Training Programme on
'Taxonomy and identification of commerciallyimportant crustaceans of India'

Compiled by

Josileen Jose
S. Lakshmi Pillai

Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
Post Box No. 1603, Ernakulam North P.O., Kochi - 682 018, Kerala, India

Crustacean Fisheries Division

Manual on

Taxonomy and Identification of Commercially Important Crustaceans of India

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Convener

Dr. Josileen Jose

Co-Conveners

Dr. S. Lakshmi Pillai

Dr. Rekhadevi Chakraborthy

LIST OF FACULTY MEMBERS

Dr. G. Maheswarudu
Principal Scientist & Head
Crustacean Fisheries Division
Central Marine Fisheries Research Institute
Ernakulam North P.O.,
Kochi-682018
Email: maheswarudu@yahoo.com
Mob: 9656405418

Dr. V.D. Deshmukh
Principal Scientist & Scientist-in-charge
Research Centre
Central Marine Fisheries Research Institute
2nd Floor, C.I.F.E. Old Campus
Fisheries University Road, Versova
Mumbai-400 061
Email: vindeshmukh@gmail.com
Mob: 09820692454

Dr. Josileen Jose
Principal Scientist
Crustacean Fisheries Division
Central Marine Fisheries Research Institute
Ernakulam North P.O.,
Kochi-682018
Email: drjoslin@gmail.com
Mob: 09447232966

Dr. A.P. Dineshbabu
Principal Scientist & Scientist-in-charge
Research Centre
Central Marine Fisheries Research Institute
PB. No. 244, Hoige Bazar
Mangalore-575001
Email: dineshbabuap@yahoo.co.in
Mob: 09449825790

Dr. S. Lakshmi Pillai
Senior Scientist
Crustacean Fisheries Division
Central Marine Fisheries Research Institute
Ernakulam North P.O.,
Kochi-682018
Email: slakshmipillai@rediffmail.com
Mob: 09446036673

Dr. Rekhadevi Chakraborthy
Senior Scientist
Crustacean Fisheries Division
Central Marine Fisheries Research Institute
Ernakulam North P.O.,
Kochi-682018
Email: rekhadevi76@yahoo.com
Mob: 09447084867

Dr. E.V. Radhakrishnan
Emeritus Scientist
Central Marine Fisheries Research Institute
Ernakulam North P.O.,
Kochi-682018
Email: evrkrishnan@gmail.com
Mob: 9447250634

Mr. Rahul G. Kumar
Research Scholar
National Bureau of Fish Genetic Resources
Kochi unit
Ernakulam North P.O.,
Kochi-682018
Email: cichlidiot@gmail.com

LIST OF PARTICIPANTS

Ms. Sandhya K.S.,
M.F.Sc. Fisheries Resource Management
KUFOS, Panangad,
Cochin, Kerala - 682 506.
E-mail:sandhyaks02kufos@gmail.com
Mobile No.9048268104

Mr. Saneer N.S.,
SRF,KUFOS, Pananghad,
Cochin, Kerala - 682 506.
E-mail:saneersaithu@gmail.com
Mobile No.9048809226

Mr.Subal Kumar Roul
CIFE, Room No.405, New Boys Hostel
Off Yari Road, Versova,
Andheri (W), Mumbai – 400 061.
E-mail:subalroul@gmail.com
Mobile No. 09699417678

Ms.Shary Rajan
HT Food Pvt. Ltd.,
Plot No.17/SDF Ground Floor
CSEZ, Kakkanad, Kochi.
E-mail:shary_biotech08@yahoo.com
Mobile No. 7736211436

Mr.Trivedi Jigneshkumar N.,
Marine Biodiversity and Ecology Lab,
Department of Zoology,
Faculty of Science,
The M.S. University of Baroda,
Vadodara, Gujarat,India
E-mail: intrivedi26@yahoo.co.in
Mobile No. 09428138374

Ms. Sumedha Arya,
Marine Biodiversity and Ecology Lab,
Department of Zoology,
Faculty of Science,
The M.S. University of Baroda,
Vadodara, Gujarat.
E-mail: aryasumedha35@gmail.com
Mobile No. 09722450009

Ms. Sangeetha K.R.,
Department of Aquaculture,
Sacred Heart College,
Thevara, Cochin
E-mail:sangeethakoyippilly@gmail.com
Mobile No. 9645757821

Dr. A. Maharajan,
PG & Research Department of Zoology,
KhadirMohideen College,
Adirampattinam -614701,
Thanjavur Dist, Tamil Nadu.
E-mail: drathimaha@gmail.com
Mobile No. 09443286900

Shri. Arshad Keethadath,
Research Scholar
PG Department of Zoology & research Centre
SN College, Kannur - 670 007
E-mail: akeethadath@gmail.com
Mobile No. 09745945702

Mr.Devkate Ajinkya Dattatrya,
M.F.Sc Fishery Hydrography,
Kerala University of Fisheries and Ocean Studies,
Panangad ,P.O.Kochi, Kerala.
E-mail: devkate.ajinkya@gmail.com
Mobile No.09405056810

Dr.Bindu Bhaskaran,
Department of Aquaculture,
S.H. College, Thevara.
E-mail: bibhaskar@yahoo.co.in
Mobile No. 9744036430

Ms.Apsara S. Krishnan,
Dept. of Aquatic Biology & Fisheries,
University of Kerala,
Thiruvanthapuram.
E-mail: apsarakrishnans@gmail.com
Mobile No. 9746608226

Dr. Balu S.,
Instructor (Fishing Technology),
CIFNET, Fine Arts Avenue, Cochin-16.
E-mail: anibalu99@gmail.com
Mobile No. 8129152293

Dr.Raju M. K.
Associate Professor,
Dept. of Zoology, S.H.College,
Thevara, Cochin.
E-mail: mkrajum@yahoo.co.in
Mobile No. 9446140481

Helna A.K
Research Scholar
PG Department of Zoology & research Centre
SN College, Kannur - 670 007
E-mail: helnahere@gmail.com
Mobile No. 9496463811

Dr. Shiny K .J,
Assistant Professor,
Govt. college, Nattakom, Kottayam
Email: shinykj@rediffmail.com
Mobile No: 9447886171

Sibi T Baby, JRF,
Centre for Marine Living Resources & Ecology,
Field Research Station
Agatti, Lakshadweep – 682 553.
E-mail: sibitbaby88@gmail.com
Mobile No. 9946917679

Dr. K. K. Prajith,
Scientist,
CIFT, Matsyapuri (P.O)
Cochin- 29
E-mail: prajithkk@gmail.com
Mobile No:9447726227

Dr. P. S. Sivaprasad,
Technical Assistant,
C/O Asst. Director of Fisheries,
Staff Training Centre,
East Kadungallur,
Aluva, Ernakulam (Dt).
E-mail: drpssprasad@yahoo.co.in
Mobile No .08891624339

Contents

Glossary of Terms Used in Taxonomy

Plural form in parentheses

ADROSTRAL CARINA: Ridge flanking the rostrum, sometimes nearly reaching the posterior margin of the carapace.

ADROSTRAL SULCUS: Groove flanking the rostrum mesial to the adrostral carina , sometimes nearly reaching the posterior margin of the carapace.

ANTENNA (ANTENNAE): .More lateral to the two paired , usually flagellate appendages projecting distally from the anterior end of the cephalothorax.

ANTENNAL CARINA: Ridge extending posteriorly along dorsal extremity of antennal region , often continuous with antennal spine.

ANTENNAL PEDUNCLE: Five basal segments of the antenna , from which the flagellum arises distally.

ANTENNAL SPINE: Spine situated on the anterior margin of the carapace.

ANTENNULAR FLAGELLUM (ANTENNAL FLAGELLA): Multiarticulate paired filaments (sometimes flattened lamellate) of the antennule.

ANTENNULAR PEDUNCLE: Three basal segments of the antennule, from which the flagella arise distally.

BASIAL SPINE: Spine projecting from basis of the thoracic appendage.

BRANCHIA (BRANCHIAE): Respiratory organ (gill) associated with an appendage or with the body wall.

BRANCHIAL REGION : Area of the carapace overlying the branchial cavity.

BRANCHIOSTEGAL CARINA: Longitudinal ridge extending along anteroventral part of carapace, usually continuous with branchiostegal spine.

BRANCHIOSTEGAL- HEPATIC CARINA: Longitudinal ridge consisting of the fusion of the branhiostegal and hepatic carinae.

BRANCHIOSTEGAL SPINE: Short spine on or near anterior margin of the carapace ventral to the antennal spine and dorsal to the anteroventral angle of the carapace.

BRANCHIOSTEGITE: Expanded ventro-lateral part of the carapace covering the gills.

CARINA (CARINAE): A ridge or keel of the exoskeleton CARPUS (CARPI). Fifth podomere from the proximal end of a typically 7-segmented appendage.

CHELA(CHELAE): Pincer formed by the two distal podomeres of a pereopod in which the movable finger (dactyl) opposes a fixed finger formed by a distal extension of the propod.

CICATRIX (CICATRICES): Longitudinally disposed ridge(s) often present on lateral part of sixth abdominal somite.

COXA (COXAE): First or proximal podomere of a typically 7-segmented appendage.

COXAL SPINE: Spine projecting from the coxa of a thoracic appendage.

DACTYL: Terminal podomere of a typically 7-segmented appendage..

DISTOLATERAL PROJECTION: Distolateral, ventrally inclined projection or spur of the basis of the endopod of the male second pleopod.

DISTOMEDIAN PROJECTION: Distal relatively narrow extension of the dorsomedian lobule of the petasma.

DISTOVENTRAL PROJECTION: Outer distal flap articulating with distal extremity of ventrolateral lobule of petasma in members of the genus *Metapenaeopsis*.

DORSOLATERAL CARINA: Longitudinal ridge on dorsolateral region of carapace running dorsal to orbital region.

ENDOPOD: Mesial ramus of biramous appendage, especially one arising from the basis or from the protopodite of the pleopod

EPIGASTRIC TOOTH: Tooth on the carapace situated above the gastric region behind the first (posterior most) rostral tooth.

EPIPOD: Lateral exite of the coxa of a thoracic appendage, sometimes branchial in function.

EXOPOD: Lateral ramus of a biramous appendage, arising from the basis, or from the protopodite.

GASTROFRONTAL CARINA: Short longitudinal ridge extending posteriorly from the ventral extremity of the orbital region.

GASTROFRONTAL SULCUS: Short longitudinal depression accompanying the gastrofrontal carina dorsally.

HEPATIC CARINA: Longitudinally or obliquely disposed ridge of variable length lying ventral to the hepatic region, sometimes extending almost to the anterior margin of the carapace.

HEPATIC REGION: Paired anterolateral areas of the carapace bounded anteriorly by the antennal region, posteriorly by the branchial region, and mesially by the gastric region.

HEPATIC SPINE: Lateral spine situated near the anterior margin of the hepatic region of the carapace.

HEPATIC SULCUS: Groove ventral to the hepatic region extending posteriorly, sometimes from near the anterior margin of the carapace

ISCHIUM (ISCHIA): Third podomere from the proximal end of a typically 7-segmented appendage.

MANDIBLE: One of the heavily calcified jaws lying anterior to (beneath, in ventral view) to other mouth parts.

MAXILLA (MAXILLAE): Paired mouthpart appendages of the fourth and fifth cephalic somites.

MAXILLIPED: One of a pair of three sets of thoracic appendages, arising posterior to the primary mouthparts. The two anterior pairs are often modified for feeding, while the third pair is often pediform, resembling the pereopods.

MERUS (MERI): Fourth segment from the proximal end of a typically 7-segmented appendage.

PARAPENAEID SPINE: Spine projecting from the distomesial margin of the first antennular segment.

PEREOPOD: One of the first posterior paired appendages or legs of the cephalothorax

PETASMA (PETASMATA): The male genital structure consisting of the much enlarged and coupled endopods of the first pair of pleopods . The presence or absence of a petasma, or in juveniles, the position of the first endopds (situated more distally in females than in males), is the easiest means of distinguishing between the sexs in penaeidean shrimps

PLEOPOD: One of the biramous paired appendages typically arising ventrally from each of the anterior five abdominal somites . In the shrimps they are primarily swimming organs

PLEURON (PLEURA): One of the lateral flaps on each of the anterior five abdominal somites

POSTANTENNAL SPINE: Spine located on anterolateral area of carapace on the posterior part of the antennal region.

POSTCERVICAL SPINE: Spine located immediately posterior to cervical carina.

POSTCERVICAL SULCUS: Subvertical carapace groove located posterior to cervical sulcus.

POSTORBITAL SPINE: Spine situated near the orbital margin posterior to the antennal spine

POSTROSTRAL CARINA: Dorsomedian ridge extending posteriorly from the bace of the rostrum, sometimes nearly reaching the posterior margin of the carapace

PROPODUS (PROPODI): Sixth or penultimate segment of a typically 7-segmented appendage

PTERYGOSTOMIAN CARINA: Ridge running posterior to pterygostomian spine on antero-ventral part of carapace.

PTERYGOSTOMIAN RIGION: Anteroventral area of the carapace.

PTERYGOSTOMIAN SPINE: Marginal spine arising from the anteroventral angle or border of the carapace.

ROSTRUM (ROSTRA): Anteromedian projection of the carapace between the eyes

SCAPHOCERITE: Laterally rigid lamellate exopod of the antenna; the antennal scale

SOMITE: Each of the main divisions of the body.

STERNUM: Ventral surface of the cephalothorax or abdomen.

SULCUS (SULCI): Groove.

SUPRAHEPATIC SPINE: Spine arising from the edge of the cervical carina dorsal to the hepatic spine

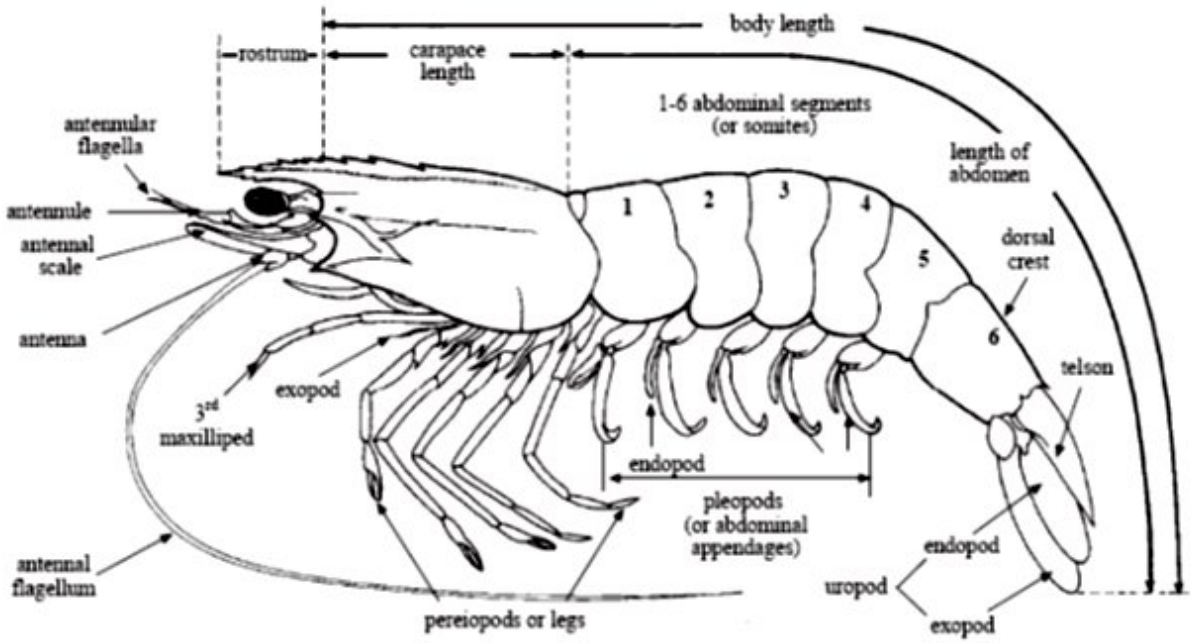
SUPRAORBITAL SPINE: Spine located posterior to the orbital margin of the carapace.

TELSON: Terminal unit of the abdomen bearing the anus

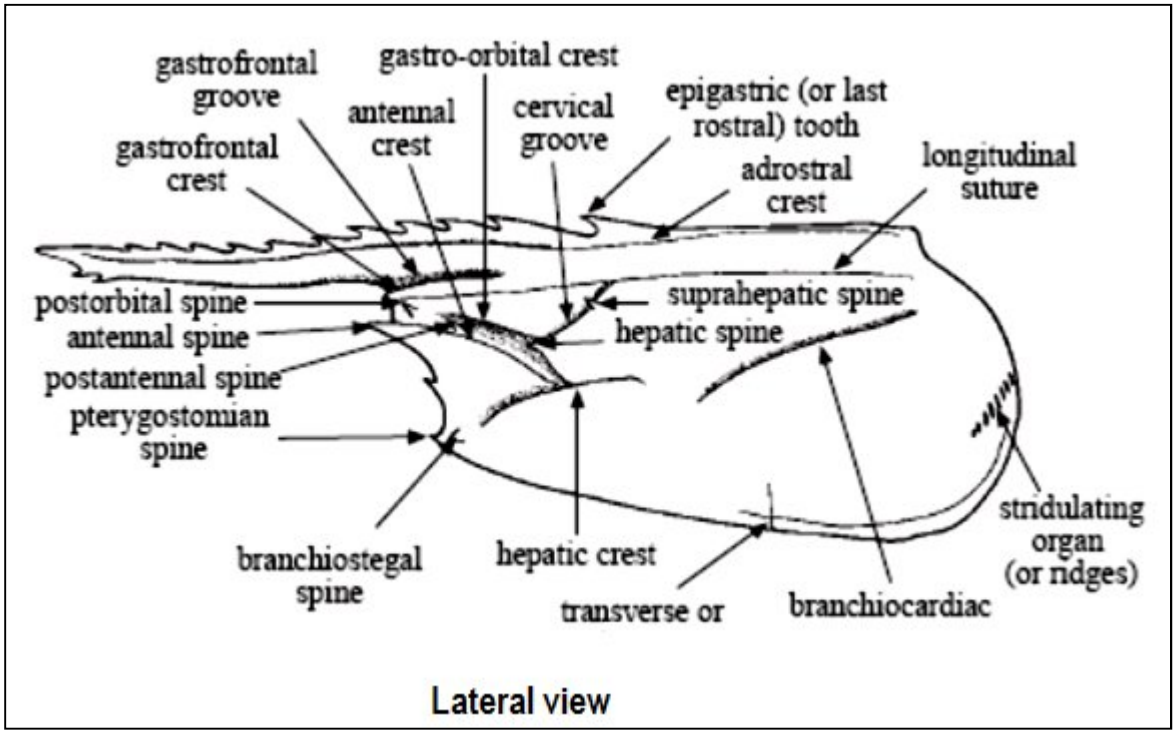
THELYCUM (THELYCA): The female genitalia consisting of modifications of the posterior two, or sometimesthree thoracic sternites (XII-XIV) serving for the storage or transfer of the sperm,usually in spermatophores, and often shielding seminal receptacles

UROPOD: Paired biramous appendage attached to the sixth abdominal somite, usually combining with the telson to form a tailfan.

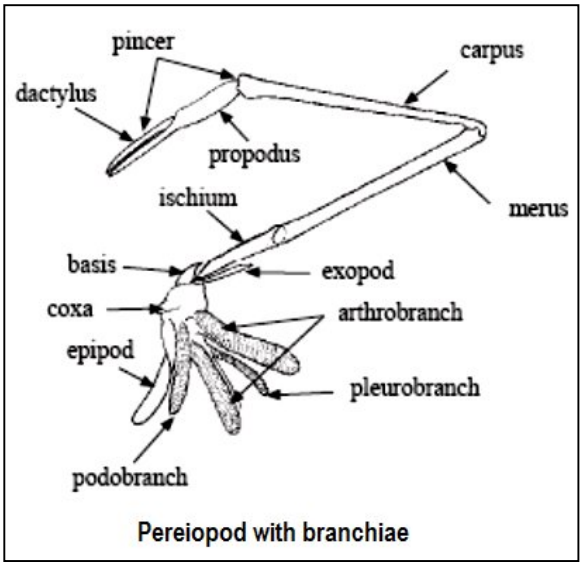
TECHNICAL TERMS AND MEASUREMENTS



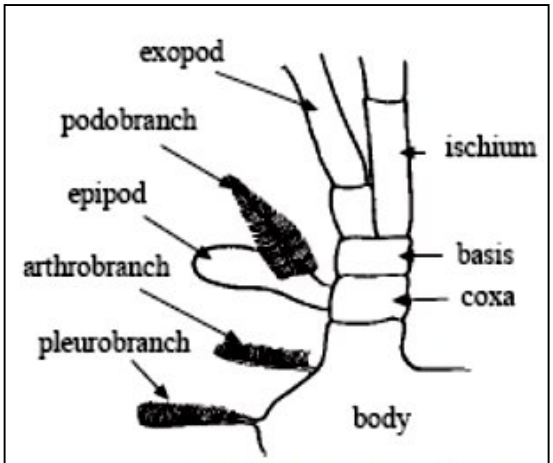
Lateral view



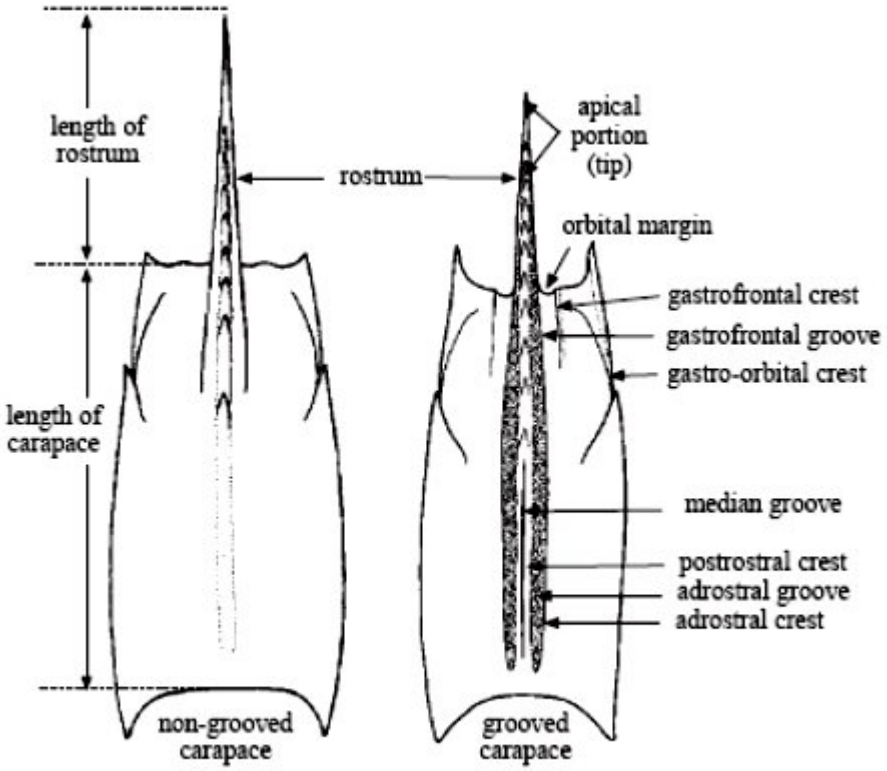
Lateral view



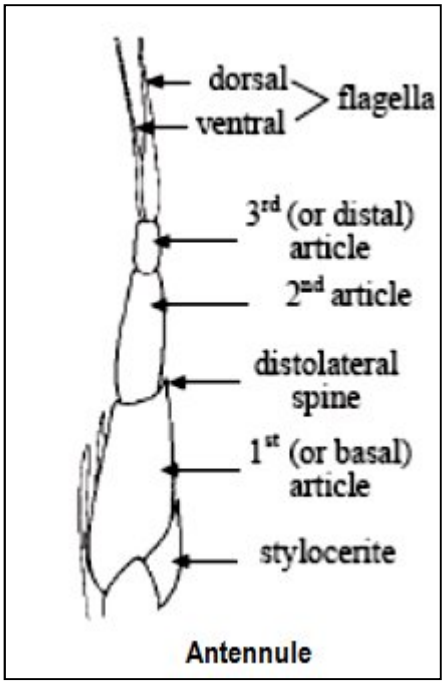
Pereiopod with branchiae



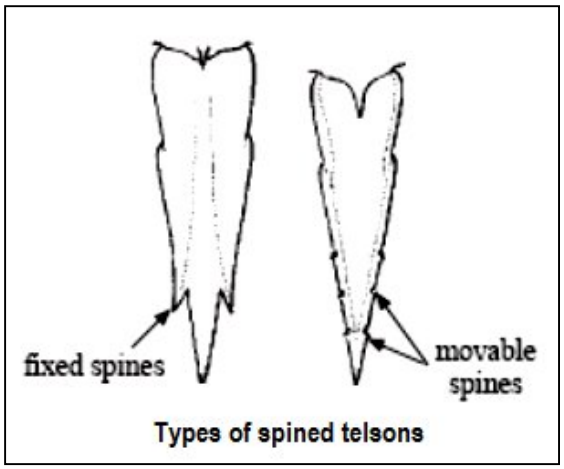
Proximal part of pereiopod (schematic)



