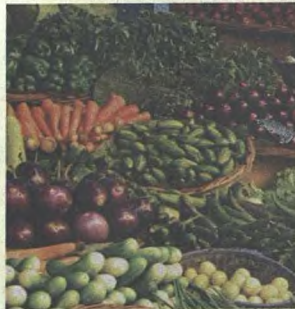


BIORESOURCES AND COMMERCIAL UTILIZATION: TRENDS, MARKET, SUPPLYCHAIN, AND SUSTAINABILITY



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Editors

Dr. C. George Thomas
Dr. Preetha Nilayangode



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3.3 CRAB RESOURCES OF KERALA – COMMERCIAL UTILIZATION, TRENDS, SUPPLY CHAIN AND SUSTAINABILITY

Jose Josileen

ICAR-Central Marine Fisheries Research Institute, Kochi

Introduction

Crabs enjoy wide distribution and landed as by-catch along with other resources. In 2020 they accounted 9.4% of crustacean landings in Kerala and have high demand in domestic as well as in export market. Crab culture is not advanced well like shrimp farming, as the seed production and farming procedures are tedious and survival also low. However, mud crab fattening is popular and many are practising it in coastal areas and Kerala is one of the leading states for live mud crab production. Except mud Crabs all other crabs are exported as different products to various countries.

Crab fishery

Kerala with 590 km long coast line, and 9 coastal districts with 174 marine fish landing centres with maximum (44) and minimum (12) numbers in Thiruvananthapuram and Kannur districts respectively (CMFRI-DoF, 2020). Fishery exists almost throughout the year except during ban period and 80% of the crabs are landed in trawls. Recent years, it was difficult to predict the fishing season and trend, as the pattern of crab landing varies over the years. During 2007-2020 the overall crab landings recorded was 51622213 tonnes (t) and the state is in 41th position contributing 7.7% of the total landings. The overall trend shows an increase, with highest landing in 2019 and lowest in 2011. The details of total crab landing (NMFDC, 2020) and the percentage in total crustaceans are presented in fig. 1.

Species Diversity

Kathirvel (2008) reported 990 species of marine brachyuran crabs belonging to 281 genera and 36 families from Indian waters. Trivedi et al. (2018) published an annotated checklist of the marine brachyuran crabs occurring in Indian waters, with a total of 910 species belonging to 361 genera and 62 families. They have reported 183 species from Kerala under 117 genera belonging to 35 families and the state is in 3rd position for species diversity. The records indicated that the east coast of India, with 803 species, is more diverse than the west coast, which has 446 species (218 genera and 51 families). Highest species diversity recorded in Kerala (183 species, 117 genera and 35 families) followed by Maharashtra (92 species). However, genetic diversity is more in Maharashtra (64 genera) than in Kerala (63 genera). Mathildellidae and Geryonidae families are found exclusively in Kerala while two families namely, Pseudozoidae and Trapeziidae, known only from Maharashtra and the family Gecarcinidae from Goa. Among the states in the west coast of India, three brachyuran families, viz., Homolodromiidae, Atelecyclidae and Goneplacidae are recorded only from the state of Kerala; their representatives do not occur in the east coast but are found only in the Andaman and Nicobar Islands and Lakshadweep within Indian territorial waters. Among the 39 families, the family Portunidae contains the maximum number of species (28) followed by Xanthidae (23 species) and

Leucosiidae (22 species). The genus *Charybdis* supports the maximum number of species (11) in the west coast (Dev Roy, 2013). (Annexure 1—Modified list is prepared with additional species not in the original list)

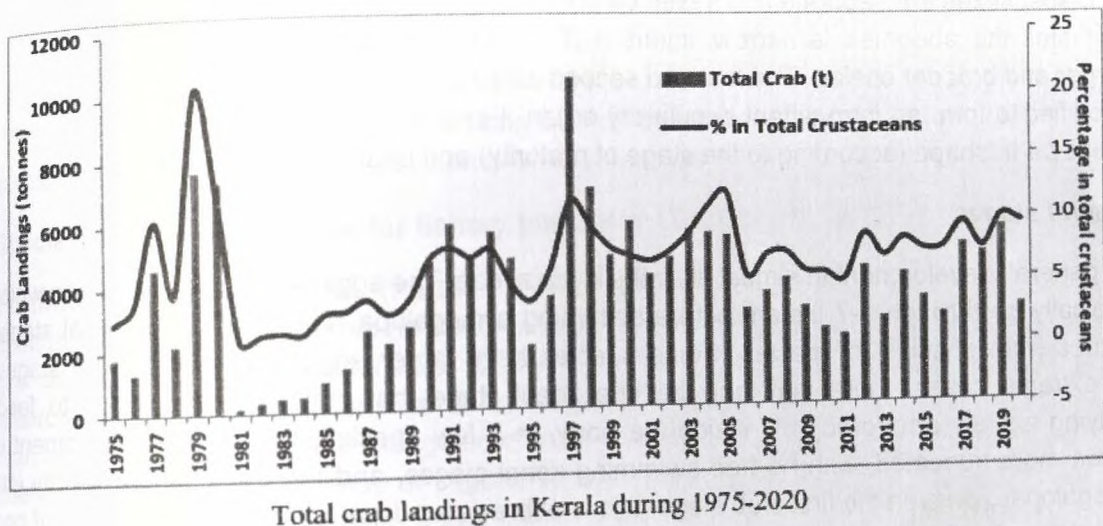


Figure 1. Total crab landing in kerala during 1975-2020.

