., & Johannesson, K. (2001). Symbiotic associations between anthozoans and crustaceans in a temperate coastal area. *Mar Ecol Prog Ser*, 209, 189–195.
- Jose, S., Paramasivam, P., Chandran, R., Bharathi, S., Dhinakaran, A., Kumar, T., & Lal, K. (2021). Two new distributional records of *Palaemonella* Dana, 1852 shrimps (Decapoda: Caridea: Palaemonidae) from Lakshadweep Islands, India. *Nauplius*, 29. DOI: 10.1590/2358-2936e2021049.
- Jose, S., Purushothaman, P., Madhavan, M., Akash, S., Bharathi, S., Dhinakaran, A., Ajith Kumar, T., & Lal, K. (2020). Two new records of hippolytoid shrimps, *Lysmata hochi* baeza & anker, 2008 (decapoda: Lysmatidae) and *Lysmata Amboinensis* (de man, 1888) from Lakshadweep Islands, India with taxonomic notes. *Zootaxa*, 4755, 353–364. DOI: 10.11646/zootaxa.4755.2.9.
- Kemp, S. (1922). Notes on crustacea decapoda in the indian museum. xv. pontoniinae. *Rec Ind Mus*, 24, 113–288.
- Kuberan, G., Rekha Devi, C., Purushothaman, P., Maheswarudu, G., Sreesanth, L., & Ragesh, N. (2019). A new record of deep sea shrimp *Glyphocrangon investigatoris* wood-mason & alcock, 1891 (decapoda: Glyphocrangonidae) from the southeastern arabian sea. *Zootaxa*, 4612(4), 566–570. DOI: 10.11646/zootaxa.4612.4.8.
- Latreille, P. (1802). *Histoire naturelle generale et particulliere des crustaces et des insectes* (Vol. 3). F. Dufart.
- Li, X. (1993). The associations between pontoniines and other marine invertebrates i. *Mar Sci*, 6, 43–48.
- Li, X., & Bruce, A. (2006). Further indo-west pacific palaemonoid shrimps (crustacea: Decapoda: Palaemonoidea), principally from the New Caledonian region. *J Nat Hist*, 40, 611–738.
- Macnae, W., & Kalk, M. (1962). The fauna and flora of sand flats at inhaca island, moçambique. *J Anim Ecol*, 31, 93–128.
- Madhavan, M., Purushothaman, P., Akash, S., Bharathi, S., Jose, S., Dhinakaran, A., Ravi, C., Kumar, T., & Lal, K. (2019). New record of *Thor hainanensis* xu & li, 2014 and taxonomical remarks on *Lysmata ternatensis* de man, 1902 (Decapoda: Thoridae & Lysmatidae) from the Lakshadweep Islands, India. *Zootaxa*, 4624. DOI: 10.11646/zootaxa.4624.3.4.
- Marin, I. (2012). New records and associations of pontoniine shrimps (Crustacea: Decapoda: Caridea: Palaemonidae: Pontoniinae) from the Nhatrang Bay, Vietnam, with taxonomic remarks on some species from the Indo-West Pacific Region. *Benthic fauna of the Bay of Nhatrang, Southern Vietnam*, 2, 345–405.
- Marudhupandi, T., Kumar, T., Prakash, S., Gopi, M., & Balasubramanian, T. (2014). A first report of symbiotic polychaete scale worm *Gastrolepidia clavigera* schmarda, 1861 (Phyllodocida: Polynoidae) from Lakshadweep Archipelago, India. *J Threat Taxa*, 6, 6385–6388.
- Mekhova, E., Martynov, A., & Britayev, T. (2018). Host selection and host switching in *Gymnolophus obscura* – a symbiotic ophiuroid associated with feather stars (Crinoidea: Comatulida). *Symbiosis*, 76, 313–320.
- Ory, N., Dudgeon, S., & Thiel, M. (2013). Host-use patterns and factors influencing the choice between anemone and urchin hosts by a caridean shrimp. *J Exp Mar Biol Ecol*, 449, 85–92.