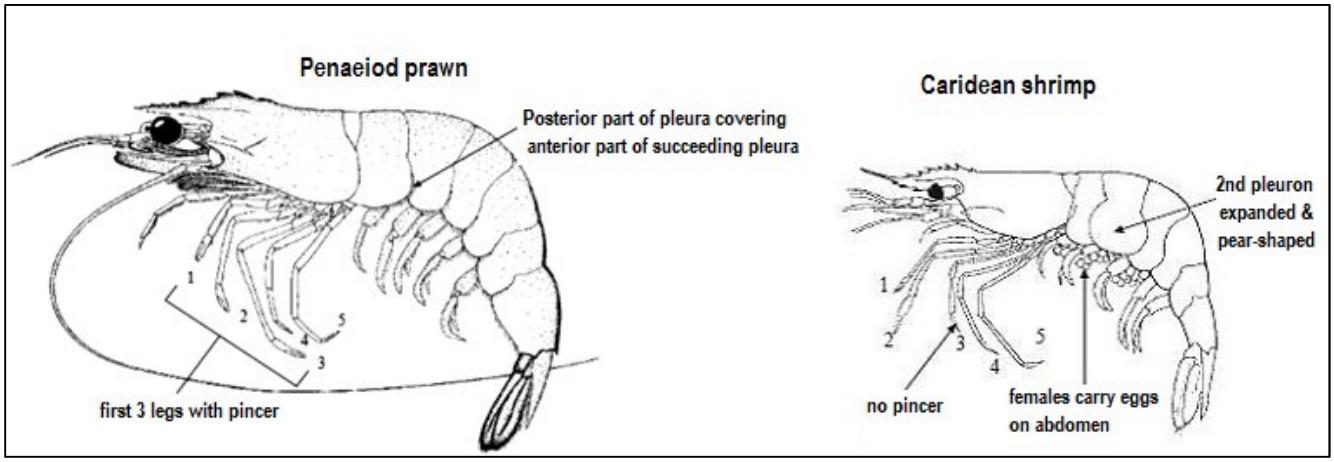
Carapace (dorsal view)

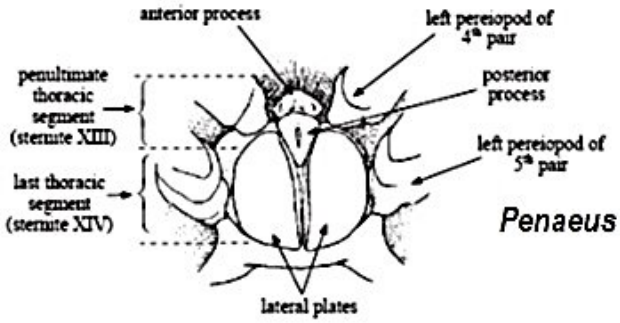


Antennule

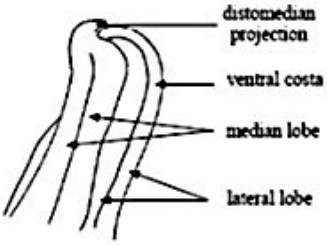


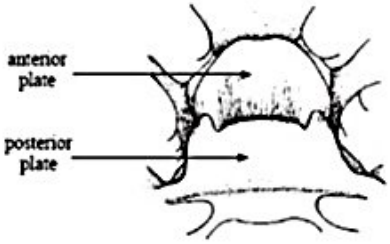
Types of spined telsons



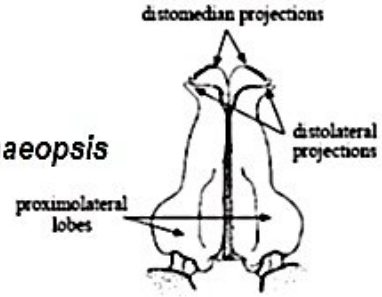


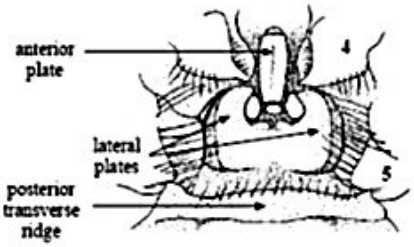
Penaeus



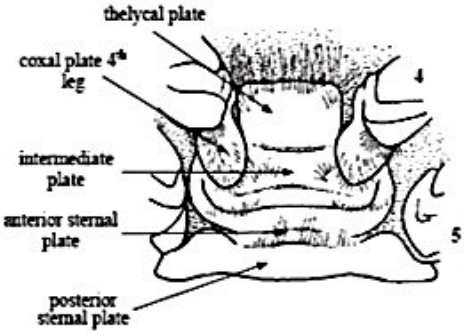


Parapenaeopsis

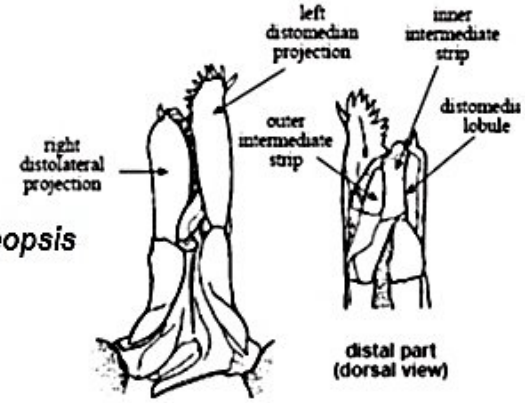




Metapenaeus



Metapenaeopsis



Basic types of thelycum of female penaeid shrimps (Ventral view)

Basic types of petasma (joined endopods of 1st pair of pleopods) of male penaeid shrimps (Ventral view - except otherwise stated)

Chapter I

Introduction to Crustacean Fisheries of India

G. Maheswarudu

India is blessed with long coastline of about 8118 km along the West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and Pondicherry along the east coast; along Gujarat, Maharashtra, Goa, Karnataka, Kerala along the west coast. India has 2.02 million sq.km exclusive economic zone area and 0.53 million sq.km contitnental shelf area, a potential source for marine fisheries. The rich continental shelf area, is a good habitat for demersal fishes as well as crustaceans such as penaeid prawns , non-penaeid prawns, crabs, lobsters and stomatopods. Mechanised trawler is the main gear operated in the continental shelf area targeting crustacean resources. Though trawl net is operated for penaeid prawn, non penaeid prawns, crabs and stomatopods form by catch as all these resources habituate in the same fishing ground.

Crustacean resources

Crustacean resources comprise penaeid prawns, non-penaeid prawns, crabs, lobsters and stomatopods. Total landings of crustacean resources, group wise and contribution of crustacean resources to total marine fish landings during 1996-2011 are shown in table, 1.

Total annual marine fish landings of India ranged from 2.29 to 3.82 million t with mean at 2.76 million t. Annual total crustacean resources ranged from 3.62 lakh t to 5.32 lakh t with mean at 4.36 lakh t, and its contribution to total marine fish landings ranged from 13.9 % to 18.9 % with mean at 15.9 %. The landings of penaeid prawns ranged from 1.71 lakh t to 2.67 lakh t with mean at 2.06 lakh t. Landings of non-penaeids ranged from 1.04 lakh t to 1.70 lakh t with mean at 1.48 lakh t. The catch for lobsters ranged from 1,201 t to 2,787 t with mean at 1921 t. Crab landings ranged from 27,538 t to 55,695 t with mean at 41,731 t. Stomatopod catches varied from 21,187 t to 72,342 t with mean at 42,294 t. On an average penaeid prawns contributed 7.4%, non-penaeid prawns 5.4 %, crabs 1.5%, stomatopods 1.5 % and lobsters 0.1 % (Fig.1).

Trends in crustacean landings, group wise, are shown in fig. 2. Increasing trend was observed in total crustacean resources during the 16 years period. Both penaeids and non – penaeids have shown increasing trend, the trend of penaeids being higher than non penaeids, comparatively. A marginal increasing trend was observed in crab landings. Though lobster catches have shown decreasing trend, its contribution to total crustacean resources was very less (0.1%). Despite increasing trends exhibited by penaeids, non penaeids, crabs, stomatopods have shown decreasing trend because of competing in the same fishing ground with penaeids.

East Coast

State wise crustacean resources (t) and crustacean resources contribution from east coast to total crustacean landings of India are shown in table, 2. The contribution of crustacean resources from the east coast is 26.4 % to total crustacean landings. Tamil Nadu contributed highest (8.2 %) followed by Andhra Pradesh (6.5 %), West Bengal (6.4%), Orissa (5.1%) and Pondicherry (0.2 %). Tamil Nadu contributed 31.1 % to the total crustacean resources of the east coast, followed by Andhra Pradesh (24.7%), West Bengal (24.1%), Orissa (19.4%) and Pondicherry (0.7%). (Fig. 3).

West Coast

State wise crustacean resources (t) and crustacean resources contribution from west coast to total crustacean landings of India are shown in table, 3. West coast contributed 73.1 % of total crustacean resources of India. Gujarat contributed highest (27.6 %) followed by Maharastra (24.1 %), Kerala (13.8 %), Karnataka (6.4 %) and Goa (1.2 %). Along the west coast Gujarat dominated (37.%%), followed by Maharastra (33.2%), Kerala (18.8%), Karnataka (8.7%) and Goa (1.8%) (fig. 4).

Commercially important species

State wise commercially important penaeids, non penaeids, crabs, lobsters are shown in table 4.

Table 1. Group wise crustacean landings (t) along the Indian Coast during 1996-2011.

Year	Penaeids	Non penaeids	Lobsters	Crabs	Stomatopods	Total crustaceans	Total fish landings	%
1996	187792	104462	2631	28908	72342	396135	**2380842**	16.6
1997	208542	153636	2787	44820	92611	502396	**2692409**	18.7
1998	214678	173950	2619	34152	72603	498002	**2635670**	18.9
1999	174384	147961	2094	27538	49918	401895	**2401706**	16.7
2000	204277	151515	2431	48253	46141	452617	**2652928**	17.1
2001	176448	145232	1389	29739	34944	387752	**2292703**	16.9
2002	203801	137714	2573	36049	48553	428690	**2589645**	16.6
2003	214780	137229	1233	41988	37341	432571	**2587095**	16.7
2004	171641	116231	1371	40900	32071	362214	**2538105**	14.3
2005	172099	121107	1201	37182	21187	352776	**2295490**	15.4
2006	172460	170787	1551	51067	30551	426416	**2710988**	15.7
2007	195599	138983	1523	40420	25163	401688	**2888461**	13.9
2008	213327	187173	1974	55695	30500	488669	**3207205**	15.2
2009	245159	168415	1872	47897	27379	490722	**3205453**	15.3
2010	260181	126997	1720	52243	30150	471291	**3346687**	14.1
2011	267932	187061	1761	50847	25250	532851	**3820207**	13.9
Mean	205194	148028	1921	41731	42294	439168	2765350	
%	7.4	5.4	0.1	1.5	1.5	15.9		

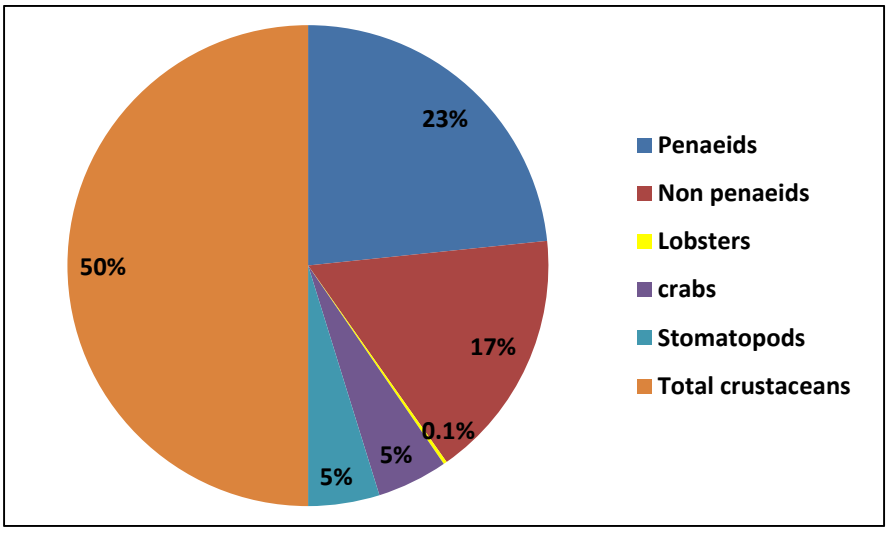


Fig.1. Mean contribution of crustacean resources to total marine fish landings during 1996-2011.

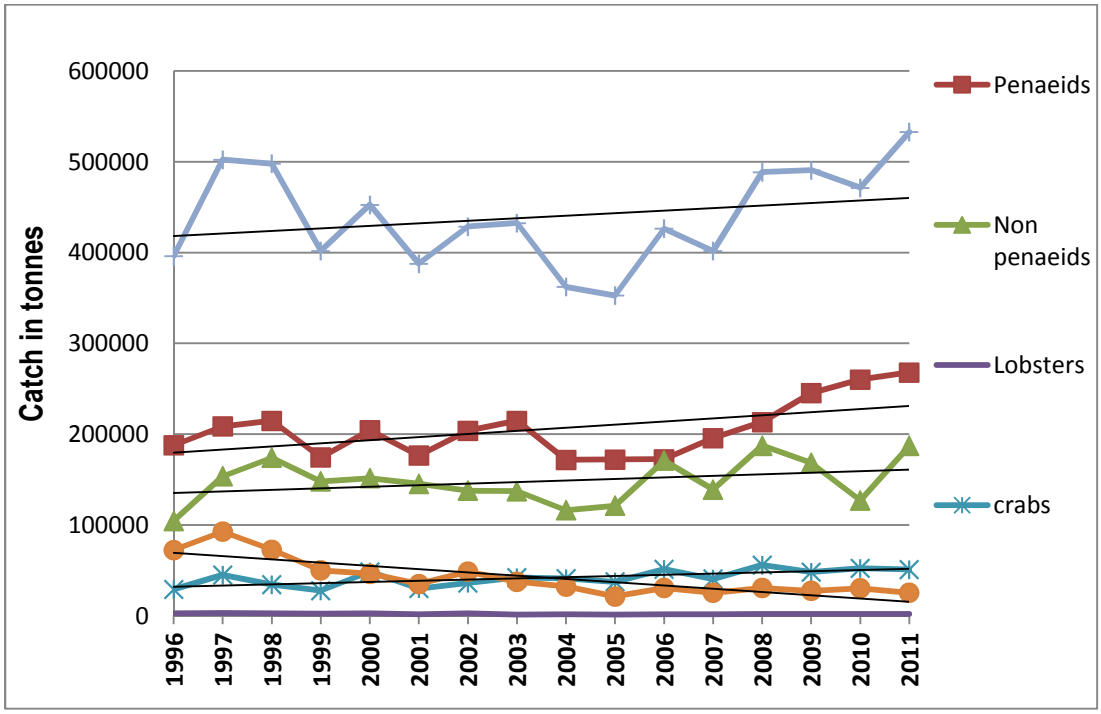


Fig.2. Group wise trends in crustacean resource landings during 1996-2011.

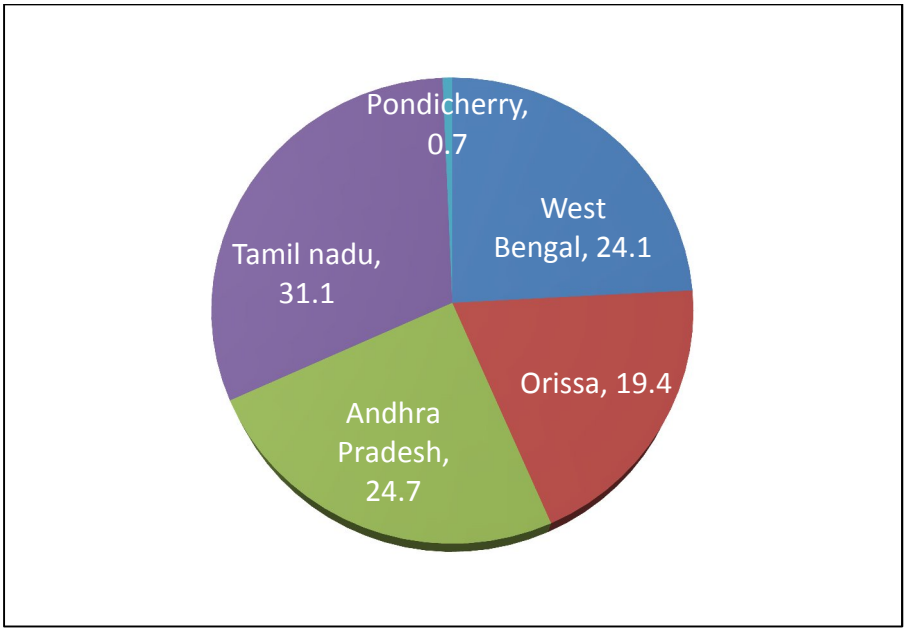


Fig.3. State wise contribution to the total crustacean resources of the east coast of India.

Table 2. State wise crustacean resources (t) and contribution of crustacean resources from the east coast to total crustacean resources of India.

Year	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondichery	Total (east coast)	Total (India)	%
1996	7865	5494	22574	38588	556	75077	396135	19.0
1997	5163	5514	22257	40964	450	74348	502396	14.8
1998	12621	3569	26564	43435	1010	87199	498002	17.5
1999	8415	6742	35125	36133	507	86922	401895	21.6
2000	13212	12157	29340	38157	450	93316	452617	20.6
2001	22391	6809	21289	32808	485	83782	387752	21.6
2002	28719	7699	25072	40038	1000	102528	428690	23.9
2003	36104	8826	28382	34723	221	108256	432571	25.0
2004	23905	12587	26607	32395	704	96198	362214	26.6
2005	29646	17293	22158	27146	248	96491	352776	27.4
2006	28135	13094	30350	35775	1619	108973	426416	25.6
2007	28158	23077	33214	32078	500	117027	401688	29.1
2008	37703	29266	30656	35450	1441	134516	488669	27.5
2009	49191	54453	34001	37127	1861	176633	490722	36.0
2010	47952	73225	36922	35358	932	194389	471291	41.2
2011	68645	79111	33877	36840	581	219054	532851	41.1
Mean % to total crustacean landings of east coast	24.1	19.4	24.7	31.1	0.7			
Mean % to total crustacean landings of India	6.4	5.1	6.5	8.2	0.2	26.4		

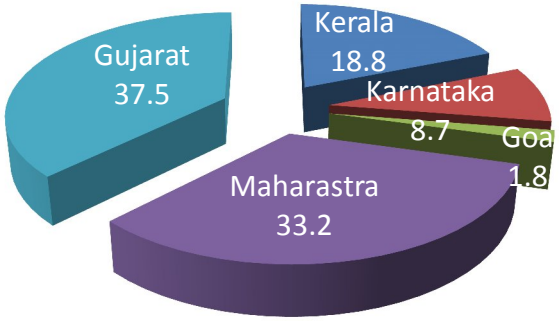


Fig.4. State wise contribution to the total crustacean resources of the west coast of India.

Table 3. State wise crustacean resources (t) and crustacean resources contribution from west coast to total crustacean landings of India.

Year	Kerala	Karnataka	Goa	Maharastra	Gujarat	Total	Total for India	%
1996	59087	22742	9840	118836	110553	321058	396135	81.0
1997	91347	32820	11925	141990	149966	428048	502396	85.2
1998	74739	19832	7617	149978	158637	410803	498002	82.5
1999	63075	23150	2573	93253	132922	314973	401895	78.4
2000	84361	21429	4705	102145	146661	359301	452617	79.4
2001	64065	23659	4998	110012	101236	303970	387752	78.4
2002	64773	43996	9222	121965	86206	326162	428690	76.1
2003	64044	26836	10478	138291	84666	324315	432571	75.0
2004	50588	23161	5919	108166	78182	266016	362214	73.4
2005	45658	35580	2684	87964	84399	256285	352776	72.6
2006	57758	28539	2904	94227	134015	317443	426416	74.4
2007	52539	33905	1405	84451	112361	284661	401688	70.9
2008	56412	25634	5687	122282	144138	354153	488669	72.5
2009	55450	27331	2761	107546	121001	314089	490722	64.0
2010	44024	32839	4383	62462	132318	276026	471291	58.6
2011	44859	27323	4094	73113	160170	309559	532851	58.1
Mean % to total crustacean resources from west coast	18.8	8.7	1.8	33.2	37.5			
Mean % to total crustacean landings	13.8	6.4	1.2	24.1	27.6	73.1		

Table 5. State wise commercially important species of penaeids, non-penaeids, crabs, lobsters and stomatopods.