Classification

Crabs belong to the order Decapoda and they can be classified into two main groups, brachyuran crabs (infraorder Brachyura) and anomuran crabs (infraorder Anomura). Most species of Brachyura, or true crabs, can easily be separated from the so-called "false crabs" belonging to the infraorder Anomura by having five pairs of locomotory appendages of a crab (the pereopods) are made up of a pair of usually powerful chelipeds (legs carrying a chela or pincer) and normally of four pairs of walking (or ambulatory) legs. The first appendage (or chela) itself consists of a palm (or manus) and two fingers, one of which is movable (the dactylus or movable finger), whereas the other one (Propodus/pollex) is fixed. The tips or edges of the fingers may be pectinated. In some families the last pair or all walking legs are modified for swimming or burrowing, as seen in the Portunidae (Carpenter and Niem, 1998). Most of the edible crabs caught from marine and brackish water environments belong to the family Portunidae Rafinesque, 1815. This family includes seven subfamilies; Caphyrinae Paulson, 1875, Carcininae MacLeay, 1838, Carupinae Paulson, 1875, Podophthalminae Dana, 1851, Polybiinae, Ortmann, 1893, Portuninae Rafinesque, 1815, Thalamitinae Paulson, 1875. In the seas around India, five genera of Portuninae have been reported by various authors. They are *Scylla*, *Portunus*, *Charybdis*, *Lupocyclus* and *Thalamita*. Among them the first three genera mainly contribute to the commercial crab fishery.

Portunidae

Carapace hexagonal, transversely ovate to transversely hexagonal, sometimes circular; dorsal surface relatively flat to gently convex, usually ridged or granulose; front broad, margin usually multidentate; usually 5 to 9 teeth on each anterolateral margin, posterolateral margins usually distinctly converging. Endopodite of second maxillipeds with strongly developed lobe on inner margin. Legs laterally flattened to varying degrees, last 2 segments of last pair paddle-like. Male abdominal segments 3 to 5 completely fused, immovable.

Life cycle & biology of Portunid crabs

Sexuality

In crabs, sexes are separate and sexes can be distinguished from the shape of the abdomen. In males the abdomen is narrow, inverted „T“ shaped and in addition mature males have larger and broader chelae. The first and second abdominal appendages (pleopods) are highly modified to form an intromittant copulatory organ. Females possess a broad abdomen, conical/oval in shape (according to the stage of maturity) and bear four pairs of pleopods.

Larval stages

In general, development in almost all crabs is via zoeae. The eggs hatch into first zoeae which typically go through 1-7 instars before becoming a megalopa. The number of zoeal stages varies from species to species. Some species have larger eggs and fewer zoeal stages. In extreme cases, there may only be one zoeal stage that may not even need to feed, relying entirely on stored yolk inside the body. In a few species, the larval development is even more truncated, with no free swimming zoeal stages, and the eggs hatch directly into megalopae, or even the first crab stage, this is abbreviated development. The life cycle of portunid crab *Portunus pelagicus* is depicted in fig. 1.

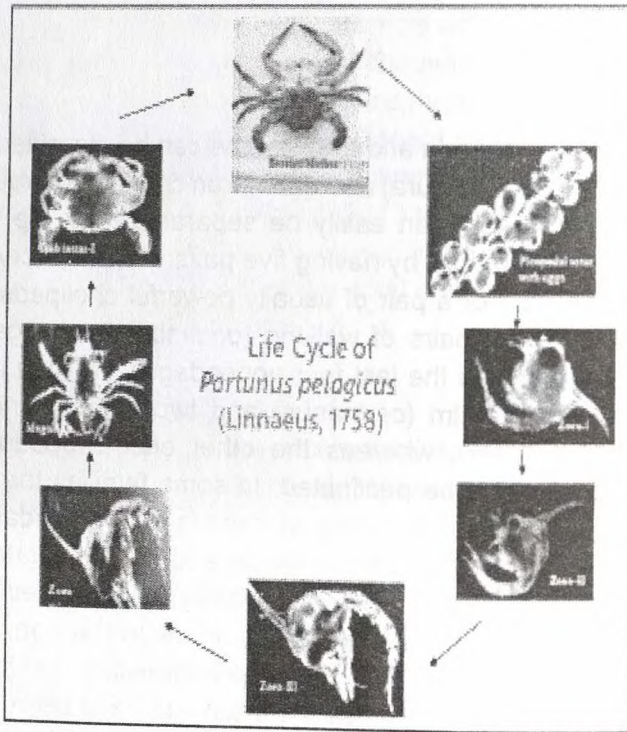


Figure 1. The life cycle of portunid crab *Portunus pelagicus*.

Commercial species

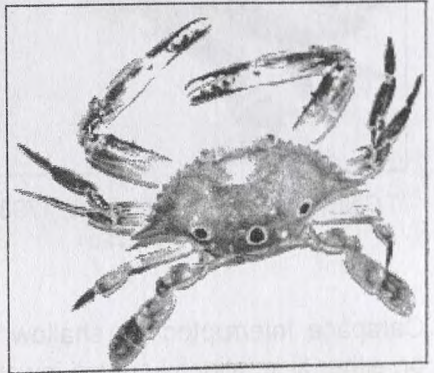
The important species which comprise the crab landings of Kerala are *Portunus pelagicus* (Blue swimmer crab), *P. sanguinolentus* (Three spotted crab), *Charybdis feriata* (Crucifix crab), *C. lucifera* (Yellowish brown crab), *C. natator* (Ridged swimming crab), *Scylla serrata* (Giant mud crab) and *S. olivacea* (Orange mud crab). Other species which appear in the landings occasionally in considerable quantities are *Charybdis smithii* (Swarming crab), *C. annulata* (Banded leg swimming crab) and *Podophthalmus vigil* (Sentinel crab).