- Paramasivam, P., Dhinakaran, T., Ajith Kumar, & Lal, K. (2022a). A new species of the genus *Actinimenes* đuriš and horká, 2017 (crustacea: Decapoda: Palaemonidae) from the Arabian sea, Lakshadweep islands, India. *Nauplius*, 30. DOI: 10.1590/2358-2936e2022008.
- Paramasivam, P., Madhavan, M., Ajith Kumar, T., & Lal, K. (2022b). New record of *Urocaridella antonbruunii* (bruce, 1967) from Southern India with taxonomic keys of *Urocaridella Borradaile*, 1915 (Decapoda; Palaemonidae). *Zootaxa*, 5138, 563–574. DOI: 10.11646/zootaxa.5138.5.4.
- Prakash, S., & Ajithkumar, T. (2013). Feeding behaviour of harlequin shrimp *Hymenocera picta* dana, 1852 (hymenoceridae) on sea star *Linckia laevigata* (ophidiasteridae). *J Threat Taxa*, 5, 4819–4821. DOI: 10.11609/JoTT.o3506.4819-21.
- Prakash, S., Ajithkumar, T., & Subramoniam, T. (2015). Notes on some indo-pacific caridean shrimps (crustacea: Decapoda: Caridea: Palaemonidae and gnathophyllidae) particularly from india. *Zootaxa*, 3914, 456–466. DOI: 10.11646/zootaxa.3914.4.5.
- Prakash, S., Idress Babu, K., Gopi, M., Ajith Kumar, T., & Balasubramanian, T. (2011). Discovery of the shrimp *Pycnocaris chagoae* bruce, 1972 (Decapoda: Caridea: Gnathophyllidae) in the Lakshadweep Archipelago, India. *Zootaxa*, 2988, 66–68. DOI: 10.11646/zootaxa.2988.1.5.
- Prakash, S., & Marimuthu, N. (2020). Notes on some crinoid-associated decapod crustaceans (Crustacea: Decapoda) of Lakshadweep Archipelago, Central Indian Ocean. *Zootaxa*, 4766, 86–100. DOI: 10.11646/zootaxa.4766.1.4.
- Prakash, S., & Marimuthu, N. (2022). First record of some crinoid and sponge-associated crustacean decapods (Crustacea: Decapoda) from Lakshadweep Archipelago. *Thalassas: Int J Mar Sci*, 1–6.
- Radhakrishnan, E., Deshmukh, V., Maheswarudu, G., Josileen, J., Dineshababu, A., Philipose, K., Sarada, P., Pillai, S., Saleela, K., Chakraborty, R., Dash, G., Sajeew, C., Thirumilu, P., Sridhara, B., Muniyappa, Y., Sawant, A., Vaidya, N., Johny, R., Verma, J., ... Raju, B. (2012). Prawn fauna (crustacea: Decapoda) of india—an annotated checklist of the penaeoid, segestoid, stenopodid and caridean prawns. *J Mar Biol Assoc India*, 54, 50–72. DOI: 10.6024/jmbai.2012.54.1.01697-08.

- Rafinesque, C. (1815). *Analyse de la nature ou tableau de l'univers et de corps organisés*. Palermo.
- Ross, D., Vernberg, F., & Vernberg, W. (1983). Symbiotic relations. *Biology of Crustacea*, 7, 163–212.
- Samuel, V., Sreeraj, C., Krishnan, P., Parthiban, C., Sekar, V., Chamundeeswari, K., Immanuel, T., Shesdev, P., Purvaja, R., & Ramesh, R. (2016). An updated checklist of shrimps on the Indian coast. *J Threat Taxa*, 8, 8977–8988. DOI: [10.11609/jott.2628.8.7.8977-8988](https://doi.org/10.11609/jott.2628.8.7.8977-8988).
- Thiel, M., & Baeza, J. (2001). Factors affecting the social behaviour of crustaceans living symbiotically with other marine invertebrates: A modelling approach. *Symbiosis*, 30, 163–190.
- Thomas, M. (1969). Notes on some interesting penaeid prawns (crustacea, decapoda) from the southeast coast of India. *J Mar Biol Assoc India*, 11, 191–197.
- Wirtz, P. (1997). Crustacean symbionts of the sea anemone *telmatactis cricoides* at madeira and the canary islands. *J Zool*, 242, 799–811.