State	Penaeids	Non-penaeids	Crabs	Lobsters
Gujarat	1. *Penaeus semisulcatus* 2. *Fenneropenaeus merguiensis* 3. *Metapenaeus affinis* 4. *M. monoceros* 5. *M. kutchensis* 6. *Parapenaeopsis stylifera* 7. *P. hardwickii* 8. *P. sculptilis* 9. *Metapenaeopsis stridulans* 10. *Solenocera crassicornis*	1. *Acetes* spp 2. *Nematopalaemon tenuipes* 3. *Exhippolysmata ensirostris*	1. *Portunus sanguinolentus* 2. *Charybdis feriatus*	1. *Panulirus polyphagus*
Maharashtra	1. *F. indicus* 2. *M. affinis* 3. *M. monoceros* 4. *M. dobsoni* 5. *P. stylifera* 7. *S. crassicornis* 8. *S. choprai*	1. *Acetes* spp 2. *N. tenuipes* 3. *E. ensirostris*	1. *C. feriatus* 2. *P. sanguinolentus* 3. *P. pelagicus*	1. *P. polyphagus*
Karnataka	1. *F. indicus* 2. *P.monodon* 3. *M.canaliculatus* 4. *M. dobsoni* 5. *M. monoceros* 6. *M. affinis* 7. *P. stylifera* 8. *S. choprai*		1. *C. feriatus* 2. *P. sanguinolentus* 3. *P. pelagicus*	
Kerala	1. *M. dobsoni* 2. *M. affinis* 3. *M. monoceros* 4. *F. indicus* 5. *P. stylifera*	1. *Plesionika spinipes* 2. *Heterocarpus gibbossus* 3. *H. woodmasoni*	1. *P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *C. lucifera* 5. *Podopthalmus vigil*	1. *Thenus unimaculatus* 2. *P. homarus*

	6. *Melicertus canaliculatus* 7. *P. semisulcatus* 6. *S. choprai* 7. *Metapenaeopsis andamanensis* 8.*Aristeus alcocki*		6. *Scylla serrata*	
Tamil Nadu	1.. *F.indicus* 2. *P. semisulcatus* 3. *Melicertus latisulcatus* 4. *P. monodon* 4. *M. dobsoni* *5. M.monoceros* 6. *M. moyebi* 7. *Parapenaeopsis maxillipedo* 7. *P. uncta* *7. M. stridulans* 8. *Solenocera hextii* 9. *Aristeus alcocki* 10. *Parapenaeus fissuroides* 11. *Parapenaeus investigatoris* 11. *Penaeopsis jerryi* 12. *M. andamanensis* 13. *Solenocera alphonso*	1. *Plesionika spinipes* 2. *H. gibbossus* 3. *H. woodmasoni*	1. *P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *C. natator* 5. *C. smithii* 6. *C. annulata* 7. *C. lucifera* 8. *C. helleri* 9. *P. gladiator* 10. *P. arentatus* 11. *Podophthalmus vigil*	1. *P. homarus* 2. *P. ornatus* 3. *P. polyphagus* 4. *P. versicolor* 5. *P. ornatus* 6. *P. peniciilatus* 7. *Thenus unimaculatus*
Andhra Pradesh	1.*M. monoceros* 2. *M. dobsoni* 3. *M. brevicornis* 4. *M. affinis* 5. *M. lysianassa* 6. *F. indicus* 7. *P. monodon* *8. F. merguiensis* *9. P. Japonicus* 10. *P. semisulctus* 11. *M. stridulans*	1. *Acetes* spp. 2. *N. tenuipes* 3. *E. ensirostris*	1.*P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *Scylla serrata* 5. *S. olivacea*	1. *Thenus unimaculatus*

	12. *M. barbata* 13. *M. mogiensis* 14. *S.crassicornis* 15. *S. melantho* 16. *P.stylifera* 17. *P. hardwickii* 18. *P. uncta* 19. *P. maxillipedo* 20. *P. coromandalica* 21. *Trachypenaeus curvirostris* 22. *T.granulosus* 23. *T.sedili* 24. *Parapenaeus longipes*			
Orissa	1. *M. dobsoni* 2. *M. monoceros* 3. *M. affinis* 4. *F. merguiensis* 5. *P. monodon* 6. *F. indicus* 7. *P. stylifera* 8. *P. hardwicki* 9. *M. lysianasa* 10.*Solenocera spp.* 11. *M. moyebi*		1.*P. pelagicus* 2. *P. sanguinolentus* 3. *C. feriatus* 4. *Scylla serrata* 5. *S. olivacea*	
West Bengal	1. *M. dobsoni* 2. *M. monoceros* 3. *M. affinis* 4. *M. lysianasa* 5. *F. penicillatus* 6. *F. merguiensis* 7. *P. monodon* 8. *P. stylifera* 9. *P. hardwicki* *10. Solenocera* spp. 11. *M. moyebi*			

Chapter 2

Principles of Crustacean Taxonomy

Vinay Deshmukh

It is very important to know the living organisms around us. A species may occur in nature in many different forms (like sexes, larvae and morphs). Over one and half million species of animals have been described and it is estimated that about 3 to 10 million species still await discovery. It is therefore, necessary to put such a large number of species into definite groups so that their identities and properties are established. The assignment of a name to an organism provides the only key to all the information available about that species and its relatives (instead of lengthy descriptions). Careful and accurate identification and classification are of vital importance and if one wants to acquire knowledge in scientific way, the organisms should be grouped into smaller units.

Crustacean diversity: Crustaceans exhibit 4th largest diversity among the animal groups on the planet and include many well-known commercially exploited groups such as the prawns, crabs, and lobsters. The number of named species of Crustaceans worldwide is estimated at approximately 50,000 to 67,000 but the potential number of species may range from as many as ten times to one hundred times that number. The Crustaceans show an enormous diversity of form, and a great range of size from microscopic species measuring as little as a tenth of a millimetre to giant crabs, lobsters, and isopods with a body size of up to 4 meters in length or breadth, and weighing up to 20 kilograms. By virtue of their highly prized edibility, the decapod crustaceans are arguably the most popular invertebrates. The numbers of "small" species may be comparable to those of insects on the land. *e.g.* isopods currently number approximately 5,800 marine species, but recent estimates suggest that as many as 50,000 species of isopods could exist on coral reef habitats alone (Kensley 1988), a figure close the current total for all Crustacea, while Wilson (2003) estimated a total of 400,000 deep-sea species.

Species of Decapod Crustaceans: Decapod crustaceans comprising of shrimps, crabs and lobsters are commercially the most important group. Chace (1951) estimated for the first time 8,321 species of decapod crustaceans distributed among 1,000 genera and recently De Grave *et*

al. (2009) estimated total number of extant species of Decapoda at 14,756 in 2,725 genera. This implies that in the last 50 years, the number of described species has nearly doubled. However, we are a long way from knowing the true global diversity of decapods. The number of known fossil species currently stands at 3,300, and discoveries will continue as new localities are explored, more revisions are completed and museum collections are more thoroughly studied.

As far as shrimps or prawns are concerned there are 3,047 species in the world grouped in to 4 categories, namely Sergestoidea (94 species), Penaeiodea (94 species), Stenopodidae (60 species) and Caridea (2,517 species) (FAO, 1998). Most of the commercial shrimp species belong to the 5 penaeidean families Solenoceridae, Aristeidae, Penaeidae, Sicyoniidae and Sergestidae - and 3 caridean ones - Pandalidae, Crangonidae and Palaemonidae. Another 2 caridean families, Hippolytidae and Alpheidae, contain species of some economic interest in the Western Indian Ocean. The shrimp fauna of the latter area is grouped into 27 families, only 9 of which include species fished commercially or of potential interest. There are about 340 species of prawns throughout the world (Holthuis, 1980), out of which 62 were recorded from the Indian waters by George (1979) until 1975. Recently, Kathirvel and Thirumilu (2011) have enlisted a total of 105 species of shrimps in 13 genera under the family Penaeidae from Indian waters.

Taxonomy, Classification, Systematics and Nomenclature

Taxonomy is the practice and science of classification. The word taxonomy coined by A.P. de Candolle (1813) is derived from the Greek words *taxis* (meaning 'order' or 'arrangement') and *nomos* (meaning 'law' or 'science'). Taxonomy uses taxonomic units, known as taxa (singular taxon). Originally *taxonomy* referred only to classification of organisms but now it is used in wider sense to the *principles* underlying such a classification. Another term ‘Systematics’ is often used in taxonomy. It is the system of classification developed by Carl Linne’ in 1735. Systematics is often incorrectly used as synonym to taxonomy. Taxonomy actually deals with the naming and classification of organisms and forms only a part of biological systematics called the science of biodiversity. Classification is placing organisms into groups on the basis of their relationships. Such relationships are associations based on contiguity, similarity or both (Simpson, 1961). Taxonomy includes classification and nomenclature but heavily leans on systematics for the concepts. In taxonomy the smallest unit of classification is called ‘species’.

Systematics includes taxonomy, identification, nomenclature, classification, diversity and differences between the organisms and their evolutionary interrelationships. The information provided by taxonomic research is a fundamental basis for all fields of biology.

Levels of taxonomy

Taxonomical study comprises 3 stages: 1) **Alpha taxonomy**, which deals with the description of new species and its arrangement in comprehensive genera. 2) **Beta taxonomy**, which works out relationships at the species level and 3) **gamma taxonomy** which emphasizes intra-specific variations and their evolutionary relationships *i.e.* study of speciation. In actual practice it is difficult to study any species in isolation as the three levels of taxonomy overlap each other. There are only a few groups of animals (birds & butterflies) where taxonomy has reached up to gamma level. Work in majority of animal groups including crustaceans is at alpha and gamma levels.

Concept of species

Species is a Latin term meaning “kind” or “appearance”. Generally, the knowledge about different organisms comes from ‘differences’ or ‘similarity’ in their appearance. According to Carl Linne’ species were distinguished by their external appearance or morphology. Although this principle is widely used to distinguish most of the species, it can not be applied to many plants and animals, and in particular micro-organisms such as bacteria and virus. Although many researchers have attempted a comprehensive definition of ‘species’, it is difficult. Traditionally, a large number of specimens of a proposed species must be studied for unifying characters before it can be regarded as a species. A usable definition of "species" is essential for stating and testing biological theories and for measuring biodiversity.

Over two dozen definitions of species are in use amongst biologists, yet none is uncontroversial. Cuvier (1829) defined ‘species’ as the assemblage descended from common parent who resemble each other. Thompson (1937) defined it as a group of individuals distinguished by common properties and connected by descent and genetic relationship. Huxley (1942) defined it as a geographically definable group having interbreeding members or potential

to interbreed in nature. Mayr (1957) reviewed the problem of species definition and suggested to consider 3 concepts.

1. *Typological species concept:* According to this concept, the species can be recognized by their essential characters which are expressed in their morphology. Species is a group which can be segregated by their physical characteristics, colour, size, habitat etc from the other organisms. It is therefore, also called the *morphological species concept*.
2. *Biological species concept:* According to this concept species is a group of interbreeding natural population that is reproductively isolated from other such groups. Thus, the species has three 3 separate functions: *(i)* It forms reproductive community which has a species specific genetic programme that ensures intra-specific reproduction *(ii)* it is an ecological unit in which individuals interact and share the same environment *(iii)* it is a genetic unit consisting of a large gene pool while individual is a small, temporary pool for a short period.
3. *Evolutionary species concept:* Biological concept fails when organisms are uniparental and reproduce asexually. Evolutionary species concept considers species as a lineage (ancestral-descendent sequence of populations) with its unitary properties evolving separately from others.

Most textbooks follow Ernst Mayr's definition of a species as: ***Groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups.*** In addition to true taxonomic species, there are many other kinds pertaining to ecological and evolutionary concepts.

- Sibling species: Groups of similar or closely related species which are reproductively isolated but morphologically identical species.
- Cryptic species: These are extremely different and often taxonomically unrelated species in which one species conceals and protects itself from the enemies by cryptic colouration.
- Sympatric species: very close species occupying the same geographic area.
- Allopatric species: Two or more related species normally inhabiting different geographical areas.

- Syntopic species: Two or more related species which occupy the same micro-habitat and possibly interbreed.
- Allotopic species: Two or more related species which do not occupy the same micro-habitat and do not interbreed.
- Continental species: Those living on large land masses.
- Insular species: Those living on isolated islands.
- Polytypic species: Consisting of two or more sub-species.
- Monotypic species: Species with no subspecies.

Some species are so widely distributed that they form many local populations. If these populations are sufficiently distinct from each other, they are called subspecies. Species which contain two or more subspecies are called polytypic; this concept of polytypic species is very important in classification of animals. Certain local species that had been described from various parts of the world can be combined in to species groups (allopatric species) because they were obviously more close to one another than to any other species and live in mutually exclusive geographical areas. When gaps in the ranges of allopatric species are explored, they can be included into a single polytypic species.

Stocks: While describing the exploited aquatic fishery resources the fundamental concept is 'stock'. A stock is a smaller unit of a species. The term stock is used to describe a population inhabiting a particular geographical area having same growth and mortality parameters. Therefore, stock is a discrete group of animals with little mixing with adjacent groups. Cushing defined stock as a population having single spawning ground to which adults return year after year. Larkin (1972) on the other hand, defines it as population which shares a common gene pool that is sufficiently discrete to warrant consideration of self perpetuating system that can be managed. Gulland (1983) states that unit stock is an operational matter *i.e.* subgroup of a species that can be treated as stock, if possible differences within the group and interchanges with other groups can be ignored. In Indian waters, although species such as *Parapeneopsis stylifera* occur all along the west coast (8°-20°N), certain biological characteristics (spawning season, sex-ratio, fecundity) and growth parameters of the populations differ considerable along the coastal waters which warrant existence of several local stocks.

Subspecies: It is a universal fact that all species vary and it is known since long that certain species split into subspecies and races. Linnaeus and Fabricius preferred to call them varieties. Subspecies is the lowest taxonomically nameable category and defined as geographically separate aggregate of local populations of the species. Or it is a group within the species with strong morphological differences combined with geographic, ecological, edaphic or physiological distinctiveness. The subspecies must be able to interbreed if given an opportunity to do so. Only professional taxonomists can make a decision that the two races of a species are taxonomically different. Geographical subspecies are synchronic aggregates of populations which are isolated during their mating but they would crossbreed freely and normally.

Demes: Demes are morphologically homogenous group of organisms which are either from a single locality or habitat. Simpson (1961) preferred calling them *Demes* while Mayr (1969) called them *Phena*; but these terms have no nomenclature status. It is a group of individuals so localized that they are in frequent contact with each other.

Variety: Under typological principles each species has fixed pattern and any variant from the pattern is called a variety. Originally proposed by Linnaeus, this term is abandoned from the zoological nomenclature.

Morphotype or Form: It is 'variety' in second sense and has no standing in the nomenclature.

Cline: Any variation having gradation within species was called by Huxley (1938) as cline. This morphological gradation must be a measurable character.

Superspecies: It is defined as a monophyletic group of closely related and largely or entirely allopatric species (Simpson, 1961). The doubtful populations which could not be kept in species or subspecies were kept under a new semi-species to mark their intermediate nature. These have no place in zoological nomenclature.

Binomial nomenclature

Nomenclature means allocation of names to the taxa. Naming the animals is the first and foremost task of a taxonomist. The system of naming species of living things is called binary

nomenclature or binomial nomenclature. This system of naming was invented by Linnaeus and the rules of naming the animals are now laid down in the International Code of Zoological Nomenclature (ICZN).

- In the binomial system of naming each species name has two parts, the **genus** name and **species** name (also known as the specific epithet), e.g. *Parapeneopsis stylifera*, which is the scientific name of the kiddi (karikadi) shrimp.
- The first letter of the genus is always capitalized, while that of the species is not, even when derived from a proper noun such as the name of a person or place.
- Every binomial scientific name is either formed out of Latin or is a Latinized version of words from other languages.
- Conventionally, all names of genera and lower taxa are always *italicized* (underlined while writing), while family names and higher taxa are printed in plain text.
- Species can be divided into a further rank, e.g. *Penaeus* (*Fenneropenaeus*) *indicus* H. Milne Edwards, 1837 giving rise to a *trinomial name* for a subspecies (*trinomen* for animals, *ternary name* for plants). The binomial name of a species is commonly known as its Latin name. However, biologists prefer to use the term 'scientific name' rather than "Latin name", because the words used to create these names are not always from the Latin language, even though words from other languages have usually been Latinized in order to make them suitable for this purpose. Often the species names are derived from Ancient Greek words, or words from numerous other languages.
- Frequently species names are based on the surname of a person, such as a well-regarded scientist (e.g. *Aristeus alcocki* and *Penaeus silasi*), or are a Latinized version of a relevant place name (e.g. *Metapenaeus kutchensis* and *Metapeneiopsis andamanensis*). The names of binomen have opposite functions- the species name expresses distinctness while generic name the relationship.
- While using the scientific name of a species, biologists usually also give the authority (Author who described it for the first time) and the date (year) of the species description. Thus, the scientific name of Indian shrimp species is given as: *Penaeus indicus* H. Milne Edwards, 1837 in which the name "H. Milne Edwards" tells the reader who described the species for the first time and 1837 is the date (year) of the publication in which the

original description can be found. In this case, the name of the author is not put in a bracket because the species name '*indicus*' was originally given by "H. Milne Edwards" and it was not transferred from any another genus described for the species. But when the latest nomenclature *Fenneropenaeus indicus* (H. Milne Edwards, 1837) is used, the author's name is put under the bracket as the species has been transferred from the genus *Penaeus* to *Fenneropenaeus* (Perez Farfante and Kinsley, 1997). In such a case, the authority that created the genus *Fenneropenaeus* does not get credit in the binomial nomenclature.

Significance of binomial nomenclature

Binomial nomenclature is widespread and it avoids confusion that is created when common names are used to refer to a species. Common names often differ even from one part of a country to another part, and certainly vary from one country to another. In contrast, the scientific name can be used all over the world, in all the languages, avoiding confusion and difficulties of translation. Scientific names are the only internationally (universally) recognized standard way of referring to biological organisms. They facilitate communication among not only scientists but also trading partners who speak different languages. Without their use and standardization, no two people could really be sure what organism they were talking about without both having seen it.

The procedures associated with establishing binomial nomenclature tend to favour stability. Even though such stability as exists is far from absolute, it is still advantageous *e.g.* when species are transferred between genera (as not uncommonly happens as a result of new knowledge), the species descriptor is kept the same. Similarly, if what were previously thought to be distinct species are demoted from species to a lower rank, former species names may be retained as infraspecific descriptors. The scientific names of animals from subgenera and above are uninominal and written with a capital letter. The ICZN stipulates standardized endings for the taxa: e.g. superfamily (-oidea), family (-idea), subfamily (-inae), tribe (-ini). This can be illustrated by classification of shrimps:

Phylum: Arthropoda
Class: Crustacea
Subclass: Malacostraca
Series: Eumalacostraca
Superorder: Eucarida
Suborder: Dendrobranchiata
Infraorder: Penaeidea
Superfamily: Penaeoidea
Family: Penaeidae
Subfamily: Penaeinae

Rules of Nomenclature

Typification: Designation of a nomenclatural type is called typification. It is the means by which scientific names are allocated to the taxa. A 'type' is a zoological object on which the original published description of a name is based. Once designated, the 'type' cannot be changed (not even by the original author) excepting the plenary powers of ICZN. Although Linnaeus never designated any specimen as 'type'; his descriptions were based on a single specimen and he substituted old specimens with the new ones. This practice continued in Europe for quite some time resulting in confusion in tracing the original specimens. The zoological code ruled for typification in 1901 for the future work. There are 41 different type series but commonly recognizes types categories are:

1) *Holotype*: A single specimen selected by the author of a species to give full description as a true type. A holotype must be labelled containing following data: Locality, date, size, sex, developmental stage, name of the host (if epizoic or parasitic) and name of the collector. It should be deposited in a recognized museum and assigned a registered number.
2) *Syntype*: Specimens from which the primary type (Holotype or Neotype) is selected.
3) *Paratype*: A specimen cited in the original description other than the holotype.
4) *Allotype*: It is a specimen of the opposite sex to the type.
5) *Apotype*: A specimen, not the type upon which a subsequent or supplementary description or figure is based on. It is also called *hypotype*.
6) *Topotypes*: Specimens identified as of special origin.

7) *Genotype*: The species which is designated as the type species of a genus upon which it is based.
8) *Geotype*: Specimen from the type locality.

***Abbreviation of species*:** Books and articles sometimes intentionally do not identify species fully and use the abbreviation "sp." in the singular or "spp." in the plural in place of the specific epithet: for example, *Metapenaeus* sp. This commonly occurs in the following types of situations: The authors are confident that some individuals belong to a particular genus but are not sure to which exact species they belong. The authors use "spp." as a short way of saying that something applies to many species within a genus, but do not wish to say that it applies to all species within that genus. If scientists mean that something applies to all species within a genus, they use the genus name without the specific epithet. In books and articles, genus and species names are usually printed in *italics.* If using "sp." and "spp.", these should not be italicized.

Name change and instability in nomenclature: One of the drawbacks with binomial system is its instability. Genera are often split or clubbed together and species are frequently shifted from one genus to another. Such changes reduce the efficiency of zoological nomenclature as a reference system. However, ICZN has flexibility to have such changes.

Michener (1964) proposed to freeze the original scientific names of a new species for all times by connecting the generic and specific names with a hyphen. This avoids the problem of homonymy, changes of generic and specific combinations and changes of specific endings to agree with gender of generic name. But it creates confusion in cases where the species have been transferred from one genus to other. The problem is aggravated further if the species belonging to altogether different family is transferred.

Use of parentheses: The author's name is put in parentheses when the species is transferred form one genus to other retaining its original author and date. It is called new combination. *e.g. Hemilea bipars* (Walker, 1862) Hardy, 1959. This means that Walker described the fruit fly species *bipars* originally in some genus but Hardy in 1959 transferred it to its correct genus *Hemilea*. This example gives the names of original authors as well as the one who transferred it.

Use of such double citation is purely optional under ICZN. Generally, original author in such cases is omitted to avoid double citation.

Under the Zoological code, the use of the citation of author's name and date in square bracket indicates that the name has been taken from indirect source (other than the original). In citing synonyms, square brackets are also used to include statement of misidentification.

Synonymy: Two or more names belonging to the same taxon are called synonyms. When there are number of synonyms for a species only the oldest one is valid by the Law of priority (ICZN). The oldest one is taken as the proper name and called senior synonym while the rest are treated as junior synonyms. The synonyms pose a great problem for the taxonomists. These are created due to lack of knowledge of the existing literature or not understanding the amount of variation a species may possess Many a times same species is described by two or more authors by different names without knowing that variations within the species. It is estimated that more than half of the synonyms are due to underestimation of the individual variations. It was reported that there were 251 species of fresh water mussel (*Anodonta* spp) which were actually variants of merely two species. However, synonymy provides considerable amount of information available in the literature.

Homonymy: The names which are spelt in an identical manner but based on different types are called homonymes. The ICZN rules that if two or more homonyms are found, only the oldest one (Senior homonym) is used while the rest are excluded. This may occur when identical based on different types are used at the same rank, e.g. subspecies in a species, species in a genus, and so on. The family-group names differing only in suffix are also considered synonyms. However, identical species names placed in different higher groups are not considered as homonyms i.e. *Noctua variegata* (Insecta) and *Noctua variegata* (Aves). The existence of two or more names based on different types is called *homonymy*.

Use of punctuation: Punctuation marks such as comma and colon are very important while writing scientific names. There should be no punctuation between the species name and the author's name and the year; if there such punctuations they have significance e.g. when *Penaeus monodon* Fabricius 1798 is written without comma between the species name and the author's

name, it means Fabricius gave the specific name *monodon* and he is the original authority. When a comma between the species name and the author's name is inserted it would mean that the author is not the original discoverer but only quoting the taxa. and the year other authors make use of already published name and it is necessary to refer to such subsequent users of the name, they are authors of junior names (i.e. junior synonyms or repetition of already published ones). They should be cited after the original name but separated from it by a colon or semi-colon, never by a comma or full stop.

Priority: This is a controversial part of the zoological nomenclature but a basic law of ICZN to promote stability. Whenever two names belonging to the same taxon are discovered, the validity of one is decided by the law of priority. This means the valid name is the oldest (taken from the published records) with few exceptions. The authority of a name in family, genus or species is not changed on its elevation or reduction in rank within the group.

Advances in taxonomy at molecular level

Alpha taxonomy, and so biodiversity assessment remains today mainly based on morphological characters. Since morphology is complex and non-neutral, it may lead to under- or over-estimation of species diversity. Today's technology for sequencing DNA and barcoding have paved a way to molecular taxonomy at more objective level. For highly diversified crustaceans, sequencing of two mitochondrial genes, COI and 16 S rRNA have been found useful for correlation between taxonomic ranks and molecular divergence (Lefe'bure *et al*., 2006). DNA barcoding requires defining for each taxonomic group a set of molecular synapomorphies that can be used as taxonomic tags.

Cryptic species are common in crustaceans (Burton and Lee, 1994; de Bruyn *et al*., 2004). Crustaceans are also particularly abundant in extreme habitats which have tendency of morphological convergences leading to biodiversity under estimation. For these reasons crustaceans constitute a group for which DNA taxonomy could be highly valuable.