Mud crab fishery

In Kerala, throughout the year fishing is taking place mainly from inshore areas and presently no fishing regulations are imposed for estuarine areas. No organised data collection procedures are not in place for mud crabs. They are not landed in main landing centres which are under observation, as the resource to be handled in live condition. Hence, accurate data on landing estimates are not available as in the case of other marine species. Main gears used are lift nets, traps, hook & line, hand-picking & other traditional devices. Other important states contributing to the mud crab production are Tamil Nadu, Andhra Pradesh & West Bengal.

Species identification guide for fishery purposes - Crabs-Portunidae

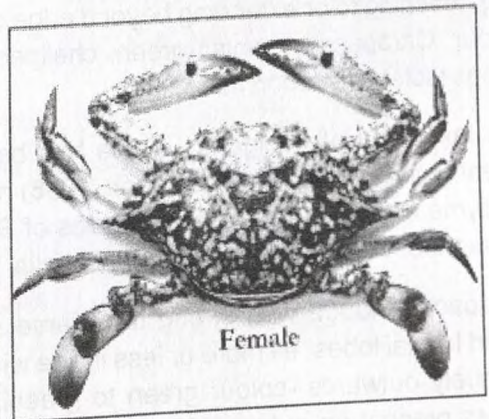
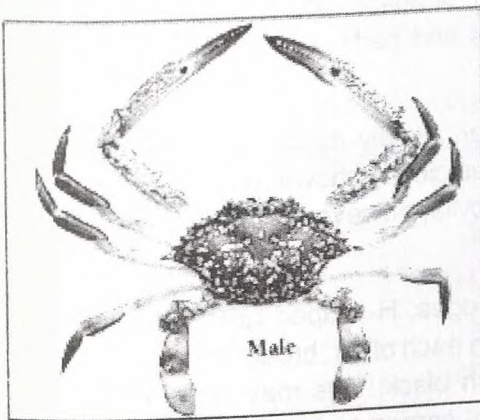
Portunus sanguinolentus (Herbst, 1783) (Blood spotted crab/Three-spot swimming crab) Carapace finely granulose, regions just discernible; 9 teeth on each anterolateral margin, the last tooth 2 to 3 times larger than preceding teeth. Chelae elongated in males; larger chela with conical tooth at base of fingers; pollex ridged
Colour: Olive to dark green, with 3 prominent maroon to red spots on posterior 1/3 of carapace.



Portunus pelagicus (Linnaeus, 1758)
(Flower crab/ Blue swimmer crab)

Carapace rough to granulose, front with 4 acutely triangular teeth; 9 teeth on each anterolateral margin, the last tooth 2 to 4 times larger than preceding teeth. Chelae elongate in males; larger chela with conical tooth at base of fingers. Sexes can be easily differentiated from their colour patterns of dorsal exoskeleton. Males are brilliantly coloured with irregular white patches and the tips of chelate and walking legs bright blue, hence the name 'blue swimmer crab'. Females are dull brown in colour with small irregular white patches on the carapace and tips of chelate and walking legs dark brown.

Genomic and morphometric studies on the species collected from Palk Bay and Gulf of Mannar regions of Tamil Nadu revealed that two species are existing in the area i.e., *Portunus pelagicus* and *P. reticulatus* (Josileen et al, 2019) and later, studies from off Cochin area also shown the existence of these two species (Josileen, personal communication). However, more studies are required for species identification and confirmation, as the results of the morphometric and genetic studies were not cent per cent consistent in precision.

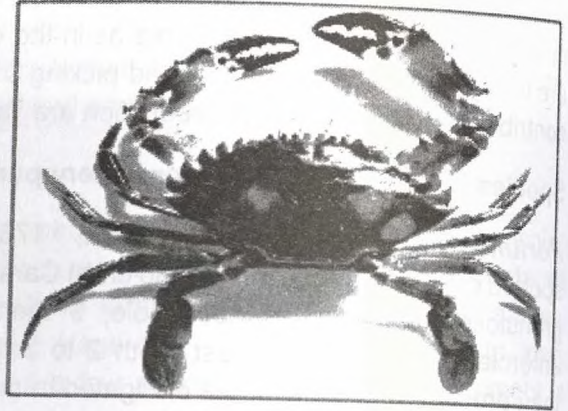


Charybdis feriata (Linnaeus, 1758) (Crucifix crab)

Carapace ovate; 5 distinct teeth on each anterolateral margin. Colour: Distinctive pattern of longitudinal stripes of maroon and white, usually with distinct white cross on median part of gastric region; legs and pincers with numerous scattered white spots.



Charybdis lucifera (Fabricius, 1798) (Yellow brown crab)



Charybdis natator (Herbst, 1789) (Ridged swimming crab)

Carapace interrupted by shallow ridges and moderately granulose; 6 anterolateral teeth on either side, slightly curved inwards, size of the spines gradually increases from anterior to the posterior side. Colour: Olive green to greenish brown, with 2 pairs of white patches in the branchial area on either side of the carapace. Dactylus and tips of the propodus of both chelae prominently in dark brown colour.