Chapter 3

Types of Types

Rahul G.Kumar

What is a type?

In zoological nomenclature, a type is a specimen (or a group of specimens) which serves to illustrate the defining characters of a species or genus. The purpose of designating a type is to provide an objective reference which can be used by later scholars to verify the identity of the species being described. As our understanding of the relationships between species evolves, it is not unusual for a given species to be shuffled amongst different genera. The presence of type material allows us to recognise the organism that is being referred to, even if the name is different.

In order to be valid as a type, a the specimen must meet certain guidelines set forth in the International Code for Zoological Nomenclature, a compendium of the rules of nomenclature, laid down by the International Commission for Zoological Nomenclature (ICZN). The rules for designating a type differ, depending on when the description was published. For species described after 1999, a holotype must be explicitly designated for the description to be considered valid.

Not all described species have types attached. The practice of explicitly designating types most likely began with the entomologist Pierre Andre Latreille in the early 1800's[(1)]. Not all early authors designated or preserved type material, often complicating later identification of specimens. When a type was not designated in the original description, it often becomes imperative to designate a type from amongst available material in order to fix the nomenclature and clarify the identity of the species.

The primary purpose of designating a type is to enable scientists in the future to definitely identify a described species. When attempting to describe a new species, rather than depending solely on the published description, it is important to physically examine previously described species to definitively conclude that a specimen we have on hand is in fact new to science. Thus, it is critically important for type species to be placed in a well maintained, universally accessible repository.

The different types of types commonly encountered in taxonomy are briefly discussed below.

Holotype

A single specimen that has been explicitly designated in the original description as the specimen on which the description is based. If a holotype is not explicitly desginated, but it is clear that only one specimen was used in describing the species, then that becomes the holotype[(2)]. The

holotype is, in many ways, the "gold standard" by which the species can be recognised. When describing a new species, it is important to designate as holotype a specimen that is as complete as possible and clearly illustrates diagnostic characters by which the species may be distinguished. E.g. If a species of prawn is described with features of the left cheliped being used to distinguish it from closely related species, designating a specimen missing that appendage as the holotype defeats the purpose.

A holotype is usually a preserved specimen or fossil, but in rare cases, it may consist of an illustration (like the reunion island parakeet, known only from pictures[(4))], a live specimen[(5)] or a tissue sample.

Allotype

A specimen of the opposite sex as the holotype, which has been used in the description. Often used to illustrate morphological characters not seen in the holotype[(2)].

Paratype(s)

Specimen(s) other than the holotype on which the description is based and where these specimens have been included in the description as type material[(2)].

Syntypes

When a species description is based on two or more specimens and the author failed to explicitly designate a holotype, all the specimens are considered syntypes. If the description was published prior to 1931, any specimens cited via references in the manuscript are also considered syntypes[(3)]. In modern times, syntypes are rarely used in new descriptions.

Lectotype

A specimen selected after the description was published, from a set of syntypes, as the type of a species[(2)].

Paralectotype

When a lectotype is designated, the remaining syntypes are considered paralectotypes[(2)].

Neotype

When a designated type of a species (holotype, syntypes, neotype or lectotype) has been previously designated, but is subsequently lost or damaged beyond recognition, a fresh specimen designated as the type is called a neotype. If paratypes are present, it is desirable to select the neotype from among the paratypes[(2)].

Topotype

A specimen collected at a later date, and not part of the type series, from the same locality as the holotype of the species[2]. When the type series consists of a small number of specimens, data from topotypes can be used to help diagnose a new species.

Isotype

A specimen collected at the same time, but not from the same place, as the holotype, paratypes or syntypes, but not included in any of these[2].

Morphotype

A specimen illustrating a morphological variant of a species[2]. Nowadays, it is likely a morphotype may be described as a new species. DNA sequences are useful in determining if a morphotype is distinct enough to be described as a new species.

Monotype

When the holotype of a species is the only specimen known to science, it is called a monotype[2].

Some technical terms are often used in conjunction with type descriptions, the most common amongst those are given below.

Type locality

The location from where the holotype or lectotype of a species was collected from. Paratypes can be from a different locality to the holotype. E.g. Specimens of a new species are collected from Mumbai, Calicut and Kanyakumari. In the description, the holotype is chosen from amongst the specimens collected in Mumbai, with the rest of the specimens listed as paratypes. The type locality thus is Mumbai, where the holotype was collected.

Type localities in early descriptions were often very vague; e.g. “Madras” or “Indian Ocean”. Nowadays, with the availability of GPS, they are quite precise.

Type series

The group of specimens explicitly (or implicitly) listed as forming the type material used in the description. Additional specimens used for measurements, but not listed as type material are considered non-type or collateral types[2].

Name bearing type

A specimen or specimens (holotype, lectotype, neotype, syntypes) which provide an objective standard by which the species can be identified.

Points to keep in mind when describing a new species

a) A holotype must be explicitly designated, along with a precise collection locality. This specimen must clearly illustrate the key features on the basis of which the taxon is distinguished.

b) Additional specimens used in the description must be designated as paratypes or non-type

c) All specimens (or at least the holotype) must be deposited in a museum or recognised educational institute, where they will be properly maintained and made available to other scientists or students for study.

d)The description must include, in addition to distinguishing characters and measurements, a diagnosis listing similarities to and differences from other closely related species. The repository where the type material is stored must also be listed.

The curious case of *Macrobrachium rosenbergii*

The giant freshwater prawn is a species of great importance to commercial aquaculture world-wide. Wowor and Ng (2007)[7] caused a stir when they conclusively showed that there were, in fact, two species, not one. What was considered *M. rosenbergii* was composed of two sub-species, *Macrobrachium rosenbergii rosenbergii* described from east of Huxley's line (a biogeographical boundary that separates Asian fauna from Australian), and *M. r. dacqueti* from west of the line. Wowor and Ng proved that the two were in fact distinct, valid species.

This had the potential to cause a lot of confusion because the species that was commercially important and widely aquacultured was in fact *M. dacqueti*, with the true *M. rosenbergii* being found only in Australia, Philippines and Papua New Guinea, with no commercial importance.

In order to prevent unecessary confusion, Wowor and Ng petitioned the ICZN to set aside the name *M. dacqueti* and retain *M. rosenbergii* for the commercially important species. In 2010, the ICZN ruled that the holotype of *M. rosenbergii* be set aside and the lectotype of *M. dacqueti* be designated a neotype[6], thus retaining the name *M. rosenbergii* for the commercially important species.

While this made aquaculturists happy, it left the species from east of Huxley's line without a name. Ng and Wowor (2011)[8] determined that the earliest available name, *Macrobrachium spinipes,* took precedence and assigned it to the species found in Australia, the Philippines and Papua New Guinea.

The above example shows how species can continue to be identified even in the face of changes in taxonomy thanks to the presence of type material.

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Chapter 4

Penaeus

Josileen Jose

Shrimps and prawns constitute a large group of crustaceans varying in size and are widely distributed in marine, brackish, and freshwater regions from the equator to the Polar Regions. Although the majority of the commercial marine species occupy shallow or moderately deep water areas along the continental shelves at depths of less than 100 m, some are found at depths of nearly 5700 m. Many shrimps are pelagic but the majority by far is benthic, living on a large variety of bottoms such as rock, mud, peat, and sand, fragments of shells or mixtures of these materials. Although there are about 4048 species of prawns known to date, they are subdivided into four major groups, namely Dendrobranchiata (68 species, 533 species), Stenopodidea (12 genera, 71 species), Caridea (389 genera, 3438 species) and Procarididea (2 genera, 6 species) (De Grave and Fransen, 2011). Although the carideans are a majority only a few are abundant enough to be of interest to fisheries. Most of the commercial prawns belong to the Penaeoidea; at present, only less than 300 species of prawns are of economic interest worldwide and of these only about 100 comprise the principal share of the annual world catch (Chan, 1998). The record of 418 species of prawns is a testimony to the high diversity of prawn fauna in Indian waters. The Carideans with 7 superfamilies and 11 families underneath has numerologically large number of species with only few with commercial potential (Radhakrishnan and Josileen, 2013). Most of the commercial species of prawns belong to the superfamily penaeoidea. Studies on penaeoids are more comprehensive and at present 5 families, 23 genera and 121 species (including the introduced species) are known to occur along the Indian coast including the Lakshadweep and Andaman and Nicobar Islands, with the penaeidae being the most important family (Radhakrishnan *et al*., 2011).

The terms “shrimp” and “prawn” have no definite reference to any known taxonomic groups. Although the term “shrimp” is sometimes applied to smaller species, while “prawn” is more often used for larger forms, there is no clear distinction between both terms and their usages is often confused or even reverse in different countries or regions (Chan, 1998). However, for uniformity the term **“prawn”** will be used throughout this text.

Systematic Position

Penaeoid prawn belongs to the largest phylum in the Animal Kingdom, the Arthropoda, characterized by jointed appendages and an exoskeleton or cuticle which is periodically molted. There are thousands of terrestrial species in this phylum, and large, predominately aquatic subphylum, the Crustacea. The more highly evolved crustaceans (Class Malacostraca) include the penaeid prawns (Order Decapoda). The class Malacostraca contains about three-fourths of the known species and includes crayfish, lobsters, shrimps and crabs (Bailey-Brock & Moss, 1992).

Prawns are included in the decapod suborder Dendrobranchiata, which are distinguished from other prawn-like Crustacea (the Caridea) and the remainder of the Decapoda by their gill structure and by not carrying the developing eggs on the pleopods of the abdomen. Decapods can be distinguished from other higher crustaceans by examining differences in the thoracic appendages. The first three pairs of thoracic appendages, the maxillipeds, are modified for feeding and the remaining five pairs are the walking legs, hence the name Decapoda or "ten-legs". Penaeid appendages typically consist of two branches (biramous), the exopodite and endopodite. These structures are variously developed for feeding, locomotion or burrowing; or they bear feathery gills (modified epipodites) contained beneath the carapace, or sensory structures on the antennae and antennules (Bailey-Brock & Moss, 1992). To study the different genera and species of the prawns, one must have knowledge on fundamentals of morphology, based on these characters, species are separated.

Classification

Phylum: Arthropoda
Sub phylum: Crustacea
Class: Malacostraca
Subclass: Eumalacostraca
Superorder: Eucarida
Order: Decapoda
Suborden: Dendrobranchiata
Superfamily: Penaeoidea

Most of the commercial species of prawns belong to the **superfamily Penaeoidea**, which is divided into families Solenoceridae, Benthescymidae, Aristeidae, Penaeidae and Sicyoniidae. Among them family **Penaeidae** comprises more species of commercial value prawns.

Superfamily PENAEOIDEA

Penaeoid shrimps

Diagnostic characters: Small to large sized, with a body length from 2.5 to about 35 cm. All 5 pairs of legs well developed, with **first 3 pairs of legs forming a pincer**, none of the pincers particularly large. Abdomen with **posterior part of pleura (lateral plates) covering anterior part of succeeding pleura**. **With large copulatory organ, on first pair of pleopods in males (petasma), and on posterior thoracic sternites in females (thelycum)**.Eggs are released directly into the water and not retained by the females on the abdomen.

Caridea:

Third leg always without pincer; **pleuron of second abdominal segment greatly expanded and overlapping those of first and third segments**; males and females without large copulatory organ on first pair of pleopods or posterior thoracic sternites, respectively; females carry the eggs on the abdomen until hatching.

Key to the families of Penaeoidea occurring in the area

1a. Either rostrum very short and armed with 1 or 2 upper teeth only, or upper antennular flagellum very short and attached to the base of distal antennular segment . . . . **Aristeidae**

1b. Rostrum always armed with more than 3 upper teeth, and both upper and lower antennular flagella of similar length and attached to the tip of antennular peduncle . .. . →

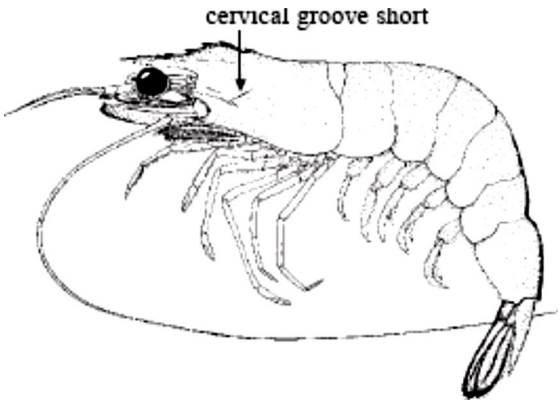
2a. Pleopods (abdominal appendages) with 1 branch only; abdomen often with many distinct furrows and grooves . . . . . **Sicyoniidae**

2b. Pleopods (abdominal appendages) with 2 branches; abdomen without or with very few distinct grooves . . . . . → ***3***

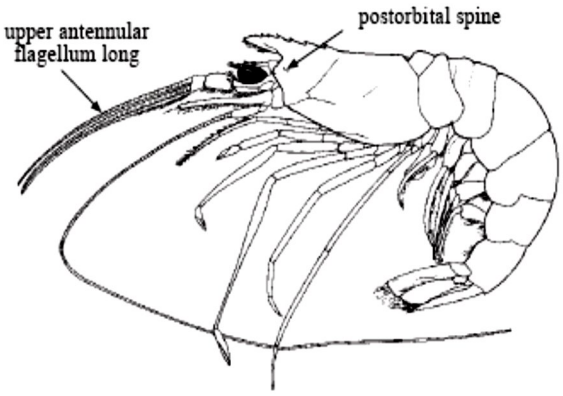
3a. Cervical groove prominent and extending to about dorsal carapace; either postorbital or postantennal spine present . . . . . **Solenoceridae**

3b. Distinct part of cervical groove far from dorsal carapace; postorbital and postantennal

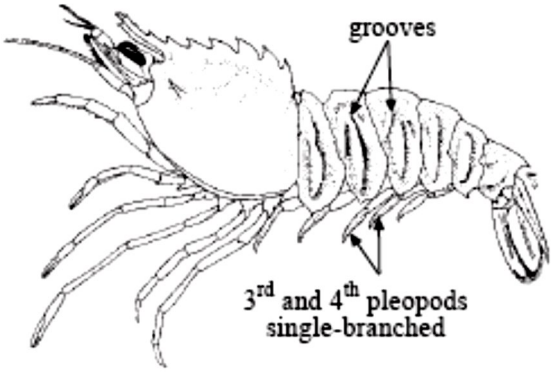
spine absent . . . . . **Penaeidae**



Penaeidae



Solenoceridae



Sicyoniidae

Aristeidae

Some of the important penaeid shrimps that support commercial fisheries along the Indian seas are *Fenneropenaeus indicus* (Indian white prawn), *Penaeus semisulcatus* (Green tiger prawn), *P. monodon* (Giant tiger prawn), *F. merguiensis* (Banana prawn), *Marsupenaeus japonicus* (Kuruma shrimp), *F. penicillatus* (Red-tail prawn), *Melicertus canaliculatus* (Witch Prawn), *M. latisulcatus* (Western king prawn), *Metapenaeus dobsoni* (flower-tail prawn), *M. monoceros* (Speckled prawn), *M. affinis* (Jinga prawn), *M. kutchensis* (Ginger shrimp), *M. brevicornis* (Yellow prawn), *Parapenaeopsis stylifera* (Kiddi prawn), *P. hardwickii* (Spear prawn), *P. sculptilis* (Rainbow prawn), *P. uncta* (Uncta prawn), *Trachysalambria curvirostris*

(Rough prawn), *Metapenaeopsis stridulans* (Fiddler shrimp), *Parapenaeus longipes* (Flaming prawn), *Solenocera crassicornis* (Coastal mud prawn) and *S. choprai* (Coastal mud prawn).

Penaeus general characters

- Body integument always glabrous.
- Rostrum toothed dorsally and ventrally
- Adrostral carina extending well back on to the carapace
- Carapace without longitudinal or transverse sutures
- Cervical and orbito-antennal sulci, antennal carina, hepatic and antennal spines, well defined and pterygostomial angle rounded.
- Antennular flagella shorter than the carapace.
- Petasma pod-like and flexible with thin median lobes, usually with small thickened distal protuberances and forming a posterior tube-like projection; lateral lobes usually with thickened distal rounded margins.
- Thelycum with anterior plate between the coxae of the 4th pereiopods variable in shape and smaller than the posterior part of the thelycum; seminal receptacle occupying the ventral surface of the last thoracic somite, usually closed by two flaps, or sometimes a single pocket, or sometimes open.

Revision of the genus *Penaeus*

Within the genus *Penaeus* there were 27 species and from the Table-1, it can be seen that 17 of the species names pre-dated the 20th century and 10 more were named thereafter, the most recent in 1967. During 1969-1972 the genus *Penaeus* was divided into sub-genera (Perez Fartante, 1969; Tirmizi, 1971; Burukovsky, 1972) based on few common morphological features (Fig.A). This had little effect on practitioners of shrimp industry or on the shrmp scientific community, since sub-genus names are rarely used in the commerce. However, in more recent monograph published in 1997 (Perez Fartante and Kensley, 1997) the generally accepted sub-genus names were elevated to the rank of genus. Flegel (2007), proposed a transitional, that included the sub-genus names in brackets between the genus *Penaeus* and the relevant species names, as recommended by the rules of the zoological nomenclature [e.g., *Penaeus*

(*Fenneropenaeus*) *chinensis*]. The reverse can not be done because *Penaeus* is not a sub-genus name and only viable option is to include a statement in brackets after the new binomial the first time it is mentioned [e.g., *Fenneropenaeus chinensis* (also called *Penaeus chinensis*].

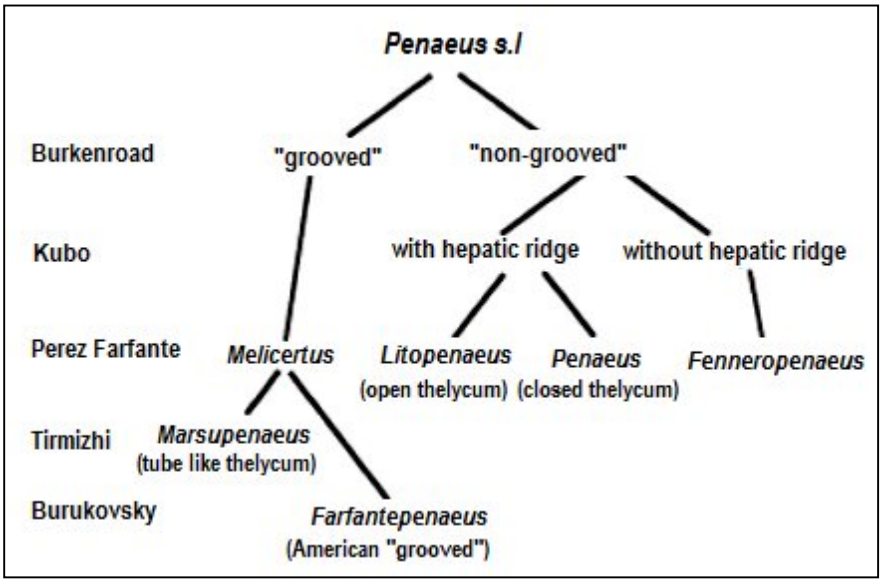


Figure A. History of penaeid shrimp division into sub-genera (after Lavery et al., 2004)

Table 1.Traditional species names for the penaeid shrimp together with their date of naming (Holthuis, 1980)

Genus	Sub-genus	Species	Authority	Year
Penaeus	*Farfantepenaeus*	*aztecus*	Ives	1891
		brasiliensis	Latreille	1817
		brevirostris	Kingsley	1878
		californiensis	Holmes	1900
		duorarum	Burkenroad	1939
		notialis	Pérez-Farfante	1967
		paulensis	Pérez-Farfante	1967
		subtilis	Pérez-Farfante	1967
	Fenneropenaeus	*chinensis*	(Osbeck)	1765
		indicus	H. Milne Edwards	1837
		merguiensis	De Man	1888
		penicillatus	Alcock	1905
	Litopenaeus	*occidentalis*	Streets	1871
		schmitti	Burkenroad	1936
		setiferus	(Linnaeus)	1767
		stylirostris	Stimpson	1874
		vannamei	Boone	1931
	Marsupenaeus	*japonicus*	Bate	1888
	Melicertus	*canaliculatus*	(Olivier)	1811
		kerathurus	(Forskål)	1775
		latisulcatus	Kishinouye	1896
		longistylus	Kubo	1943
		marginatus	Randall	1840
		plebejus	Hess	1865
	Penaeus	*esculentus*	Haswell	1879
		monodon	Fabricius	1798
		semisulcatus	De Haan	1844

Important species

***Penaeus* (*Fenneropenaeus*)** Pêrez Farfante, 1969

Penaeus (*Fenneropenaeus*) *indicus* (H. Milne Edwards, 1837 in Milne Edwards, 1834-1840)©

Penaeus (*Fenneropenaeus*) *merguiensis* (De Man, 1888a)©

Penaeus (*Fenneropenaeus*) *penicillatus* (Alcock, 1905)©

Penaeus (*Fenneropenaeus*) *silasi* (Muthu & Motoh, 1979 a)*

***Penaeus* (*Litopenaeus*)** Pérez Farfante, 1969

Penaeus (*Litopenaeus*) *vannamei* (Boone, 1931)®

***Penaeus* (*Marsupenaeus*)** Tirmizi, 1971

Penaeus (*Marsupenaeus*) *japonicus* (Bate, 1888)©

***Penaeus* (*Melicertus*)** Rafinesque, 1814

Penaeus (*Melicertus*) *canaliculatus* (Olivier, 1811)©

Penaeus (*Melicertus*) *latisulcatus* (Kishinouye, 1896)©

Penaeus Fabricius, 1798

Penaeus monodon Fabricius, 1798©

Penaeus semisulcatus De Haan, 1844©

© - Commercial; * - not common ® - Introduced for aquaculture

Key for commercially important *Penaeid* species

1. Rostrum with dorsal and ventral teeth Adrostral carina reaching almost to posterior margin of carapace; gastrofrontal carina present ……..….. 2
   Adrostral carina not reaching behind middle of carapace; gastrofrontal carina absent …4

2. Telson usually with 3 pairs of spinules ……..……3
   Telson without movable spines; rostrum with 1 ventral tooth and body with cross bands
   ……..……. ***Melicertus canaliculatus***

3. Adrostral sulcus narrower than post-rostral carina; Thelycum of females a well developed pouch, opened anteriorly, anterior plate rounded at the apex, anterior and posterior processes fused, forming a subtriangular concave plate. ……***Marsupenaeus japonicus***

   Adrostral sulcus as wide as post-rostral carina; anterior plate of thelycum bifid at the apex
   …… ***Melicertus latisulcatus***

4. Hepatic carina present ……..…… 5
   Hepatic carina absent …….. 6

5. Hepatic carina horizontally straight; fifth pereopod without exopodite……
   ……..…..***Penaeus monodon***

   Hepatic carina inclined at an angle of 20^0 anteroventrally; fifth pereopod with small exopodite ……..***Penaeus semisulcatus***

6. Gastro-orbital carina occupying posterior 2/3 distance between hepatic spine and orbital angle; rostral crest may be elevated but not triangular in profile

…… ***Fenneropenaeus indicus***

Gastro-orbital carina absent or not reaching hepatic spine, and occupying middle 1/3rd distance between hepatic spine and orbital angle…….. 7

7. Dactyl of third maxilliped of adult male ½ propodus; adrostral carina not reaching as far as epigastric tooth; rostral crest triangular in profile.