Carapace with densely covered with very short pubescence which is absent on several distinct transverse granulated ridges in anterior half. Colour: Orangish red overall, with ridges on carapace and legs dark reddish brown.

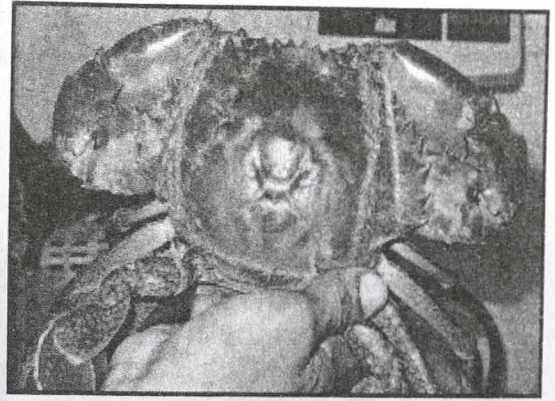
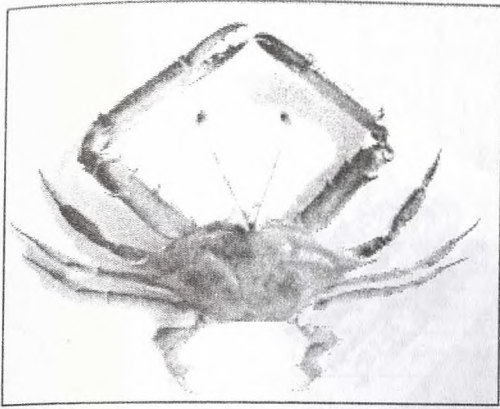
Carapace distinctly broader than long; anterior margin much broader than posterior margin, with posterolateral margins converging strongly towards narrow posterior carapace margin; orbits very broad. Eyes very long, reaching to or extending beyond edge of carapace. Colour: Carapace brownish green; chelipeds and parts of legs violet to maroon in adults.



Podophthalmus vigil (Fabricius, 1798)

The taxonomy of the genus *Scylla* has been terribly confused and is still difficult. Recent research in Australia (Keenan et al., 1998) has clearly shown, using morphological, DNA, and allozyme data, that there are 4 species of *Scylla*, however further studies carried out in India proved that two species only exists in India.

Carapace smooth, with strong transverse ridges; H-shaped gastric groove deep; relatively broad frontal lobes, all more or less in line with each other; broad anterolateral teeth, projecting obliquely outwards, colour green to greenish black; legs may be marbled. Well-developed spines present on outer surface of chelipedal carpus and anterior and posterior dorsal parts of palm.



Carapace brownish to brownish green in colour (sometimes orangish), palm orange to yellow. It has a smoother, more evenly convex carapace with very low transverse ridges, a shallow H-shaped gastric groove, the median pair of the frontal lobes more rounded and projecting slightly forwards of the lateral ones, the anterolateral teeth gently curving anteriorly, giving the carapace a less transverse appearance. It also has very low spines on both the outer surface of the chelipedal carpus and the dorsal surface of palm.

Commercial utilization and trade

All the commercial species have good demand in domestic market and a few species like Mud crabs (*Scylla* spp.) and *Portunus pelagicus* (Blue swimmer crab) are having high demand in export. Crab merchants procure the live mud crabs at collection centres and keep them in moist condition till the consignment is ready to send. After tying the chelate legs they are packed very carefully following the standard procedures in Styrofoam boxes and exported to different countries viz., Singapore, Hong Kong, Taipei, Shanghai, Beijing, London, Dubai etc. through Chennai, Kolkata, Cochin, Hyderabad, Ahmedabad international airports. The following table gives the details of commercial grades and the respective price of the mud crabs.

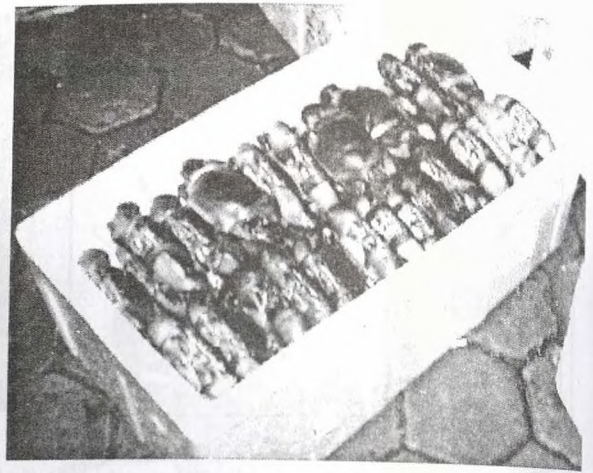
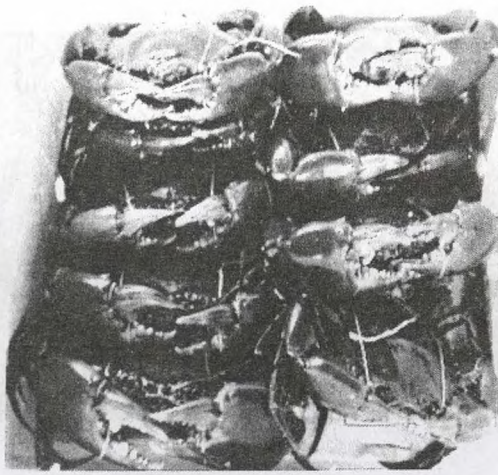
Crab Products