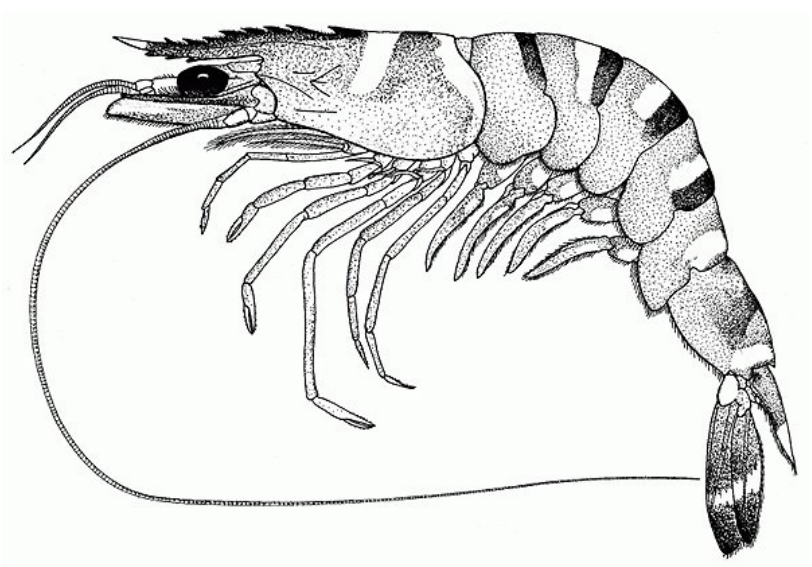
……. ***Fenneropenaeus merguiensis***

Dactyl of third maxilliped of adult male much longer than propodus; adostral carina Reaching just beyond epigastric tooth; rostral crest markedly elevated.

…… ***Fenneropenaeus penicillatus***

Description of the species

Penaeus monodon (Giant tiger prawn/ Black Tiger prawn)



Rostrum generally armed with 6 to 8 upper teeth (including those on carapace) and 3 lower teeth; postrostral crest well developed and reaching nearly to posterior margin of carapace, with or without a feeble median groove; adrostral crest extending to just before last postrostral tooth;

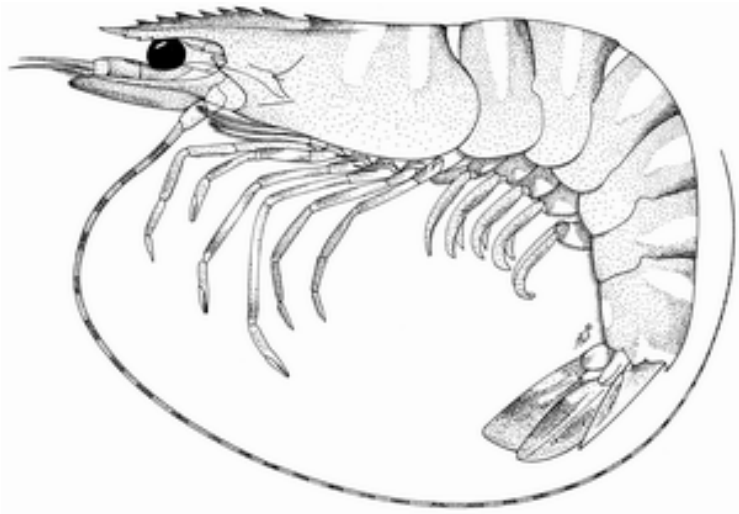
gastrofrontal crest absent; **hepatic crest almost horizontal** and extending far behind antennal crest. **Fifth pereiopod without exopod**.

Colour: body grayish greenish or dark greenish blue; becoming reddish brown in large adults; carapace covered with mud-yellow transverse bands, while abdomen bears dark brown and mud-yellow cross bands.

Distribution and fishery: Both east and west coasts of India and Andaman waters; depth upto 150m (usually less than 30 m); maximum size (TL) in females, 35cm; males 26.8 cm.

Penaeus semisulcatus *Penaeus monodon*

Penaeus semisulcatus (Green tiger prawn)

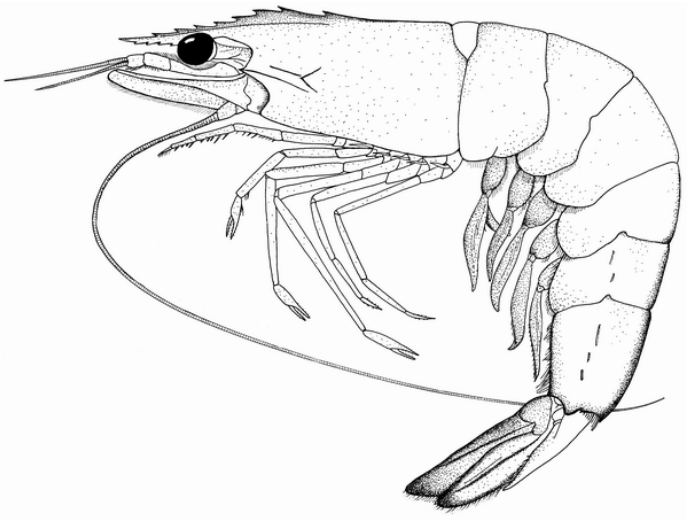


Rostrum generally armed with 6 to 8 upper teeth (including those on carapace) and 3 lower teeth; postrostral crest well developed and reaching nearly to posterior margin of carapace, with a distinct median groove; adrostral crest extending beyond last postrostral tooth; gastrofrontal crest absent; **hepatic crest long and extending behind antennal crest, straight but distinctly sloping antero- ventrally. Fifth leg with exopod (somewhat hidden beneath carapace).**

Colour: body reddish brown to pale brown or dark green, carapace covered with mud-yellow transverse bands while abdomen including tail fan bears grayish brown and mud- yellow cross bands.

Distribution and fishery: Both east and west coasts of India and Andaman waters; depth upto 130m; maximum size (TL) in females, 25cm; males 18cm (commonly between 13& 18 cm).

Penaeus (Fenneropenaeus) indicus (Indian white prawn)

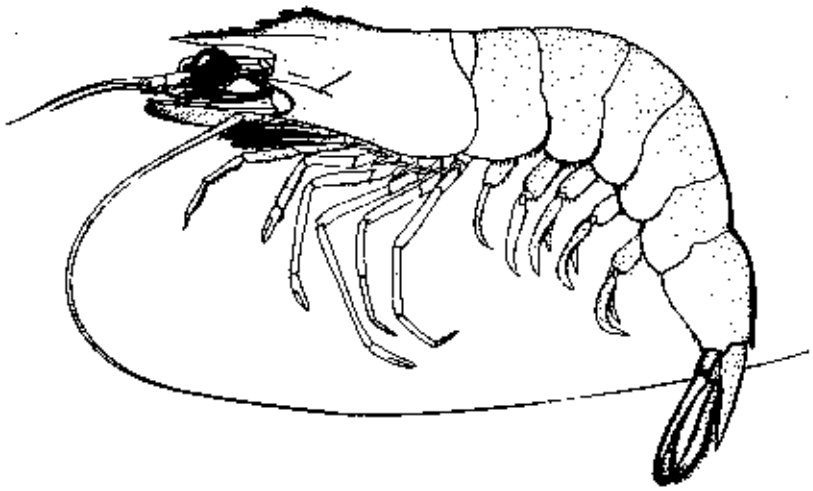


Carapace rather smooth, lacking gastrofrontal and hepatic crests; adrostral crest extending as far as or just before epigastric tooth; **rostrum slightly cruved at tip and sigmoidal-shaped,** usually bearing 7 to 9 upper teeth (including those on carapace) and 3 to 6 lower teeth. **Postrostral crest extending near to posterior margin of carapace**

Colour: Body semi-translucent, Somewhat yellowish white (small specimens) or grayish green and covered with numerous minute dark brown dots.

Distribution and fishery: Both east and west coasts of India and Andaman Islands; depth up to 9 0m (usually less than 30); maximum size (TL) in females, 23 cm; males, 18.4 cm.

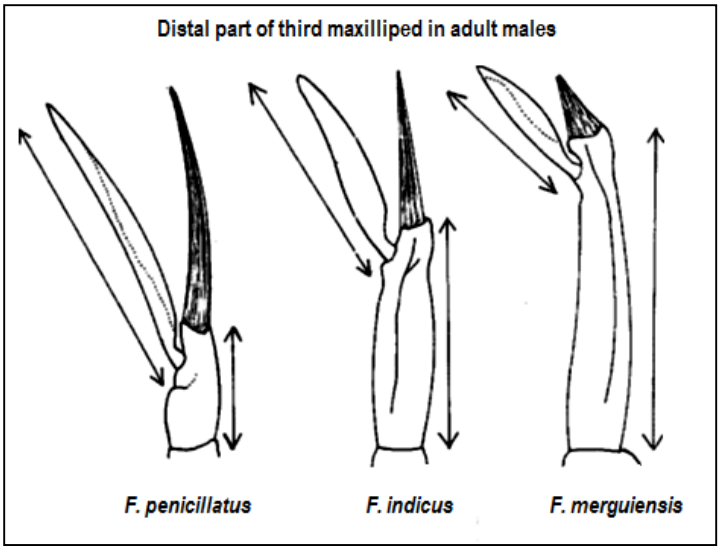
Penaeus (Fenneropenaeus) merguiensis (Banana prawn)



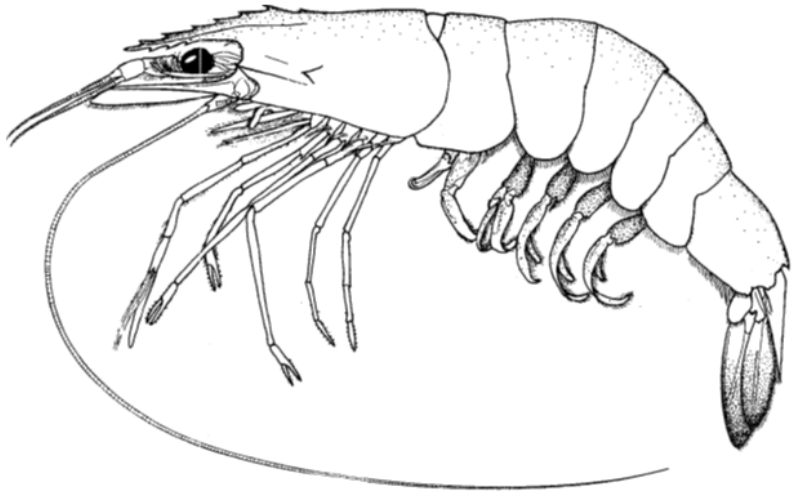
Carapace rather smooth, lacking gastrofrontal and hepatic crests; adrostral crest extending to, or just before, epigastric tooth; tip of rostrum horizontally straight, and **rostral crest becoming very high and broadly triangular in large specimens (even stronger in females),** generally bearing 6 to 9 upper teeth (including those on carapace) and mostly 3 to 5 lower teeth; postrostral rest extending near to posterior margin of carapace. In adult males, third maxilliped with distal segment only about half as long as second segment this bears **a tuft of dense short hairs** (slightly shorter than distal segment) at tip.

Colour: body semi- translucent, some- what yellowish to greenish (in very large specimens) and covered with numerous minute dark brown dots; distal part of uropods yellowish green with red margins; young specimens often with many longitudinal black broken lines on abdomen.

Distribution and fishery: Both east and west coasts of India; depth up to 150m (usually less than 30); maximum size (TL) in females, 35 cm; males, 26.3 cm.



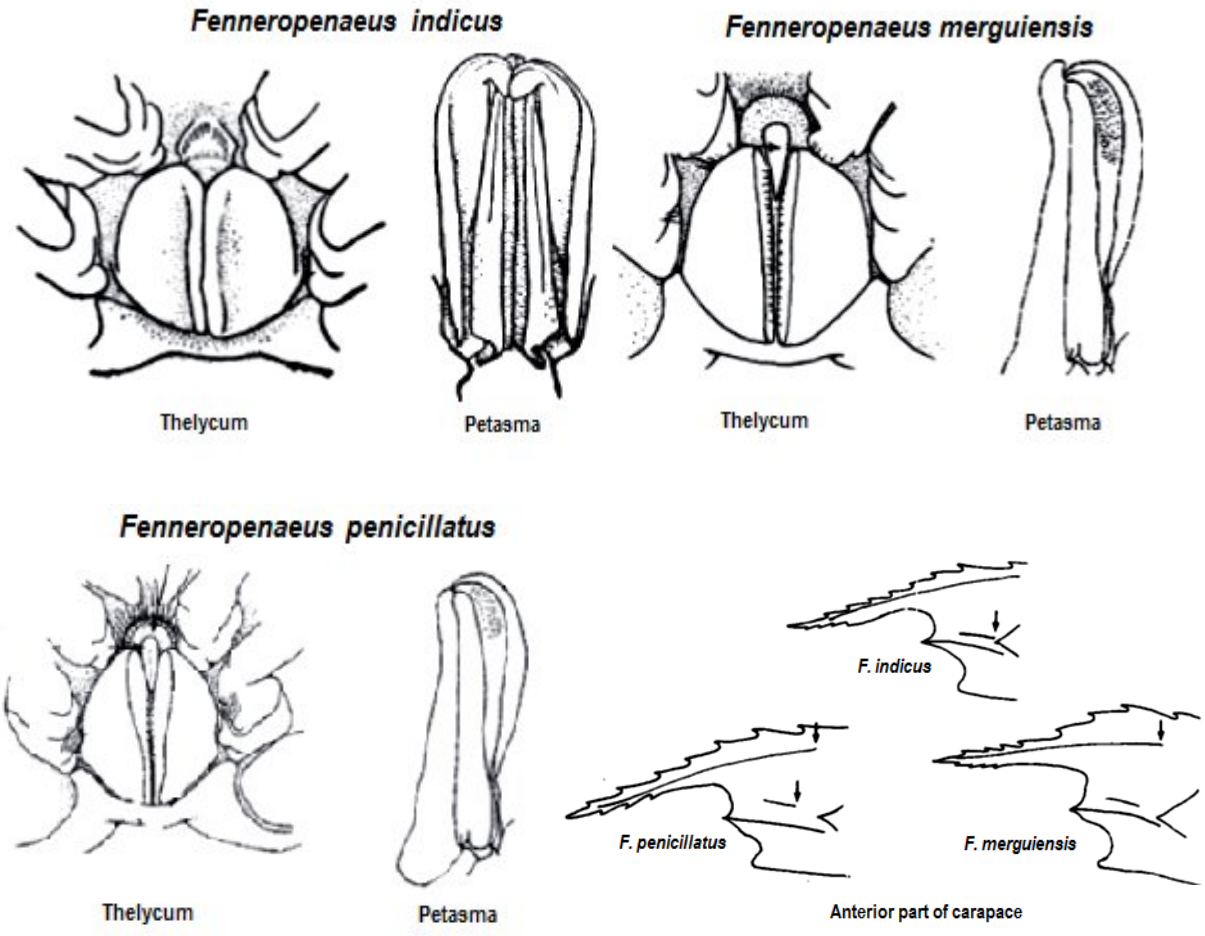
Penaeus (Fenneropenaeus) penicillatus (Red tail prawn)



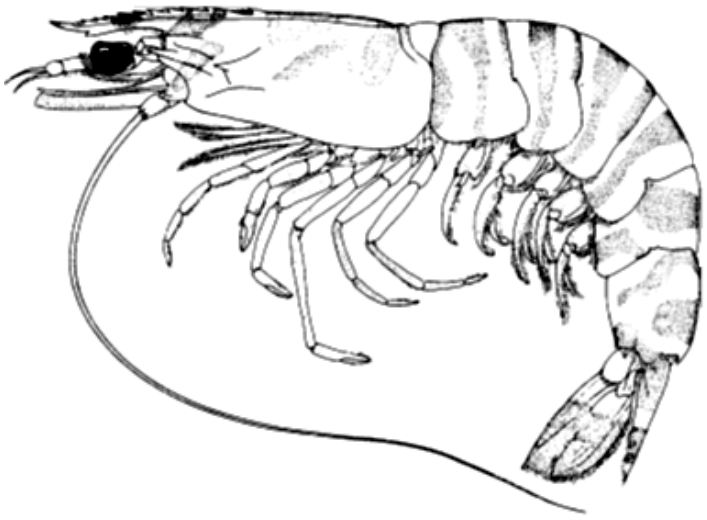
Carapace rather smooth, **lacking gastrofrontal and hepatic crests**; adrostral crest extending just beyond epigastric tooth; **tip of rostrum horizontally straight, and rostral crest generally slightly elevated in youngs and adult males, to moderately high in large females**; In **adult males,** third maxilliped with distal segment much longer than second segment which bears **a tuft of dense long hairs** (as long as distal segment) at tip.

Colour: body semi-translucent, slightly greenish and covered with numerous minute dark brown dots; rostral and abdominal dorsal crests reddish brown to dark brown; **antennal flagella reddish brown**; legs translucent and somewhat whitish; pleopods rather reddish; **distal half of uropods yellowish to greenish but always with reddish tips.**

Distribution and fishery: Gujarat,Maharashtra, Orissa and West Bengal,; depth upto 90 m; maximum size (TL) in females, 21.2 cm; males, 16.3 cm (commonly between 10 & 16cm).



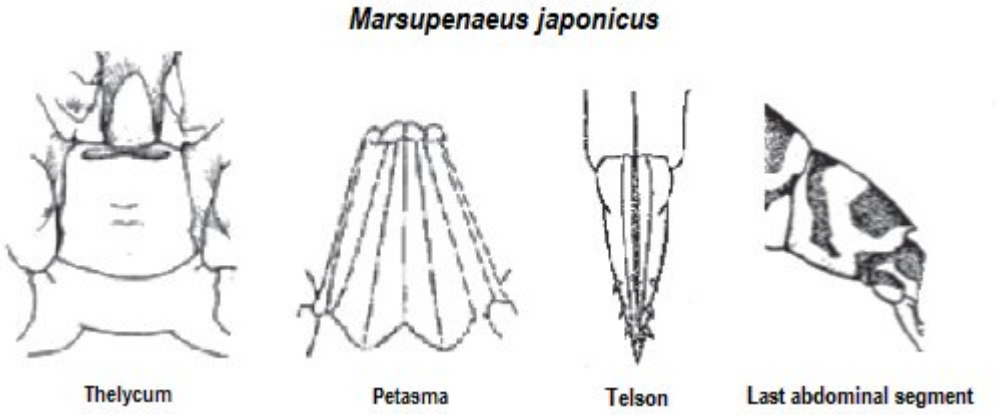
Penaeus (Marsupenaeus) japonicus (Kuruma prawn)



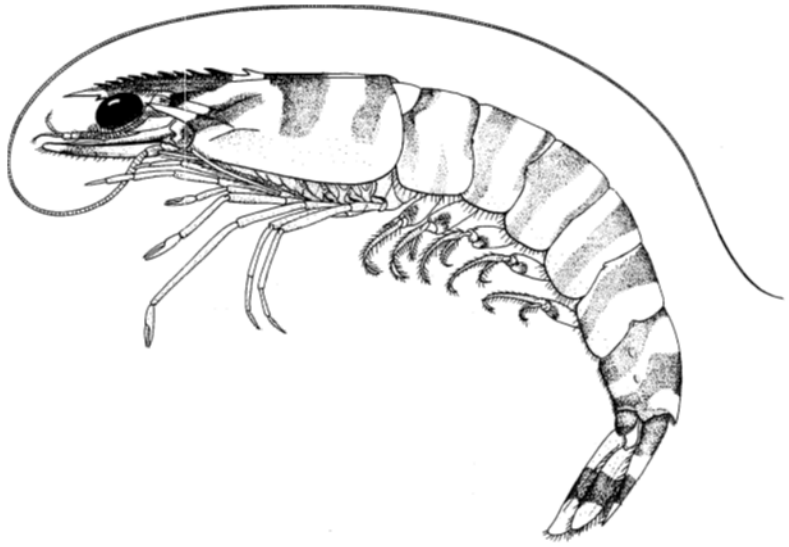
Carapace with grooves and crests very distinct, bearing both gastrofrontal and hepatic crests; **rostrum generally armed with 9 or 10 upper teeth (including those on carapace) and 1 lower tooth,** postrostral crest well developed and with a deep median groove throughout its length; adrostral groove extending near to posterior margin of carapace and almost as wide as postrostral crest; **Telson with 3 pairs of movable lateral spines.**

Colour: body pale yellowish and crossed with dark brown transverse bands; those on carapace generally extending to lower half of carapace, **last abdominal band interrupted**.

Distribution and fishery: Gujarat, Tamil Nadu, West Bengal, Maharashtra; depth upto 90m (usually less than 50); maximum size (TL) in females, 30 cm; males, 20 cm.



Penaeus (Melicertus) canaliculatus (Witch Prawn)

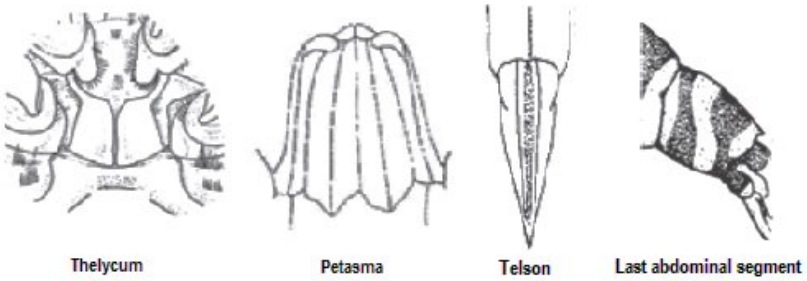


Carapace with grooves and crests very distinct, bearing both gastrofrontal and hepatic crests; rostrum armed with 10 or 11 upper teeth (including those on carapace) and 1 lower tooth; postrosral crest well developed and with a deep median groove throughout its length; adrostral groove extending almost to posterior margin of carapace and slightly wider than postrostral crest; First leg without ischial spine. **Telson without lateral spines**.

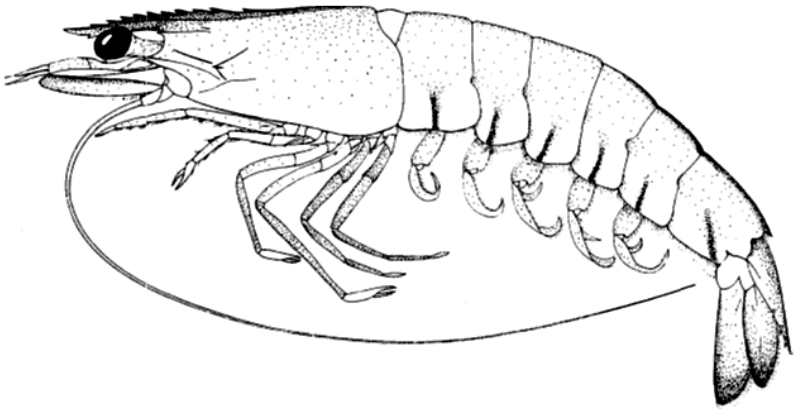
Colour: body pale yellowish and crossed with dark brown **transverse bands**; those on carapace note extending over lower half of carapace **while those on last abdominal segment usually continuous to the ventral margin.**

Distribution and fishery: Gujarat, Orissa, West Bengal, Maharashtra, Tamil Nadu, Kerala, Andaman and Nicobar Islands & Lakshadweep; depth upto 50 m; maximum size (TL) in females, 18.2 cm; males, 14.5 cm.