Apart from live export many crab products are been exported to various countries and details are given in following table. An exclusive market for Blue Swimmer Crab (BSC) products exists in Palk-Bay and Gulf of Mannar region of Tamil Nadu and the presented the details in following figure. Fishers bring crab in live condition and sell to the merchants, most of them are associated with one of the processing companies. At each BSC landing centres have th the present price of landed BSC is between Rs. 800-850/kg and products are exported to United States, where 98 % of the products are sold. However, in Kerala this is not been initiated so far

Commercial Name	Weight (g)	Price (Rs./kg)*
Double excel	>1000	2200
Excel	>800-1000	1800
Big	>550-800	1200
Medium	>350-550	550
Small	>250-350	250

*The prices given are for before pandemic period, during pandemic prices dropped.

Source: <https://5.imimg.com/data5/HT/IR/UR/SELLER-103259066/live-mud-crab-for-restaurant>.



Packed mud crabs in Styrofoam boxes ready for export

List of crab products exported

Frozen crab meat	Frozen pasteurised crab
Frozen stuffed crab	Frozen crab claws
Frozen mud crab	Frozen cut crab with claws
Frozen cut swimming crab	Frozen cut crab
Frozen dressed crab	Frozen swimming cut crab without claw
IQF whole crab	Frozen pasteurised crab meat
Frozen whole crab	Frozen crab meat with shell/crab chunks
Frozen soft shell crab	Frozen crab stick



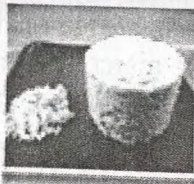
Colossal



Jumbo Lump



Super Lump



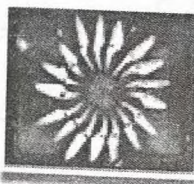
Lump



Special



Claw meat



Cocktail claws



Claw finger



Claw stick

Different BSC pasteurised products exported from India

Fishery and Management

Crabs are mainly landed by as a by-catch in trawls in Kerala and no separate management guidelines are available for the state other than the existing trawl ban during the months June-July every year. Minimum Legal Size has been implemented in Kerala (Mohamed et al., 2014) which includes three species of crabs and the details are given below.

MLS for 3 major species of Crabs
<i>Charybdis feriata</i> - 5 CW
<i>Portunus sanguinolentus</i> -7 CW
<i>Portunus pelagicus</i> - 9 CW

At present, there is no management plan is available exclusively for crabs other than for Blue Swimming Crab in Palk Bay region of Tamil Nadu by CMFRI (Josileen et. al, 2019). It is advised to educate fishermen to release the berried and soft crabs to the sea while crabs are alive. The state governments should take steps to implement ban during peak spawning seasons to prevent indiscriminate fishing. The immediate option is to ban fishing and marketing of berried crabs to ensure a sustainable fishery throughout the year as well as to improve the quality of the yield.

Reference

- Carpenter, K. E., and Niem, V. H. 1998. FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific (Volume 2. Cephalopods, crustaceans, holothurians and sharks ed.). food and agriculture organization of the United Nations Rome, 2: 687–1396 p.
- CMFRI-FSI-DoF. 2020. *Marine Fisheries Census 2016*. Central Marine Fisheries Research Institute, Indian Council of Agricultural Research, Ministry of Agriculture and Farmers Welfare; Fishery Survey of India and Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India. 116p.
- Dev Roy, M. K. 2013. Diversity and Distribution of Marine Brachyuran Crab Communities Inhabiting West Coast of India. In: *Ecology and Conservation of Tropical Marine Faunal Communities*. Springer- Verlag Berlin Heidelberg. pp. 147–169.
- Josileen, J., Maheswarudu, G., Padua, S., Geetha, S., Eldho, V., and Mohamed, K. S. 2019. CMFRI Marine Fisheries Policy Series No.15; Fishery Management Plan for Palk Bay Blue Swimming Crab. ICAR - Central Marine Fisheries Research Institute, Kochi. CMFRI Marine Fisheries Policy Series No.15: p. 100.
- Kathirvel, M. 2008. Biodiversity of Indian marinebrachyuran crabs. *Rajiv Gandhi Chair Special Publicaton 7*: 67–78.
- Mohamed, K. S., Zacharia, P. U., Maheswarudu, G., Sathianandan, T. V., Abdussamad, E. M., Ganga, U., Lakshmi, S. P., Sobhana, K. S., Rekha Nair, J., Josileen, J., Rekha Chakraborty, D., Joe, S. K., and Najmudeen, T. M. 2014. Minimum Legal Size (MLS) of capture to avoid growth overfishing of commercially exploited fish and shellfish species of Kerala. *Marine Fisheries Information Service; Technical and Extension Series (220)*: 3–7.
- NMFDC. (2020). National Marine Fishery Resources Data centre. ICAR-CMFRI.
- Trivedi, J. N., Trivedi, D. J., Vachhrajani, K. D., and NG, P. K. L. 2018. An annotated checklist of the marine brachyuran crabs (Crustacea: Decapoda: Brachyura) of India. *Zootaxa*, 4502(1): 1. <https://doi.org/10.11646/zootaxa.4502.1.1>

(1)	Family: Calappidae De Haan, 1833
1	<i>Calappa bilineata</i> Ng, Lai & Aungtonya, 2002
2	<i>Calappa calappa</i> (Linnaeus, 1758)
3	<i>Calappa capellonis</i> Laurie, 1906
4	<i>Calappa exanthematos</i> Alcock & Anderson, 1894
5	<i>Calappa gallus</i> (Herbst, 1803)
6	<i>Calappa pustulosa</i> Alcock, 1896
7	<i>Cycloes marisrubri</i> Galil & Clark, 1996
8	<i>Mursia bicristimana</i> Alcock & Anderson, 1895
9	<i>Mursia curtispina</i> Miers, 1886
(2)	Family: Carpiliidae Ortmann, 1893
10	<i>Carpilius maculates</i> (Linnaeus, 1758)
(3)	Family: Dorippidae MacLeay, 1838
11	<i>Dorippe quadridens</i> (Fabricius, 1781)
12	<i>Dorippoides facchino</i> (Herbst, 1785)
13	<i>Dorippoides nudipes</i> Manning & Holthuis, 1986
(4)	Family: Dotillidae Stimpson, 1858
14	<i>Dotilla intermedia</i> De Man, 1888
15	<i>Dotilla malabarica</i> Nobili, 1903
16	<i>Dotilla myctiroides</i> H. Milne-Edwards, 1852
17	<i>Scopimera proxima</i> Kemp, 1919
(5)	Family: Dromiidae De Haan, 1833
18	<i>Homalodromia coppingeri</i> Miers, 1884
(6)	Family: Epialtidae MacLeay, 1838
19	<i>Acanthonyx scutellatus</i> MacLeay, 1838
20	<i>Doclea muricata</i> (Fabricius, 1788)
21	<i>Doclea ovis</i> (Fabricius, 1787)
22	<i>Doclea rissoni</i> Leach, 1815
23	<i>Hyastenus planasius</i> (Adams & White, 1848)
24	<i>Hyastenus pleione</i> (Herbst, 1803)
25	<i>Menaethius monoceros</i> (Latreille, 1825)
26	<i>Oxypleurodon aurora</i> (Alcock, 1899)
27	<i>Rochinia riversandersoni</i> (Alcock, 1895)
28	<i>Simocarcinus camelus</i> Klunzinger, 1906
29	<i>Simocarcinus simplex</i> (Dana, 1852)
(7)	Family: Ethusidae Guinot, 1977
30	<i>Ethusa indica</i> Alcock, 1894
(8)	Family: Geryonidae Colosi, 1923
31	<i>Chaceon alcocki</i> Ghosh & Manning, 1993
(9)	Family: Goneplacidae MacLeay, 1838
32	<i>Carcinoplax fasciata</i> Ng & Kumar, 2016
33	<i>Carcinoplax longipes</i> (Wood-Mason, in Wood-Mason & Alcock, 1891)

34	<i>Carcinoplax specularis</i> Rathbun, 1914
(10)	Family: Grapsidae MacLeay, 1838
35	<i>Grapsus albolineatus</i> Latreille, in Milbert, 1812
36	<i>Metopograpsus messor</i> (Forsk., 1775)
(11)	Family: Hexapodidae Miers, 1886
37	<i>Hexapus sexpes</i> (Fabricius, 1798)
(12)	Family: Homolidae De Haan, 1839
38	<i>Gordonopsis profundorum</i> (Alcock & Anderson, 1899)
39	<i>Lamoha longipes</i> (Alcock & Anderson, 1899)
40	<i>Moloha tumida</i> Ng & Kumar, 2015
41	<i>Paramolopsis boasi</i> Wood-Mason, in Wood-Mason & Alcock, 1891
(13)	Family: Homolodromiidae Alcock, 1899
42	<i>Dicranodromia baffini</i> (Alcock & Anderson, 1899)
(14)	Family: Hymenosomatidae MacLeay, 1838
43	<i>Rhynchoplax messor</i> Stimpson, 1858
44	<i>Neorhynchoplax alcocki</i> (Kemp, 1917)
45	<i>Neorhynchoplax attenuipes</i> (Chopra & Das, 1930)
46	<i>Neorhynchoplax tuberculata</i> (Chopra & Das, 1930)
47	<i>Rhynchoplax messor</i> (Stimpson, 1858)
(15)	Family: Inachidae MacLeay, 1838
48	<i>Achaeus curvirostris</i> (A. Milne-Edwards, 1873)
49	<i>Achaeus lacertosus</i> Stimpson, 1858
50	<i>Cyrtomaia suhmii</i> Miers, 1885
51	<i>Encephaloides riversandersoni</i> Alcock, 1899
52	<i>Grypachaeus hyalinus</i> Alcock & Anderson, 1899
53	<i>Physachaeus ctenurus</i> Alcock, 1895
(16)	Family: Iphiculidae Alcock, 1896
54	<i>Pariphiculus coronatus</i> (Alcock & Anderson, 1894)
55	<i>Pariphiculus mariannae</i> (Herklots, 1852)
(17)	Family: Leucosiidae Samouelle, 1819
56	<i>Arcania brevifrons</i> Chen, 1989
57	<i>Arcania cornuta</i> (MacGilchrist, 1905)
58	<i>Arcania gracilis</i> Henderson, 1893
59	<i>Euclosiana crosnieri</i> (Chen, 1989)
60	<i>Euclosiana nitida</i> (Galil, 2003)
61	<i>Euclosiana obtusifrons</i> (De Haan, 1841)
62	<i>Ixa inermis</i> Leach, 1817
63	<i>Leucisca rubifera</i> (Muller, 1887)
64	<i>Lyphira heterograna</i> (Ortmann, 1892)
65	<i>Lyphira perplexa</i> Galil, 2009
66	<i>Myra fugax</i> (Fabricius, 1798)
67	<i>Myra pernix</i> Galil, 2001
68	<i>Nursia nasuta</i> Alcock, 1896
69	<i>Oreophorus reticulatus</i> Adams & White, 1849