Melicertus canaliculatus



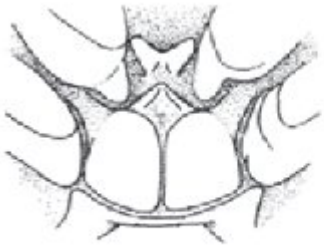
Penaeus (Melicertus) latisulcatus **(**Western king prawn)



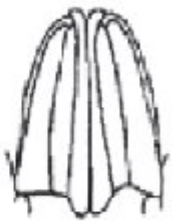
Carapace with grooves and crests very distinct, bearing both gastrofrontal and hepatic crests; rostrum generally armed with 10 or 11 upper teeth (including those on carapace) and 1 lower tooth, lacking distinct accessory crest on the blade; postrostral crest well developed and with a deep median groove throughout its length; adrostral groove extending almost to posterior margin of carapace and distinctly wider than postrostral crest; posterior end of gastrofrontal groove divided into 2. **Telson with 3 pairs of movable lateral spines.**

Colour: body generally yellowish green, becoming slightly reddish inlarge adults; **abdominal segments each with a short vertical black bar on pleuron; hinges on abdomen often bearing dark brown spots** and posterolateral part of carapace also sometimes with 2 black stripes positioned at a right angle.; uropods bright yellow, with distal half and outer margins of exopods bright blue, other margins reddish.

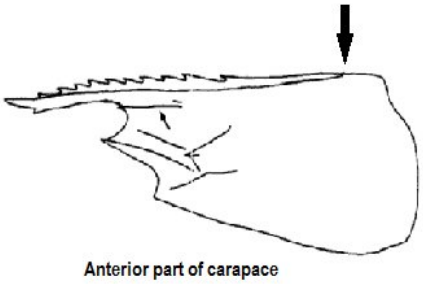
Distribution and fishery: Gujarat, tamil Nadu, Kerala, Andaman and Nicobar Islands & Lakshadweep; depth upto 90m; maximum size (TL) in females, 20.2 cm; males, 16.2 cm (commonly between 10&16 cm).



Thelycum

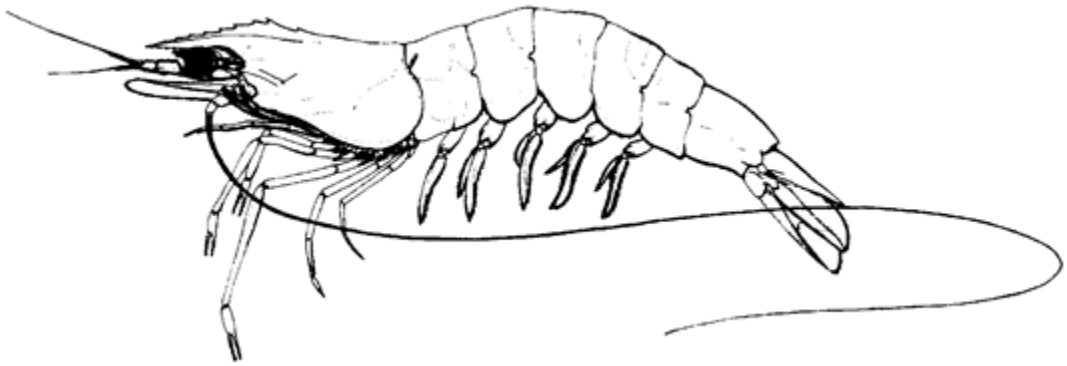


Petasma

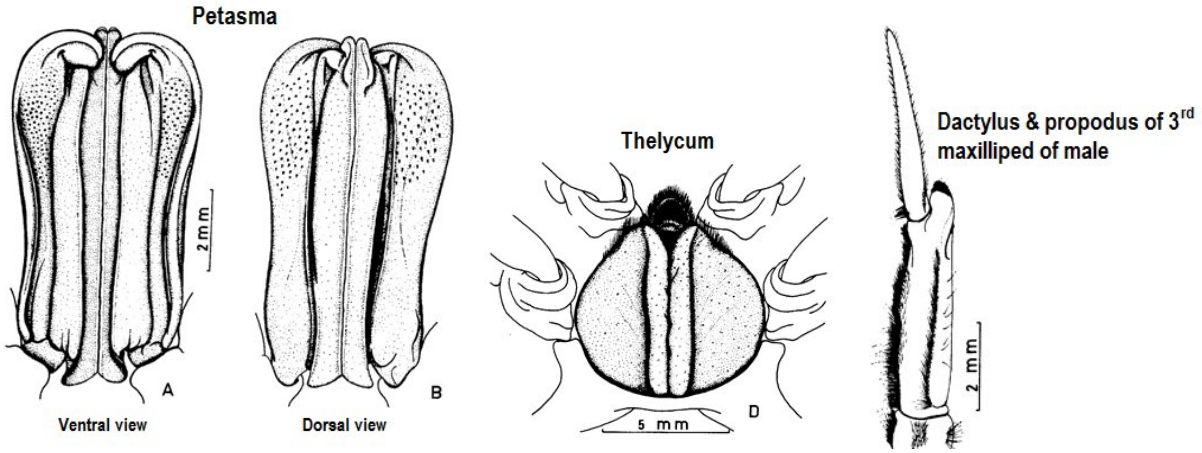


Anterior part of carapace

Penaeus (Fenneropenaeus) silasi



Rostrum almost straight, reaching or slightly exceeding tip of antennular peduncle, sometimes reaching only tip of second segment, with low rostral creast in males and higher crest in large females almost approaching the condition in *P.(F). merguiensis*. Rostral teeth 1+ 6-8/4-5. Adrostral carina and sulcus reaching just behind epigastric. Carapace glabrous. Gastrorbital carina well defined occupying posterior 2/3rd distance between hepatic spine and the postorbital margin; hepatic carina absent. Petasma with median distal projections not overhanging lateral lobes when seen from side. Distal margin of the lateral laobe minutely serrae, outer surface of lateral lobe with a patch of minute conical teeth.



The species is closely related with *P.(F). indicus, P .(F).merguiensis* and *P.(F). penicillatus* and characterized by features in the 3rd maxilliped and thelycum. The 3rd maxilliped

in adult male has dactylus as long as or slightly shorter than the propodus, dactylus narrower than propodus which has only a rudimentary (conical) tuft of hairs instead of a long tuft of bristles as in *P.(F). indicus*. In females the anterior plate of the thelycum is triangular with rounded apex and relatively prominent (Muthu and Motoh, 1979).

LIFE CYCLE

Based on their mode of life, penaeid shrimps can be grouped into wandering and burrowing groups.

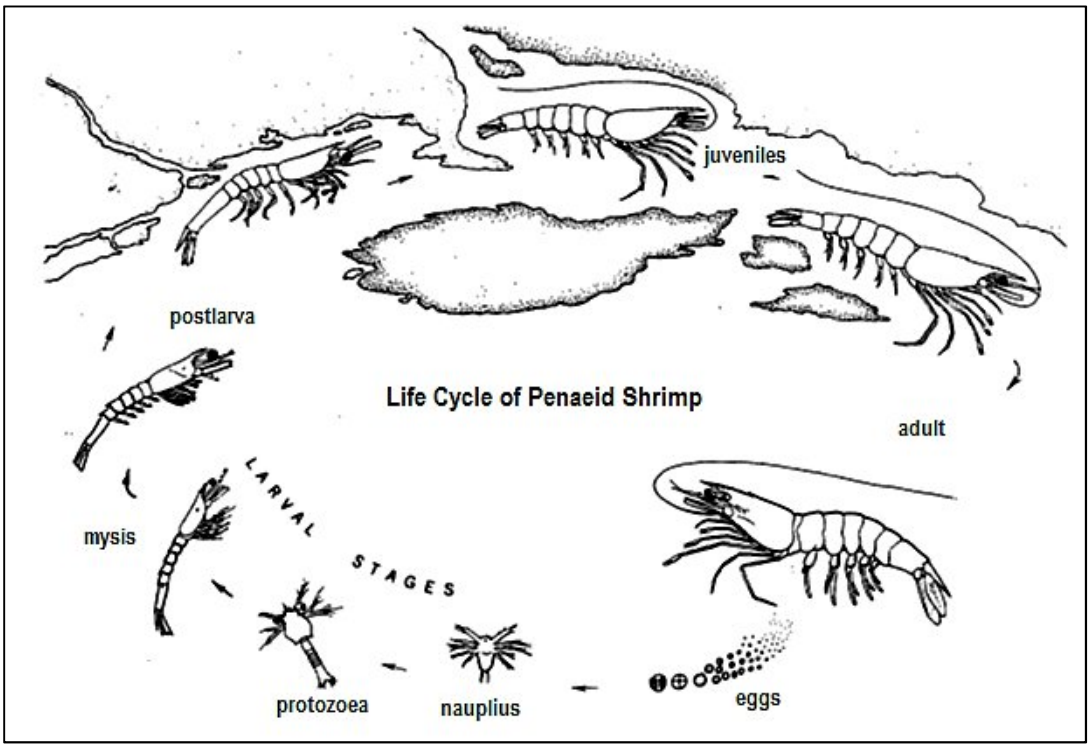
Wandering group

Species belonging to this category have pronounced age groups, from dense schools and are always on the move and active day and night. They prefer turbid waters with soft mud bottom, burrowing slightly or not at all into the substrates. A typical wandering species, *P. orientalis* in the Yellow Sea migrates southward for over wintering and northward in spring to its spawning ground. The distance between the areas for overwintering and spawning is approximately 700–1300 km. Other species belonging to this group are *P. setiferus* of the Atlantic coast, *Fenneropenaeus merguiensis* and *F. indicus* of the Southeast Asian region. These tropical species however, do not need overwintering. *F. merguiensis* and *F. indicus* generally spawn at a depth of 7–30 meters in offshore waters, usually near the nursery ground. The larvae spend part of their life cycle in nursery ground until adolescent stage when they start migrating to deeper and more saline waters. Since *F. merguiensis, F. indicus* and other wandering type of penaeid shrimps from dense schools, fishermen can easily collect large number of spawners during peak seasons.

Burrowing groups

This group prefers certain habitats with sandy bottom. They do not have pronounced age groups. They show marked nocturnal activity, burrowing into the bottom substratum during the day and emerging at night to search for food. This diurnal activity is closely associated with changes in light intensity but may also be due to other factors. Examples of this group are *Marsupenaeus japonicus* in the Japanese coast, *P. dourarum* off Florida and *P. monodon* in Southeast Asia.

Life cycle of the shrimps is completed after passing through two distinct environments - the sea and the estuary. The larval development takes place in the sea, and the migration into the estuaries, lakes and backwaters commences when they are in late mysis or early postlarval stages. They then migrate to deeper water when they become adolescent and finally move to spawning grounds upon becoming adults.



Sexuality

Shrimps are Bisexual. Sexes can be distinguished by external characters such as the presence of morphologically differentiated male and female sex organs. While the male sex organ, petasma, is abdominal in position, being the endopodite of the first pleopod, the female sex organ, thelycum, is a modification of the thoracic sternite. The presence of an appendix masculina on the endopod of the second pair of pleopods is another male character. While the genital openings of the male are situated on the coxa of the fifth pair of pereiopods those of the female are on the coxa of the third pair of pereiopods.

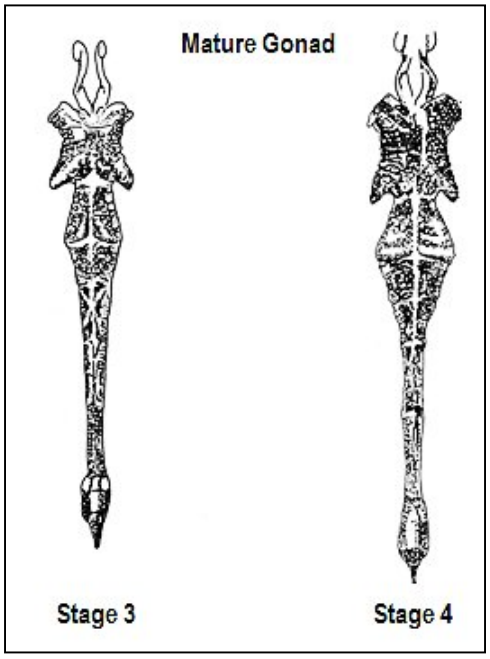
The thelycum is on the ventral side of the cephalothorax and between 4th and 5th walking legs and oviducts open at the base of the 3rd pair of walking legs. The ovary is found on the

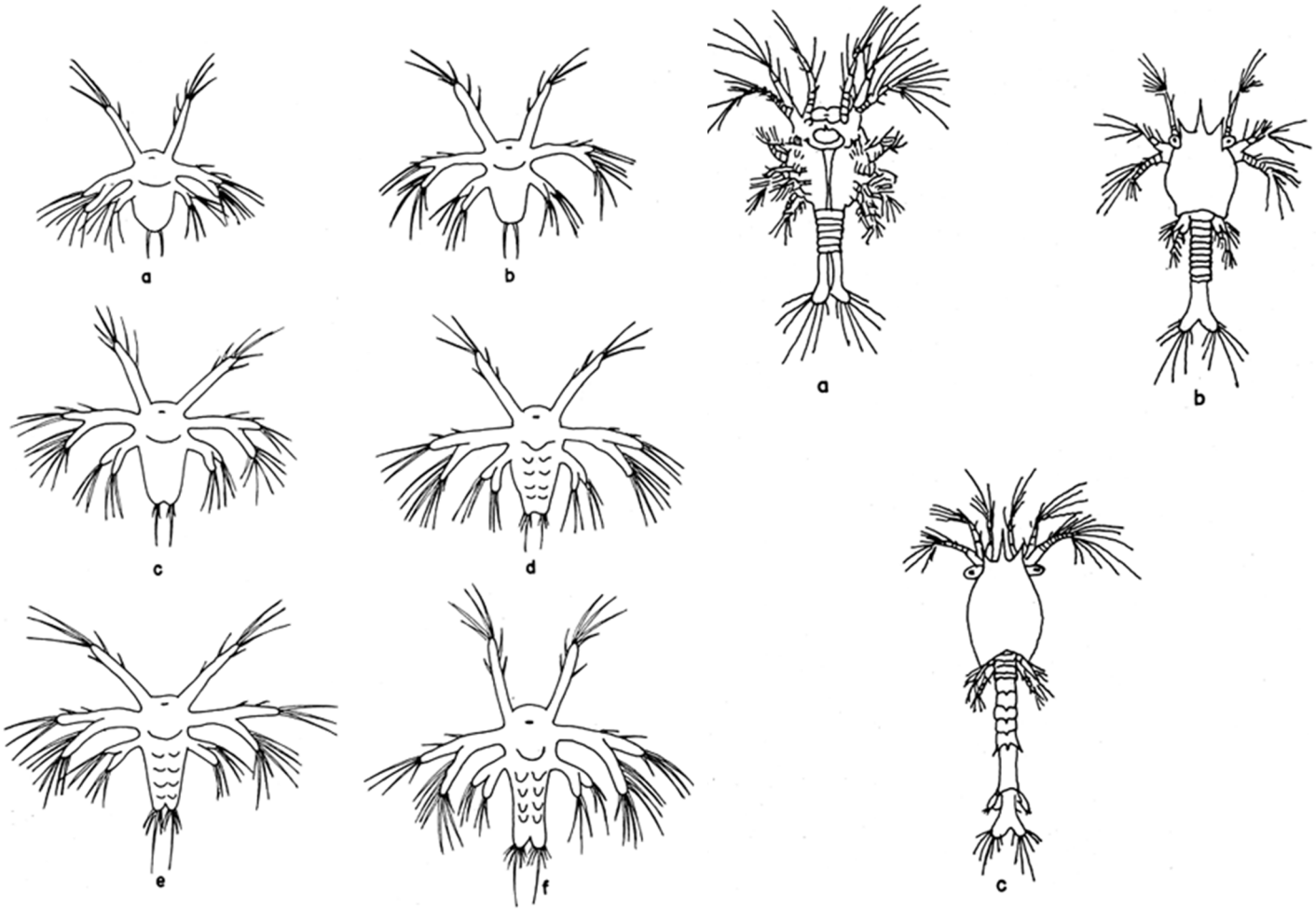
dorsal side of the animal along the entire length. In a fully ripe female ready to spawn, the ovary is dark oive green in colour ans has a lateral expansion in the first abdominal segment.

In males, the petasma is attached to the ventral side of the first pair of swimming legs, which is a modified part of first pair of swimming legs. The two sperm ducts from the testis open at the base of the 5th pair of walking legs. The terminal portion of the sperm duct is enlarged to form the terminal ampoule in which the the spermatophore or sperm packet is stored. It is visible as a white mass at the base of the 5th pair of walking legs in mature males. Females attain relatively larger sizes than males.

Mating and Fertilization

Mating takes place soon after the female moults, when it is still in the soft condition. During mating the sperm packs known as spermatheca are deposited by the male in the external genitalia of the female. In mated females it can be seen as a whitish mass below the translucent cuticle of the thelycum. The females carry the spermatheca during the entire intermoult period and sperms remain viable throughout the period. The sperms are dispensed at the time of spawning. Fertilization is external. As the eggs are extruded from the genital openings of the female the sperms are dispensed from the spermatheca.





NAUPLIUS STAGES

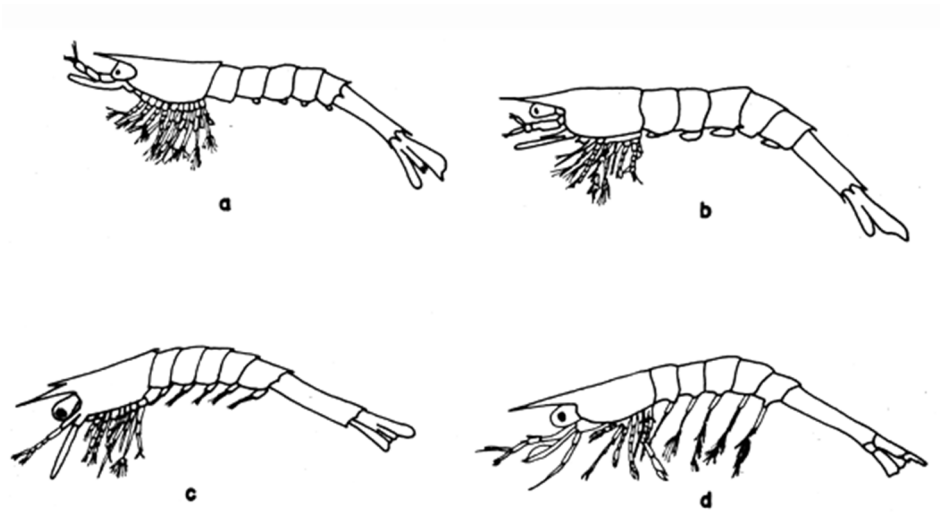
a. Nauplius I b. Nauplius II

c. Nauplius III d. Nauplius IV

e. Nauplius V f. Nauplius VI

PROTOZOEAL STAGES

a. Protozoea 1
b. Protozoea 2
c. Protozoea 3



Mysis and post larval stages

a. Mysis 1
b. Mysis 2
c. Mysis 3
d. Postlarvae 1

At post larval stages the pleopods become fully developed and functional. The animals grow very fast in terms of size and are able to swim freely although early postlarvae are still planktonic in offshore waters. At a body size of 0.8–1 cm in body length, they enter estuaries and inshore shore waters where they first adopt a benthic existence. The shrimps spend their juvenile, adolescent and sub-adult stages in estuarine waters and then gradually move toward deeper water as they grow and eventually returning to offshore water when they attain sexual maturity.

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Editorial

Use of the generic name *Penaeus*

The editors wish to draw to the attention of authors to the publication in this issue of Aquaculture of a paper by T.W. Flegel entitled "The right to refuse revision in the genus *Penaeus*". This paper discusses the effects of the publication by Pérez Farfante and Kensley (1997) of a monograph of shrimps and prawns of the world which included a proposed taxonomic revision raising former sub-genera in the genus *Penaeus* to generic rank.

The editors of Aquaculture have for some time felt that this revision had resulted in some confusion with some authors and journals using the new binomials of Pérez Farfante and Kensley (1997) and others remaining with the traditional *Penaeus* binomials.

The editors are in agreement with the arguments put forward in T.W. Flegel's paper and have agreed that Aquaculture will prefer that authors of future submissions to this journal that concern species of Penaeid shrimp use the generic epithet *Penaeus*, preferably qualified at the first mention by Flegel's proposal, namely to follow the rules of zoological nomenclature by placing the sub-genus names in brackets between the traditional genus name *Penaeus* and the relevant species name at first mention [e.g., *Penaeus* (*Fenneropenaeus*) *chinensis*].

The editors do not however wish to be "coercive" in this matter and so authors who feel strongly supportive of the revised Pérez Farfante and Kensley (1997) generic names should use Flegel's alternative at the first mention of the genus to indicate that another name is also used [e.g., *Fenneropenaeus chinensis* (also called *Penaeus chinensis*)].

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Pérez Farfante, I., Kensley, B., 1997. Penaeoid and sergestoid shrimps and prawns of the world (keys and diagnoses for the families and genera). Muséum National d'Histoire Naturelle, Paris.

D.J. Alderman
B.A. Costa-Pierce
E.M. Donaldson
G. Hulata
R.P. Wilson

Chapter 5

Trachypenaeus, Metapenaeopsis and *Parapenaeus*

V.D. Deshmukh

Shrimps belonging to genera *Trachypenaeus, Metapenaeopsis* and *Parapenaeus* are non-conventional, lesser valued species of penaeid shrimps in India. They are small in size, with rough appearance and hard shell as compared to other highly valued penaeid shrimps. Generally, these species are seen in multi-day the trawl landings. Prior to late 1980s, the non-conventional species were noticed occasionally in shallow coastal waters and did not constitute a regular fishery resource in the country. But, with multi-day trawlers that ventured beyond 40-60 m depth, the species occurred almost regularly and formed substantial part of the prawn landings. A brief account of taxonomy, distribution and common names of the species belonging to these genera is given below:

Genus *Trachysalambria* Burkenroad, 1934a

The genus *Trachypenaeus* now renamed as *Trachysalambria* was first described by Stimpson in 1860 as a species (*T. anchoralis*) in the genus *Penaeus* with a type locality of Shimoda in Japan. In 1901, Alcock erected the genus *Trachypeneus* and later emended to *Trachypenaeus* after a petition to the International Commission of Zoological Nomenclature by Holthuis in 1969. In 1934, Burkenroad introduced *Trachysalambria* as subgenus of *Trachypenaeus*, assigning *T. curvirostris* as its type species. This subgenus was in turn elevated to the rank of genus in 1997 by Pérez Farfante and Kensley. However, some species initially grouped under the genus *Trachypenaeus* are now assigned a new genus *Megokris* erected by Pérez Farfante and Kensley in 1997. The genus *Megokris* appears more akin to *Melicertus* and *Marsupenaeus*. The species occurring in Indian waters included in the new genus are *Megokris granulosus*, *M. pescadoreensis* and *M. sedili.*

Diagnosis: Integument thick, body densely pubescent. Rostrum relatively short, uptilted, straight or upcurved and armed with 7 to 11 dorsal teeth only, reaching distal end of second antennular segment; carapace with orbital, antennal and hepatic spines; abdomen with a small median tubercle on second segment and a middorsal crest on last 4 segments; telson armed with 3 or 4

pairs of small movable lateral spines subequal in size; epipod present on first 3 pereopods; however, based on the absence of epipods on the first two pereopods Burkenroad (1934a) erected a new genus *Trachysalambria* that was later on found to be a futile by Dall (165) at least in the case of Indo-pacific species. Petasma with broad symmetrical, wing-like distolateral projections, directed laterally and curved dorsoventrally; distomedian projections small, curved ventrally. In females, anterior plate of thelycum concave anteriorly, with a middle groove posteriorly and a bluntly pointed anterior margin; posterior date notched anteromedially; in fertilized specimens the groove can be hidden and the notch obliterated; coxae of 4th pereopods often with a small projection, always densely fringed with setae.