70	<i>Paranursia abbreviate</i> (Bell, 1855)
71	<i>Philyra corallicola</i> Alcock, 1896
72	<i>Philyra globus</i> (Fabricius, 1775)
73	<i>Philyra malefactrix</i> (Kemp, 1915)
74	<i>Philyra scabriuscula</i> (Fabricius, 1798)
75	<i>Philyra syndactyla</i> Ortmann, 1892
76	<i>Seulocia pubescens</i> (Miers, 1877)
77	<i>Seulocia marmoreal</i> (Bell, 1855)
78	<i>Tanaoa granulosa</i> (Alcock & Anderson, 1894)
79	<i>Tanaoa pustulosus</i> (Wood-Mason, in Wood-Mason & Alcock, 1891)
80	<i>Urashima lamellidentatus</i> (Wood-Mason, 1892)
81	<i>Urnalana margaritata</i> (A. Milne-Edwards, 1873)
(18)	Family: Lyreididae Guinot, 1993
82	<i>Lysirude channeri</i> (Wood-Mason, 1885)
(19)	Family: Macrophthalmidae Dana, 1851
83	<i>Macrophthalmus (Macrophthalmus) brevis</i> (Herbst, 1804)
84	<i>Macrophthalmus (Mareotis) pacificus</i> Dana, 1851
(20)	Family: Mathildellidae Karasawa & Kato, 2003
85	<i>Mathildella sinclairi</i> (Alcock & Anderson, 1899)
(21)	Family: Matutidae De Haan, 1835
86	<i>Ashtoret lunaris</i> (Forsk., 1775)
87	<i>Ashtoret miersi</i> (Henderson, 1887)**
88	<i>Matuta planipes</i> Fabricius, 1798
89	<i>Matuta victor</i> (Fabricius, 1781)
(22)	Family: Menippidae Ortmann, 1893
90	<i>Menippe rumphii</i> (Fabricius, 1798)
91	<i>Myomenippe hardwickii</i> (Gray, 1831)
(23)	Family: Ocypodidae Rafinesque, 1815
92	<i>Austruca annulipes</i> (H. Milne-Edwards, 1837)
93	<i>Austruca lactea</i> (De Haan, 1835)
94	<i>Austruca perplexa</i> (H. Milne-Edwards, 1837)
95	<i>Austruca sindensis</i> (Alcock 1900)
96	<i>Gelasimus vocans</i> (Linnaeus, 1758)
97	<i>Ocypode brevicornis</i> H. Milne-Edwards, 1837
98	<i>Ocypode ceratophthalmus</i> (Pallas, 1772)
99	<i>Ocypode cordimana</i> Latreille, 1818
100	<i>Tubuca dussumieri</i> (H. Milne-Edwards, 1852)
(24)	Family: Oziidae Dana, 1851
101	<i>Epixanthus frontalis</i> (H. Milne-Edwards, 1834)
102	<i>Ozius rugulosus</i> Stimpson, 1858
103	<i>Ozius tuberculosis</i> H. Milne-Edwards, 1834
(25)	Family: Parthenopidae MacLeay, 1838
104	<i>Cryptopodia echinosa</i> Chiong & Ng, 1998
105	<i>Parthenope longimanus</i> (Linnaeus, 1758)