Trachysalambria* (*Trachypenaeus*) *species in Indian waters:

Trachysalambria aspera (Alcock, 1905) Chennai, Orissa coast & A & N Islands
Trachysalambria curvirostris (Stimpson, 1860) Southern Rough Shrimp East & West coast
Trachysalambria fulva (Dall, 1957)* Chennai

Genus Megokris Perez Farfante & Kensley, 1997
Megokris granulosus (Haswell, 1879)* Coarse Shrimp, Chennai & Kakinada
Megokris pescadoreensis (Schmitt, 1931a) Bighead Sand Prawn South west & east coasts.
Megokris sedili (Hall, 1961) Malayan Rough Shrimp Southwest, Southeast & Northeast

Common names: 'Cocktail shrimp', 'hardback prawn', 'southern rough prawn', and the name preferred by the Food and Agriculture Organization, "southern rough shrimp".

Trachysalambria curvirostris is a small prawn, with males reaching a total length of up to 81 mm, and females reaching 105 mm. It is one of the five most important single species targeted by shrimp and prawn fisheries worldwide, with most of the harvest landed in China. In Korea, *T. curvirostris* is the dominant species in the shrimp fishery, accounting for more than 50% of landings.

Genus *Metapenaeopsis* Bouvier (1905)

The genus *Metapenaeopsis* originally established by Bouvier (1905) was redefined as sub-genus of *Penaeopsis* Bate by Burkenroad (1934). However, the genus was again elevated to its generic rank by Kubo (1949) as he concluded that these shrimps exhibited many distinctive characters to give them a generic rank (Farfante, 1971).

Diagnostic characters: Integument thick, densely pubescent; rostrum usually over-reaching antennal peduncle, epigastric conspicuously separated from the first rostral tooth, branchial spine absent; basial spine on 3rd pereopod lacking. In males petasma asymmetrical with complex distal part which is subdivided in to one or several projections. In females, thelycal plate subquadrate, slightly wider than long; intermediate plate broadly trapezoidal, much wider than long, flat or with a shallow median groove; coxal plates of fourth pereopods smaller than thelycal plate.

Metapenaeopsis is a unique genus with asymmetrical petasma in males which marks the striking difference when compared to other penaeids in which it is symmetrical. The asymmetrical petasma in most of the species of the genus is with or without a lobulated structure at the tip. Furthermore, some species of the genus show ridges or stridulations (also called stridulating organ) and some without stridulations along the posterior border of the carapace. The species with stridulations were greatly confused in taxonomical studies of the genus. It was due to the extensive work by Hall (1961, 1962) and Racek and Dall (1965) that ten stridulating species got taxonomically recognized. The stridulating ridges usually exhibit different patterns. Some of the ridges are curved but vertical and some are tapering *e.g.* in *Metapenaeopsis stridulans* the stridulating ridge consists of 5 to 7 strong ridges as a straight band placed at 4/10 of the carapace ridge where as in the case of *Metapenaeopsis tolensis* there are 14-22 small ridges arranged in a curve occupying ¼ depth of carapace.

Metapenaeopsis is the largest genus among penaeid prawns with 72 listed species found all over the world. In the Indo-Pacific region over 28 species have been listed (Racek-Dall 1965) out of which 14 are distributed in the Indian waters. The Indian species, their common names and distribution are as follows:

Genus: *Metapenaeopsis* Bouvier, 1905.

1. *Metapenaeopsis andamanensis* (Wood-Mason in Wood-Mason & Alcock, 1891a) Rice Velvet Shrimp Southwest, Southeast & Andamans
2. *Metapenaeopsis barbata* (De Haan, 1844) Whiskered Velvet Shrimp South & Northeast
3. *Metapenaeopsis ceylonica* Starobogatov, 1972* Kakinada
4. *Metapenaeopsis commensalis* Borradaile, 1899* Red Shrimp Lakshadweep
5. *Metapenaeopsis coniger* (Wood-Mason in Wood-Mason & Alcock, 1891a)* Southwest, South &Northeast, Andamans
6. *Metapenaeopsis gaillardi* Crosnier, 1991 Southern India
7. *Metapenaeopsis gallensis* (Pearson, 1905) Chennai
8. *Metapenaeopsis hilarula* (De Man, 1911a) Minstrel Shrimp East & West coast
9. *Metapenaeopsis mogiensis* Rathbun, 1902 Mogi Velvet Shrimp East & West coast, Andamans
10. *Metapenaeopsis novaeguineae* (Haswell, 1879)* Northern Velvet Prawn India
11. *Metapenaeopsis palmensis* (Haswell, 1879)* Southern Velvet Shrimp A & N Islands
12. *Metapenaeopsis philippi* (Spence Bate, 1881)* Philip Velvet Shrimp Southwest coast
13. *Metapenaeopsis stridulans* (Alcock, 1905) Fiddler Shrimp Northwest, South & Northeast, Andamans
14. *Metapenaeopsis toloensis* Hall, 1962 Tolo Velvet Shrimp Chennai.

Metapenaeopsis stridulans (Alcock, 1905) is distributed off Malabar coast, Andamans, Chennai, Mandapam, Cuddalore, Union Territory of Pondicherry, Mumbai, Visakhapatnam, Kakinada, and Mangalore.

Parapenaeus

The genus was first mentioned by Lucas in 1846 and established by Smith in1885 after which it was re-described by several researchers on different occasions *viz.* Bate in 1881, Burkenroad 1934, Kubo in 1949, Barnard in 1950 and Dall in 1957 after which it was officially placed in the list of generic names of International Commission on Zoological nomenclature in 1961.

Diagnostic characters: The genus can be distinguished by the presence of a pair of minute lateral spines anterior to sub apical spines, in addition to showing a longitudinal suture on the carapace extending at least 0.8 the length of the carapace (Perez Farfante & Kensley, 1997). *P. longipes* predominantly differs from the other species due to absence of branchiostegal spine at the antero-inferior angle of the carapace.

Around 31species of Genus *Parapenaeus* are found around the world. *P. fissures, P. investigatoris, P. rectacutus* and *P. longipes* are found in Indian waters. *Parapenaeus longipes* also known as Flamingo shrimp is commonly found in a mix catch amongst the other non-conventional species but it does not hold a special recognition amongst the local fishers. The name Flamingo is derived from its pinkish colour in very fresh condition.

It is reported to occur off Ganjam coast, Vizagapatam, Malabar Coast of Mangalore and some parts of river Hooghly and recently from the North West coast of India along Saurashtra and Mumbai. The species shows a diverse occurrence in catches which maybe because of dependency on temperature of water or breeding.

Genus: Parapenaeus Smith, 1885

Parapenaeus fissuroides fissuroides Crosnier, 1986a [Old name: *Parapenaeus fissuroides* Crosnier, 1986]

**Parapenaeus fissuroides indicus* Crosnier,1986a False Rose Shrimp Mangalore

Parapenaeus fissurus (Spence Bate, 1881) Neptune Rose Shrimp Orissa & A & N Islands

Parapenaeus investigatoris Alcock & Anderson, 1899 Explorer Rose Shrimp Southwest, SE & A & N Islands

Parapenaeus longipes Alcock, 1905 Flamingo Shrimp East & West coast

Parapenaeus sextuberculatus Kubo, 1949a* Domino Shrimp India

Distinguishing characters: Shrimp with a well developed and toothed rostrum which generally extends to or beyond distal edge of eye. No tubercle on the base of eyestalk mesial (inner) border. Carapace without postorbital spine and with short cervical groove ending well below dorsal midline. Last 2 pairs of pereopods well developed; third and fourth pairs of pleopods biramous; endopods of second pair of pleopods in males bearing appendix masculine only.

Identification key for species under the genera

Penaidean prawns with rostrum toothed on dorsal margin only, pleura of 2nd abdominal segment overlapping first and second; pereopods 1-3 chelate.

1. Carapace without lateral keels: cutting portion of mandible short and massive
2. Rostrum toothed on dorsal margin only

3a. Telson tridentate, with a fixed spine on each side of tip.

3b. Telson usually without fixed spines; no spine (parapenaeid spine) on inner border of first article of antennular peduncle.

4a. Carapace with longitudinal and transverse sutures---------- *Parapenaeus*

4b. Carapace without longitudinal or transverse sutures.

5. Males with asymmetrical petasma; 2 arthrobrachs present on last thoracic segment, one of them well developed, the other vestigial---------- *Metapenaeopsis*
5. Exopod present on second to fifth pereopods; no pleurobranch on penultimate thoracic segment.
6. Carapace with longitudinal suture.
7. Longitudinal suture short; epipod present on third pereopod------*Trachypenaeus*

Chapter 6

Metapenaeus & Metapenaeopsis

S. Lakshmi Pillai

The genus *Metapenaeus* comprise several species of commercial interest and they form an important fishery along the Indian coast. *Metapenaeus dobsoni* dominates the prawn fishery along the southwest and southeast coasts of India. The adults live in the coastal sea up to 37 m depth while their juveniles inhabit estuaries, backwaters and paddy fields. The sizes of these larvae vary from 1 to 3.5 mm and they are pelagic. Advanced post larvae above 3.5 mm in size are not btained in the surf collections and it would appear that they have by this time settled to the bottom (Mohamed and Rao, 1971). The egg of *M. dobsoni* passes through six naupliar, three protozoea and five mysis stages before it becomes post larva. The post larvae enter the backwaters and estuaries to complete their life cycle. When they reach the juvenile stage they migrate to the sea. Sexual maturity is attained in the sea. It spawns in the coastal waters not far off from the coast. *Metapenaeus monoceros* is a commercially important prawn in the backwaters and estuaries, and up to about 100 m depth in the sea. There is no information on eggs and early larvae from the sea. Late mysis and postlarval stages of the species migrate into backwaters and estuaries all along the coastline of India and the juveniles contribute to a fishery in these waters. *Metapenaeus kutchensis* George, George and Rao, 1963 is a commercially important penaeid prawn, endemic to the Gujarat coast of India (George *et al*., 1963). Very little is known about the larval history of *M. kutchensis*. In the case of *M affinis* there does not seem to be large-scale migration of the postlarval stages into nearby estuaries as in *M. dobsoni* and the species never accounts for more than 20 percent of the catch in the fishery for juvenile prawns in the backwaters of Cochin (George, 1968).

Diagnostic features: Integument variably pubescent, sometimes almost entirely glabrous; rostrum armed with dorsal teeth only; epigastric tooth often conspicuously separated from first rostral tooth; orbital and pterygostomian spines lacking; antennal and hepatic spine pronounced; gastro-orbital carina absent; hepatic sulcus anterior to hepatic spine well-defined and accompanied by ventral carina often descending almost vertically from spine then turning

towards pterygostomian angle; sulcus posterior to hepatic spine ill-defined or absent; telson lacking fixed subapical spines but bearing movable, sometimes minute and very numerous posterolateral ones. antennular flagella shorter than carapace; fifth pereiopod modified in male; Petasma symmetrical, semiclosed, depressed with median lobes usually produced into simply curved, hoodlike or convoluted distal projections; Thelycum closed with paired lateral plates of sternite XIV often continuous across sternite, usually more or less enveloping posterior end of elongate median protuberance of sternite XIII.

Key to *Metapenaeus* spp.

1. Rostrum without ventral teeth and no distal fixed pair of spines on the telson; lateral mobile spines may be present; No exopod on 5th pereiopod; pleurobranch on 7th thoracic somite present 2

2. Distomedian petasmal projection with fully developed or vestigial apical filament; thelycum of impregnated females usually with white conjoined pads 3

Distomedian petasmal projection without apical filament; thelycum of impregnated females usually without white conjoined pads 5

3. Rostrum wide and short, not reaching to distal end of basal antennular segment; thelycum with ovoid anterior and lateral plates of subequal size; conjoined pads usually set askew; apical filaments of petasma vestigial, represented by a pair of rounded bosses ..... ***Metapenaeus lysianassa***

Rostrum projecting beyond basal antennular segments, with a marked edentate distal portion 4

4. Posterior part of rostrum with distinctly elevated crest; basial spine on male 3rd pereiopod simple; apical petasmal filaments slender, slightly converging; thelycum with a large anterior and small lateral plates ..... ***Metapenaeus brevicornis***

Posterior part of rostrum without distinctly elevated crest; basial spine on male 3rd pereiopod long and barbed; apical petasmal filaments not readily visible; anterior thelycal plate tongue-like ..... ***Metapenaeus dobsoni***

5. Branchiocardiac sulcus distinct in at least posterior 1/3 carapace; distomedian petasmal projections flap-like 6

Branchiocardic sulcus almost completely absent; distomedian petasmal projections anteriorly filiform, each with a serrate ventral margin ..... ***Metapenaeus stebbingi***

6. Ischial spine on 1st pereiopod distinct 7

Ischial spine on 1st pereiopod small or absent 11

7. Ischial spine subequal to basial spine; distomedian lobes having bluntly triangular apices with median

margins parallel to each other; anterior thelycal plate tongue-like with raised lateral margins parallel; lateral plates flat ..... ***Metapenaeus krishnatrii***

Ischial spine much smaller than basial spine; anterior thelycal plate tongue-like 8

8. Distomedian petasmal projections directed anteriorly; lateral thelycal plates with raised lateral ridges, each with a posterior inwardly curved triangular plate ..... ***Metapenaeus ensis***

Distomedian petasmal projections directed anterolaterally; anterior thelycal plate tongue-like 9

9. Lateral thelycal plates with salient and parallel ear-shaped lateral ridges; distomedian petasmal projections hood-like ..... ***Metapenaeus monoceros***

Lateral thelycal plates without lateral raised ridges; distomedian petasmal projections not hood-like 10

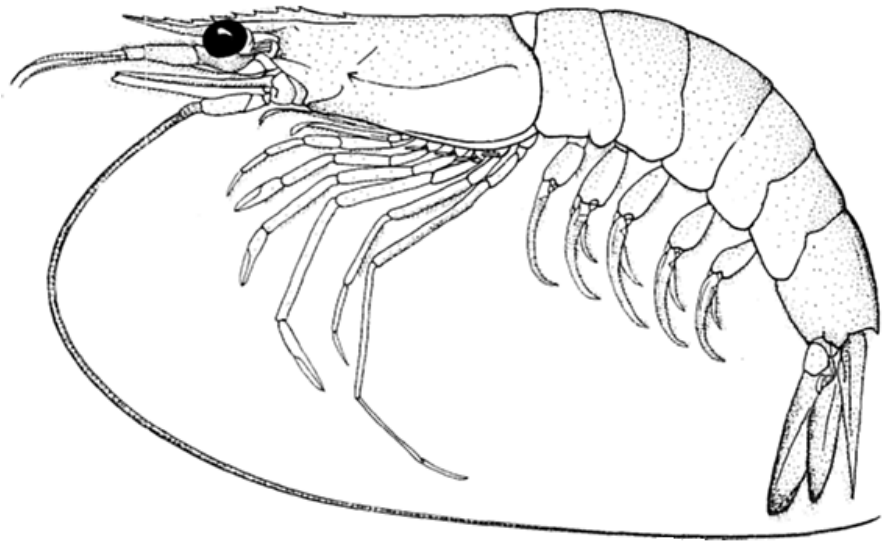
10. Posterior extension of the anterior median thelycal plate bound laterally by an oval flat plate on each side; distomedian petasmal projections overlying lateral projections and distally trilobed ..... ***Metapenaeus alcocki***

Posterior extension of the anterior median thelycal plate not bound laterally by oval plate on either side; distomedian petasmal projections not overlying lateral projection ..... ***Metapenaeus kutchensis***

11. Branchiocardiac carina feeble or ill-defined, anterior end not exceeding posterior 1/3 of carapace; distal margin of anterior thelycal plate convex to indistinctly triangular; petasma with laminose and strongly diverging distomedian projections ..... ***Metapenaeus moyebi***

Branchiocardiac carina distinct, extending from posterior margin of carapace almost to hepatic spine; anterior thelycal plate longitudinally grooved, wider posteriorly than anteriorly; distomedian petasmal projections crescent-shaped ..... ***Metapenaeus affinis***

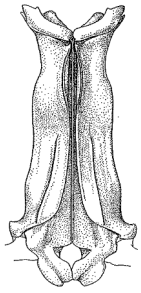
Metapenaeus affinis (H. Milne Edwards, 1837)
(Jinga Shrimp)



Diagnostic features: Almost entire body pubescent, rarely partly or completely hairless; rostrum straight; in adult males, merus of fifth pereiopod bears a proximal notch, followed by a twisted, keeled tubercle; distomedian projection of petasma crescent shaped; anterior plate of thelycum long and deeply grooved; lateral plates with strongly raised lateral margins forming 2 longitudinal crests

Colour: body pale greenish to pale pinkish or pink-brownish with green or red-brown specks.

Distribution and fishery: Throughout west and east coasts of India and Andaman waters; major landing from Maharashtra and Kerala; depth 5-90 m; maximum size (TL) in females, 18.6 cm; males, 14.6 cm.

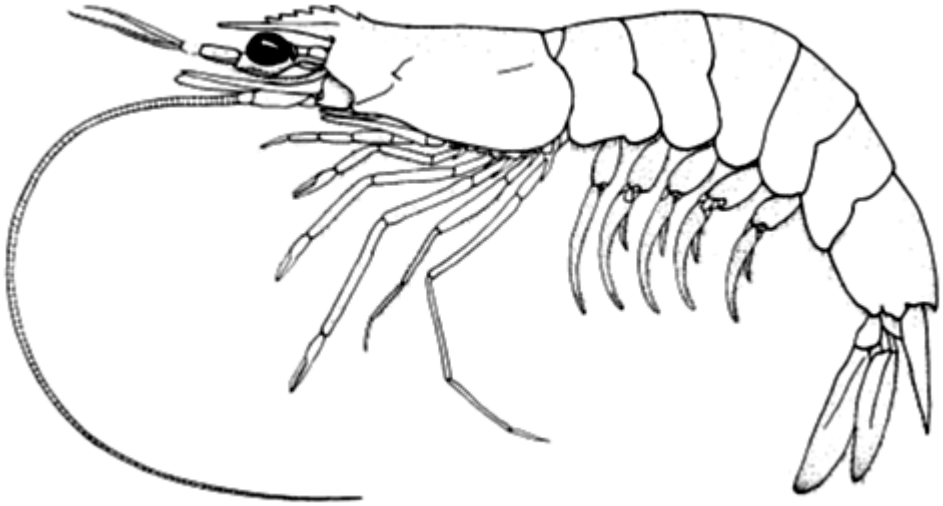


Petasma

Thelycum

Merus of fifth walking leg

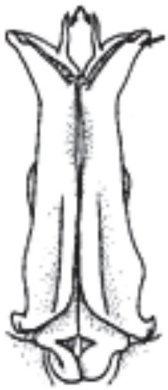
Metapenaeus brevicornis (H. Milne Edwards, 1837)
(Yellow Shrimp)



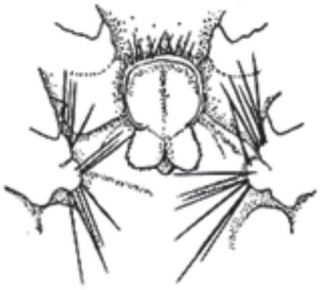
Diagnostic features: rostral crest high; in adult males, merus of fifth pereiopod with a proximal notch, followed by a keel-shaped tubercle; disto-median projection of petasma with a long and slender apical filament; anterior plate of thelycum large square and grooved; lateral plates boomerang shaped (often continuous to posterior sternite) and enclosing 2 pear-shaped plates.

Colour: body yellow to white, sometimes greyish, with distinct dark green to bluish-brown specks; pleopods yellowish to pinkish; distal part of uropods brown to rusty red sometimes only the tips are coloured.

Distribution and fishery: Northwest and Northeast coasts of India & Andaman waters; supports fishery in the "bheries"of West Bengal; depth 4-90 m; maximum size (TL) in females, 13.5 cm; males, 10.3 cm.



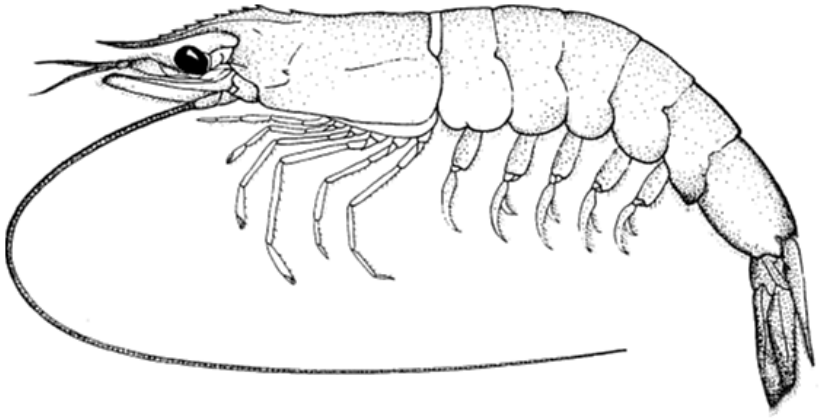
Petasma



Thelycum

Merus of fifth walking leg

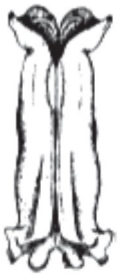
Metapenaeus dobsoni (Miers, 1878)
(Kadal Shrimp)



Diagnostic features: almost entire body pubescent, rostrum long;in adult males, basial spine of third pereiopod is extremely long and barbed, and merus of fifth pereiopod with 1 or 2 large, triangular teeth; each distomedian projection of petasma with a short filament on ventral surface and another on dorsal surface; thelycum with a long grooved tongue-like anterior plate partially en-sheathed in a horse-shoe-like process formed by the lateral plates.

Colour: body pale yellow to brownish with red, brownish or greenish specks; antennae red; pereiopods and pleopods white to pinkish; uropods grey-brownish, darker distally.

Distribution and fishery: South of Goa on the west coast through southeast coast to south of Visakhapatnam on the east coast; depth 1-40 m; maximum size (TL) in females, 13 cm; males, 12.5 cm.

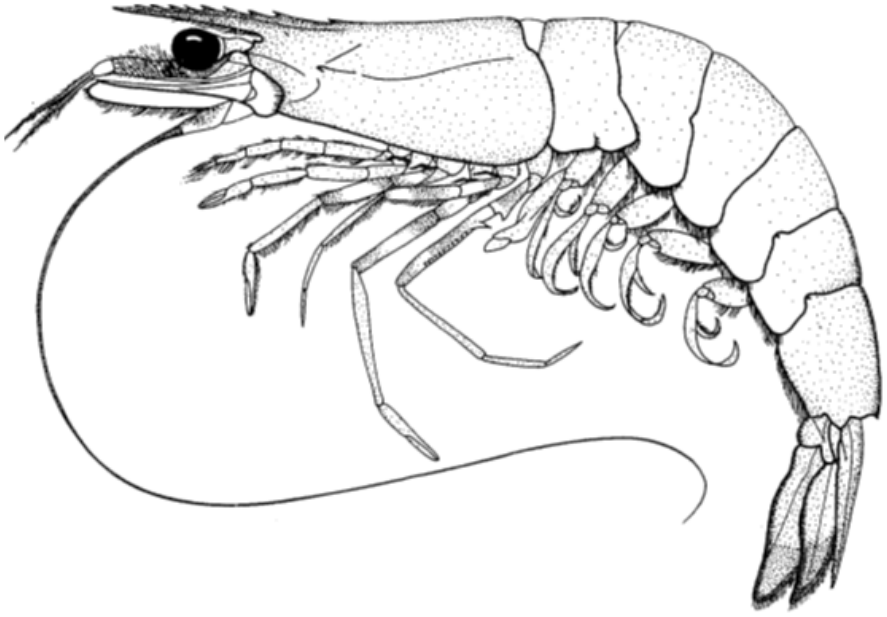


Petasma

Thelycum

Merus of fifth walking leg

Metapenaeus ensis (De Haan, 1844)
(Greasy Back Shrimp)

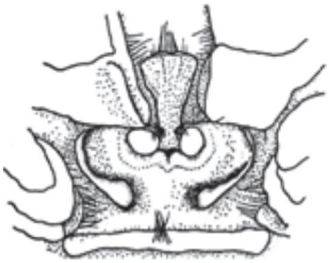


Diagnostic features: rostrum reaches, or nearly to tip of antennular peduncle; in adult males, merus of fifth pereiopod with a proximal notch; distomedian projections of petasma convoluted, greatly swollen and directed forward, triangular in shape, concealing almost entirely distolateral projections in ventral view; anterior plate of thelycum lone and deeply grooved.