106	<i>Pseudolambrus calappoides</i> (Linnaeus, 1764)
(26)	Family: Pilumnidae Samouelle, 1819
107	<i>Actumnus squamosus</i> (De Haan, 1835)**
108	<i>Benthopanope indica</i> (De Man 1887)
109	<i>Eurycarcinus orientalis</i> A. Milne-Edwards, 1867
110	<i>Heteropanope glabra</i> Stimpson, 1858
111	<i>Heteropilumnus ciliates</i> (Stimpson, 1858)
112	<i>Pilumnus minutes</i> De Haan, 1895
113	<i>Serenepilumnus pisifer</i> (MacLeay, 1838)
114	<i>Typhlocarcinus kerala</i> Ng. Devi & Kumar, 2017
115	<i>Zebrida adamsii</i> White, 1847
(27)	Family: Pinnotheridae De Haan, 1833
116	<i>Abyssotheres abyssicola</i> (Alcock & Anderson, 1899)
117	<i>Afropinnotheres ratnakara</i> Ng & Kumar, 2015
118	<i>Arcotheres casta</i> (Antony & Kuttyama, 1971)
119	<i>Arcotheres ridgewayi</i> (Southwell, 1901)
120	<i>Nepinnotheres sanguinolariae</i> (Pillai, 1951)
(28)	Family: Plagusidae Dana, 1851
121	<i>Plagusia depressa</i> (Fabricius, 1775)
122	<i>Plagusia squamosa</i> (Herbst, 1790)
(29)	Family: Portunidae Rafinesque, 1815
123	<i>Charybdis (Charybdis) amboinensis</i> Leene, 1938
124	<i>Charybdis (Charybdis) annualata</i> Fabricius, 1798
125	<i>Charybdis (Charybdis) brevispinosa</i> Leene, 1937**
126	<i>Charybdis (Charybdis) callianassa</i> (Herbst, 1798)
127	<i>Charybdis (Charybdis) feriata</i> (Linnaeus, 1758)
128	<i>Charybdis (Charybdis) hellerii</i> (A. Milne-Edwards, 1867)
129	<i>Charybdis (Charybdis) lucifera</i> (Fabricius, 1798)
130	<i>Charybdis (Charybdis) miles</i> (De Haan, 1835)
131	<i>Charybdis (Charybdis) natator</i> (Herbst, 1794)
132	<i>Charybdis (Charybdis) riversandersoni</i> Alcock 1899
133	<i>Charybdis (Charybdis) variegata</i> (Fabricius, 1798)
134	<i>Charybdis (Goniohellenus) hoplites</i> (Wood-Mason, 1877)
135	<i>Charybdis (Goniohellenus) omanensis omanensis</i> Leene, 1938
136	<i>Charybdis (Goniohellenus) omanensis septentrionalis</i> Turkey & Spiridonov 2006
137	<i>Charybdis (Goniohellenus) smithii</i> MacLeay, 1838
138	<i>Cycloachelous granulatus</i> (H. Milne-Edwards, 1834)
139	<i>Lissocarcinus laevis</i> Miers, 1886
140	<i>Lissocarcinus polybiodes</i> Adams & White, 1849
141	<i>Monomia argentata argentata</i> (A. Milne-Edwards, 1861)
142	<i>Monomia gladiator</i> (Fabricius, 1798)
143	<i>Podophthalmus vigil</i> (Fabricius, 1798)
144	<i>Portunus reticulatus</i> (Herbst, 1799)
145	<i>Portunus sanguinolentus</i> (Herbst, 1783)

146	<i>Scylla olivacea</i> (Herbst, 1796)
147	<i>Scylla serrata</i> (Forsk., 1775)
148	<i>Thalamita crenata</i> (Latreille, 1829)
149	<i>Thalamita taprobanica</i> Alcock, 1899
150	<i>Thalamita woodmasoni</i> Alcock, 1899
151	<i>Xiphonectes hastatoides</i> (Fabricius, 1798)
(30)	Family: Polybiidae Ortmann, 1893
152	<i>Parathranites orientalis</i> (Miers, 1886)
(31)	Family: Raninidae De Haan, 1839
153	<i>Notosceles serratifrons</i> (Henderson, 1893)
(32)	Family: Sedarmidae Dana, 1851
154	<i>Clistocoeloma balansae</i> (A. Milne-Edwards, 1873)
155	<i>Clistocoeloma lanatum</i> (Alcock, 1900)
156	<i>Clistocoeloma merguense</i> De Man, 1888
157	<i>Episesarma mederi</i> (H. Milne-Edwards, 1854)
158	<i>Metasesarma obesum</i> (Dana, 1851)
159	<i>Nanosesarma andersonii</i> (De Man, 1887)
160	<i>Nanosesarma batavicum</i> (Moreira, 1903)
161	<i>Neosarmatium indicum</i> (A. Milne-Edwards, 1868)
162	<i>Neosarmatium malabaricum</i> (Henderson, 1893)
163	<i>Neosarmatium punctatum</i> (A. Milne-Edwards, 1873)
164	<i>Parasesarma pictum</i> (De Haan, 1835)
165	<i>Parasesarma plicatum</i> (Latreille, 1803)
166	<i>Perisesarma bidens</i> (De Haan, 1835)
167	<i>Pseudosesarma edwardsii</i> (De Man, 1887)
168	<i>Pseudosesarma glabrum</i> Ng, Rani & Bijoy Nandan, 2017
169	<i>Selatium brockii</i> (De Man, 1887)
(33)	Family: Trapeziidae Miers, 1886
170	<i>Quadrella coronata</i> Dana, 1852 **
(34)	Family: Trichopeltariidae Tavares & Cleva, 2010
171	<i>Trichopeltarion glaucus</i> (Alcock & Anderson, 1899)
(35)	Family: Varunidae H. Milne Edwards, 1853
172	<i>Parapyxidognathus deianira</i> (De Man, 1888)
173	<i>Varuna litterata</i> (Fabricius, 1798)
(36)	Family: Xanthidae MacLeay, 1838
174	<i>Actiomera erythra</i> (Lanchester, 1902)
175	<i>Atergatis laevigatus</i> A. Milne-Edwards, 1865
176	<i>Atergatis reticulants</i> (De Haan, 1835)
177	<i>Euxanthus exsculptus</i> (Herbst, 1790)
178	<i>Nectopanope rhodobaphes</i> Wood-Mason, in Wood-Mason & Alcock, 1891
179	<i>Serenius pilosus</i> (A. Milne-Edwards, 1867)
(37)	Family: Xenophthalmidae Stimpson, 1858
180	<i>Neoxenophthalmus garthii</i> (Sankarankutty, 1969)
181	<i>Neoxenophthalmus pinnotheroidesi</i> White, 1846