Colour: body pink to greenish-grey.

Distribution and fishery: Andhra Pradesh, Orissa, West Bengal and Andaman & Nicobar islands; minor fishery at upper east coast and Paradeep; depth 18-64 m; maximum size (TL) in females, 18.9 cm; males, 15.4 cm.

Petasma



Thelycum

Merus of fifth walking leg

Metapenaeus kutchensis (George, George and Rao,1963)
(Ginger Shrimp)

Diagnostic features: rostrum slightly curved with upturned tip, extends beyond the antennular peduncle in females, slightly falling short of in males; the disto-median lobes of the petasma bifid and transversely placed; the thelycum with an anterior median plate extending beyond and lying in level with the coxal projections; the posterior lateral plates larger, rounded and swollen.

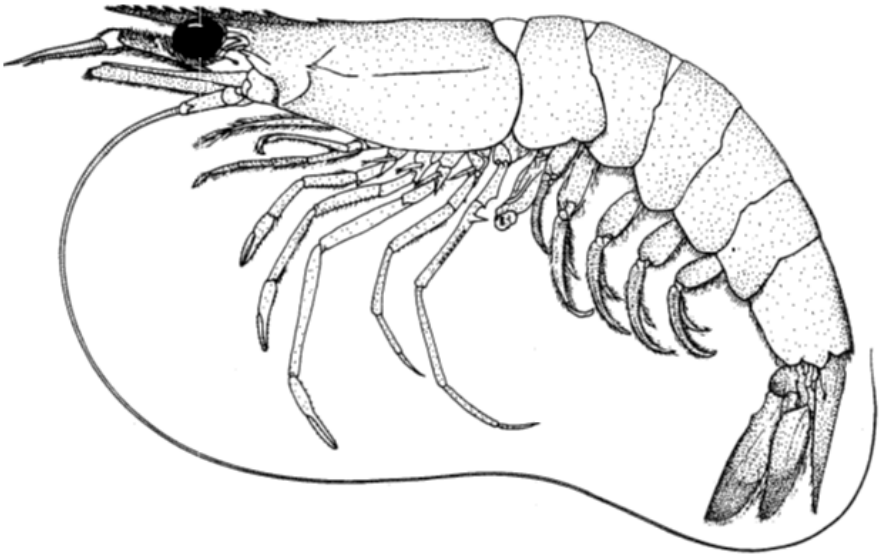
Colour: body reddish orange in the shade of carrot in fresh condition; pubescence present in shallow grooves and in irregular patches on the carapace and abdomen.

Distribution and fishery: North-west coast of India and minor fishery at Mumbai, Veraval and Kandla; depth 3-12 m; maximum size (TL) in females, 17.5 cm; males 15 cm.

Petasma

Thelycum

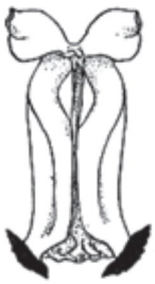
Metapenaeus monoceros (Fabricius, 1798)
(Speckled Shrimp)



Diagnostic features: Body covered with stiff, very short tomentum; rostrum nearly straight, uptilted; 5th pereiopod of adult male with proximal end of merus notched on outer side, notch deepened anteriorly by a large hood-like spine, and posteriorly by subterminal lobule; distomedian petasmal projections hood-like, lateral thelycal plates with salient end parallel ear-shaped lateral ridges.

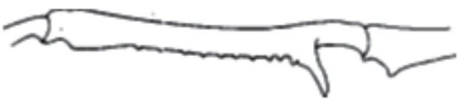
Colour: body pink, green-greyish or whitish with brown specks; distal parts of uropods purple blue.

Distribution and fishery: All along the west and east coasts of India; depth upto 60 m; maximum size (TL) in females 22 cm; males, 19.5 cm.



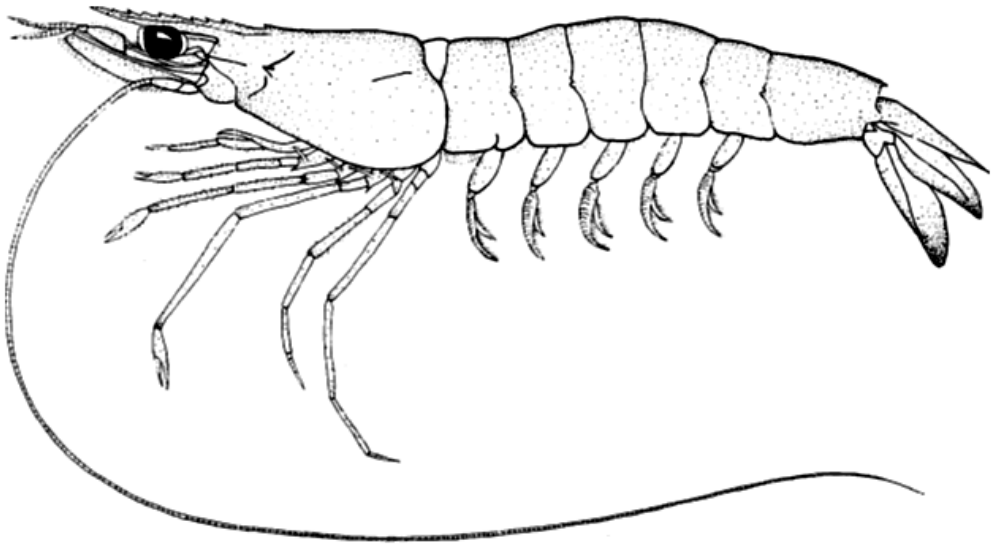
Petasma

Thelycum



Merus of fifth walking leg

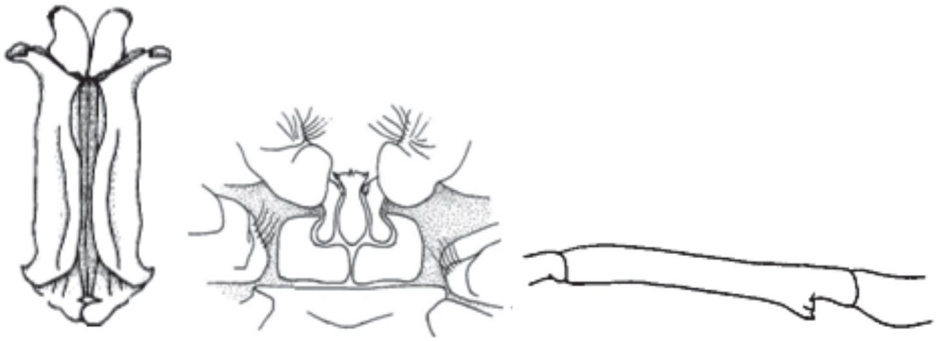
Metapenaeus moyebi (Kishinouye, 1896)
(Moyebi Shrimp)



Diagnostic features: pubescence covers almost entire body or confined to dorsal carapace and a few abdominal patches; rostrum nearly straight, slightly uptilted; in adult males, merus of fifth pereiopod with a proximal notch followed by a twisted keeled tubercle; anterior plate of thelycum flask-shaped and lateral plates kidney-shaped.

Colour: body semi-translucent pale green with brownish-green specks; pereiopods and pleopods of same colour as body; distal part of uropods green.

Distribution and fishery: South and middle west coast, southeast coast and Andaman Islands; depth 5.5-45 m; maximum size, (TL) in females, 12.6 cm; males, 10 cm.



Petasma **Thelycum** **Merus of fifth walking leg**

Metapenaeopsis Bouvier, 1905

Species under the genera *Metapenaeopsis* form minor fishery along the southeast and Northwest coast of India. *Metapenaeopsis barbata* is a small penaeid species with a hard integument. It can be found at 20-70 m in depth on rocky, sandy, and muddy bottoms (Holthuis 1980). The shrimp has an offshore planktonic larval phase, estuarine post-larval and juvenile phases, and offshore adult and spawning phases (Dall et al., 1990). *M. stridulans* forms a minor fishery along the Northwest and Southeast coasts and *M. toloensis* along the Southeast coast.

Diagnostic features: Rostrum with teeth only on the dorsal side; carapace without longitudinal or transverse sutures; antennal, pterygostomian and hepatic spine well developed; orbital spine small; telson with a pair of fixed lateral sub-apical spines and with several pairs of movable lateral relatively large spines anterior to fixed pair; antennular flagella variable in length usually shorter and sometimes longer than carapace; basial spines on third maxilliped and first and second pereiopod present, lacking on third; petasma asymmetrical, divided transversely at about mid length, distal half complex and divided into various elements and projections; proximal half with dorso-lateral lobules produced proximally into spur-like projections, left one oblique directed medially and longer than right; thelycum consist of well developed median plate on the 13$_{th}$ sternite.

Key to *Metapenaeopsis* spp.

1. A distal fixed pair of spines on the telson and 1-3 pairs of mobile spines 1
Third maxilliped and second pereiopod with basial spine; petasma asymmetrical 2
2. Stridulating organ present on posterior branchiostegite 3
Stridulating organ absent from posterior branchiostegite 7
3. Stridulating ridges usually 4-6 and stridulating organ almost straight 4
Dorsal carina of 3rd pleonic somite sulcate; anterior edge of thelycal plate entire, left petasmal lobe sharply pointed and triangular ..... ***Metapenaeopsis stridulans***
Stridulating ridges more than 7 and stridulating ridges arranged on a curve 5
5 Pterygostomian spine moderately to well developed 6
Pterygostomian spine reduced or small ..... *Metapenaeopsis palmensis*
6. Dorsal carina of 3rd pleonic somite flat or hardly sulcate; thelycal plate about as wide as long; left petasmal lobe with 7-12 sharp projections at tip, arranged in a semicircular manner; inner intermediate strip much longer than outer; stridulating ridges usually 16-27 ..... ***Metapenaeopsis barbata***

Dorsal carina of 3rd pleonic somite with deep median groove; left petasmal distoventral projection broadly swollen and with distomedian and distolateral processes; stridulating organ with 14-22 small ridges in a curved band ..... ***Metapenaeopsis toloensis***

7. Hepatic sulcus descending almost vertically to ventral edge of branchiostegite ..... *Metapenaeopsis commensais*

Hepatic sulcus absent or not reaching to ventral edge of branchiostegite 8

8. A pair of tooth-like platelets immediately posterior to thelycal plate 9

No tooth-like platelets immediately posterior to thelycal plate 10

9. A distinct groove present on 3rd abdominal carina 10

3rd abdominal carina without groove ..... *Metapenaeopsis hilarula*

10. Anterior edge of anterior sternal plate between 5th pair of legs in female almost straight with flat triangular spine at anterolateral corners; distomedian lobule of petasma distally broad ..... *Metapenaeopsis gallensis*

Anterior edge of anterior sternal plate between 5th pair of legs in female with 4 rounded teeth, 2 median ones being incurved; distomedian lobule of petasma small ..... *Metapenaeopsis mogiensis*

11. Rostrum as long as or longer than antennular peduncle 12

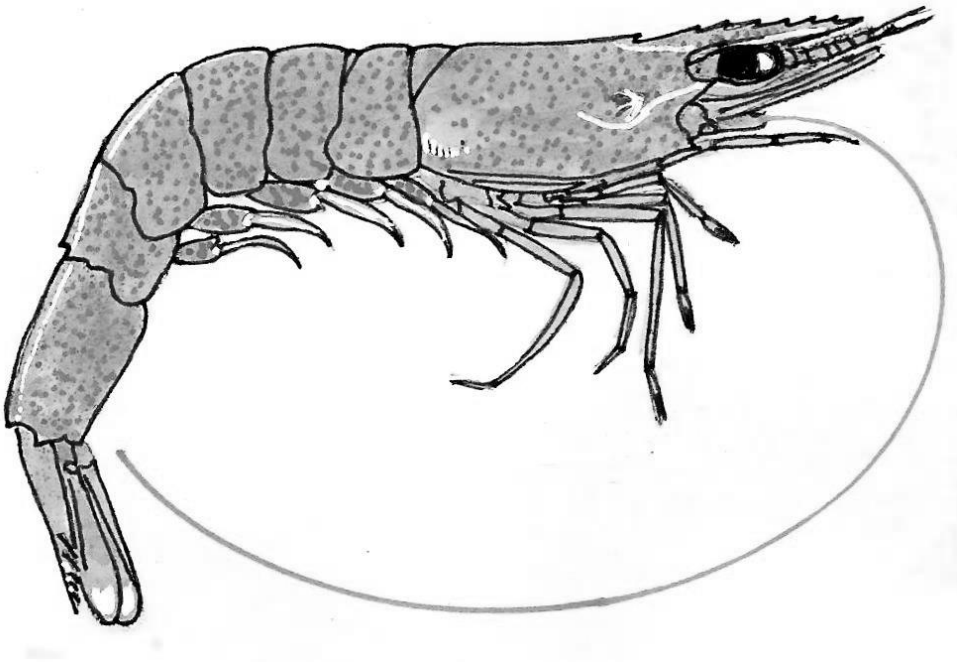
Rostrum not reaching tip of antennular peduncle; centre of the thelycal plate non-sulcate ..... *Metapenaeopsis coniger*

12. Posterior extension of thelycal plate with indistinct median sulcus and angular posterolateral corners ..... ***Metapenaeopsis andamanensis***

Posterior extension of thelycal plate with distinct medium sulcus and evenly rounded posterolateral corners ..... *Metapenaeopsis philippii*

13. Rostrum forming a crest and epigastric tooth situated a little posterior to the middle of carapace; scaphocerite twice as long as wide ..... *Metapenaeopsis lamellate*

Metapenaeopsis barbata (De Haan, 1844)
(Whiskered Velvet Shrimp)

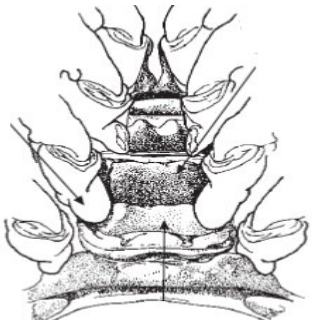


Diagnostic features: Rostrum directed slightly upward, almost straight reaches tip of antennular peduncle; 16-27 stridulating organ present on postero-lateral carapace; dorsal crest of third abdominal segment flat or very slightly concave; left distoventral projection of petasma long; thelycal plate broadly subquadrate.

Colour: body whitish, mottled with irregular red blotches, antennal flagella indistinctly crossed with red and white bands; uropods reddish with distal and basal parts pale yellowish.

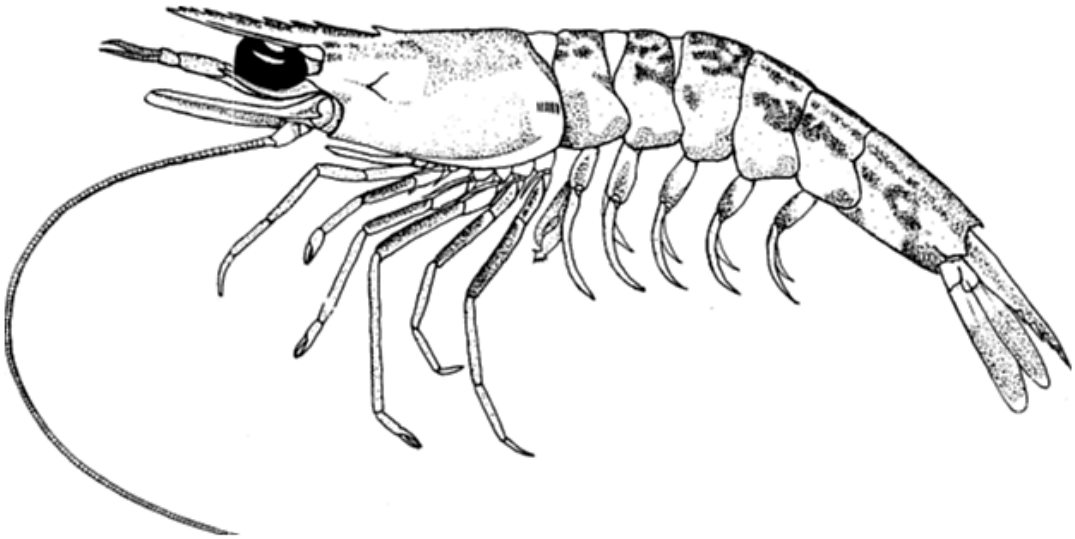
Distribution and fishery: Chennai, Visakhapatnam and Kakinada; depth 20-70 m; maximum size (TL) in females, 10.5 cm; males, 9.5 cm.

Petasma



Thelycum

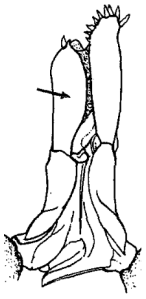
Metapenaeopsis stridulans (Alcock, 1905)
(Fiddler Shrimp)



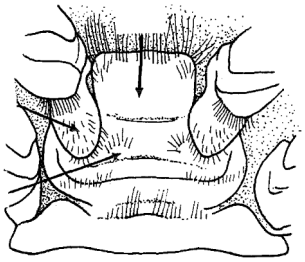
Diagnostic features: rostrum straight; 5-7 strong stridulating ridges in a wide straight band on the posterior part of carapace; mid-dorsal crest on the third abdominal segment with a broad groove; left lobe of petasma sharply pointed and triangular; the intermediate plate of the thelycum with more prominent lateral elevations, posterior transverse groove also deeper and well marked compared to *M. barbata.*

Colour: carapace, abdomen and telson with red to dark brown mottling; pereiopods pinkish to dark red with white except on their proximal parts.

Distribution and fishery: Maharashtra, Andhra Pradesh, Tamil Nadu and Andamans; depth 90 m; maximum size (TL) in females, 12 cm; males, 11.5cm.



Petasma



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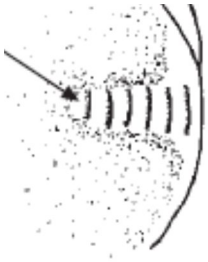
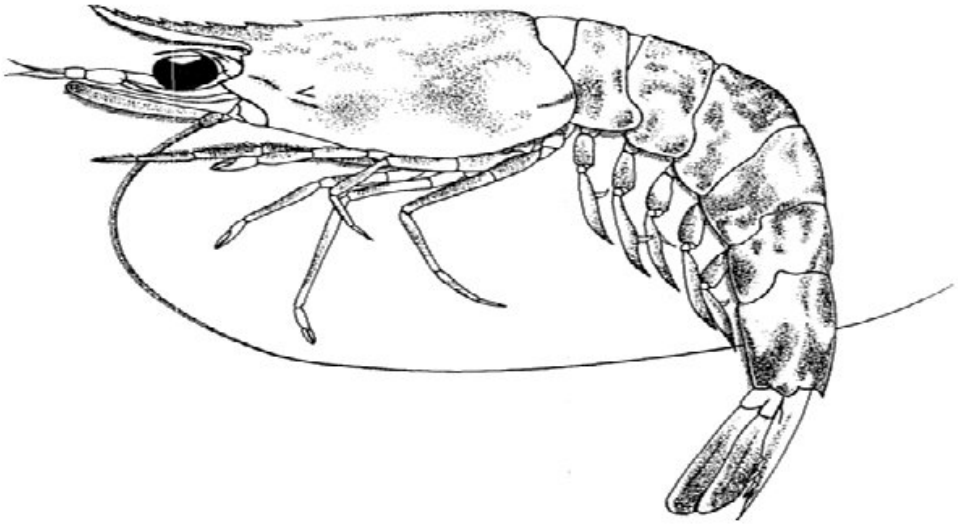


Stridulating organ

Metapenaeopsis toloensis (Hall, 1962)
(Tolo Velvet Shrimp)



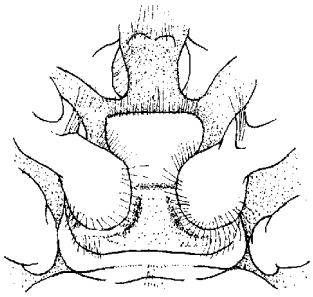
Diagnostic features: rostrum moderately upcurved reaching end of second antennular segment or little beyond; stridulating ridges consists of 14-22 small ridges in a curved band; dorsal crest of third abdominal segment with a deep median groove; right disto-ventral projection of petasma short and left distoventral projection broadly swollen;thelycal plate subquadrate with rounded corners;

Colour: body brownish with dark red to dark brown mottling; pereiopods pinkish to redbrown; uropods dark red to brown except for their proximal

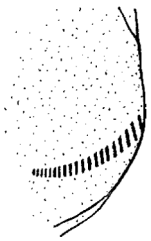
parts.

Distribution and fishery: few locations along east coast (Chennai, Kakinada); depth 60-70 m; maximum size (TL) recorded is 10 cm.

Petasma



Thelycum



Stridulating organ

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Chapter 7

Solenocera

A. P. Dineshbabu

Family SOLENOCERIDAE (Wood-Mason & Alcock, 1891)

Shrimps are generally distinguished into two catogories; penaeid shrimps and non-penaeid shrimps. The penaeid shrimps come under sub-order Dendrobranchiata and are distinguished from other shrimps (Caridea) by their gill structure (Dall *et al*.,1990). Solenoceridae comes under Dendrobranchiata, under super family Penaeoidae. Thus the shrimps of Solenoceridae family are also referred as penaeid shrimps (as per their infraorder). Majority of the species belonging to Solencoceridae family occur in offshore, deeper waters and were earlier caught by exploratory surveys. Since the fishing in deeper waters started during last 25 years species belong to the family became regular fishery in many parts of the world.

DIAGNOSIS: Rostrum laterally compressed, usually shorter than the antennular peduncle, mostly with dorsal with dorsal teeth only and more than three; ventral teeth if present, restricted to the tip. Antennular flagella usually longer than the peduncle, often longer than the carapace. Prosartema variable, usually prominent, sometimes reduced to a small lobe; ocular scale present sometimes poorly developed. Cervical sulcus well defined, reaching or nearly reaching the mid-dorsum of the carapace. A postorbital spine (sometimes called postantennal spine) and hepatic spine are always present; antennal spine usually present, other carapace spines variable. Abdomen wholly or partially carinated. Telson with two fixed sub-apical spines, occasionally with moveable lateral spines as well; very rarely without spines at all. Exopods present on thoracic somites 1-7, in some genera on 8 as well; those on the pereopods sometimes reduced. Petasma tubular and simple; appendix masculine with two endites and with a projection on the outer side of the basal segment; thelycum open, often a simple basin shape. Pleurobranchs on thoracic somites 3-8; usually a single arthrobranch, but sometimes two, which may be small or rudimentary on somite 1; two well-developed arthrobranchs on somites 2-7; a podobranch on somite 2, except in *Haliporus* where they are on 2 and 3, sometimes with very small or rudimentaly podobranchs on 4-6; epipods on 1-7. (Dall, 1999)

Diagnostic features of the family are the presence of post-orbital spine, cervical sulcus reaching to or almost to the mid-dorsum, the long antennular flagella and a spur-like projection on the outer side of the basal segment of the appendix masculine. Most inhabit the outer continental shelf down to several hundred metres, with a few occurring at over 1,000 m.

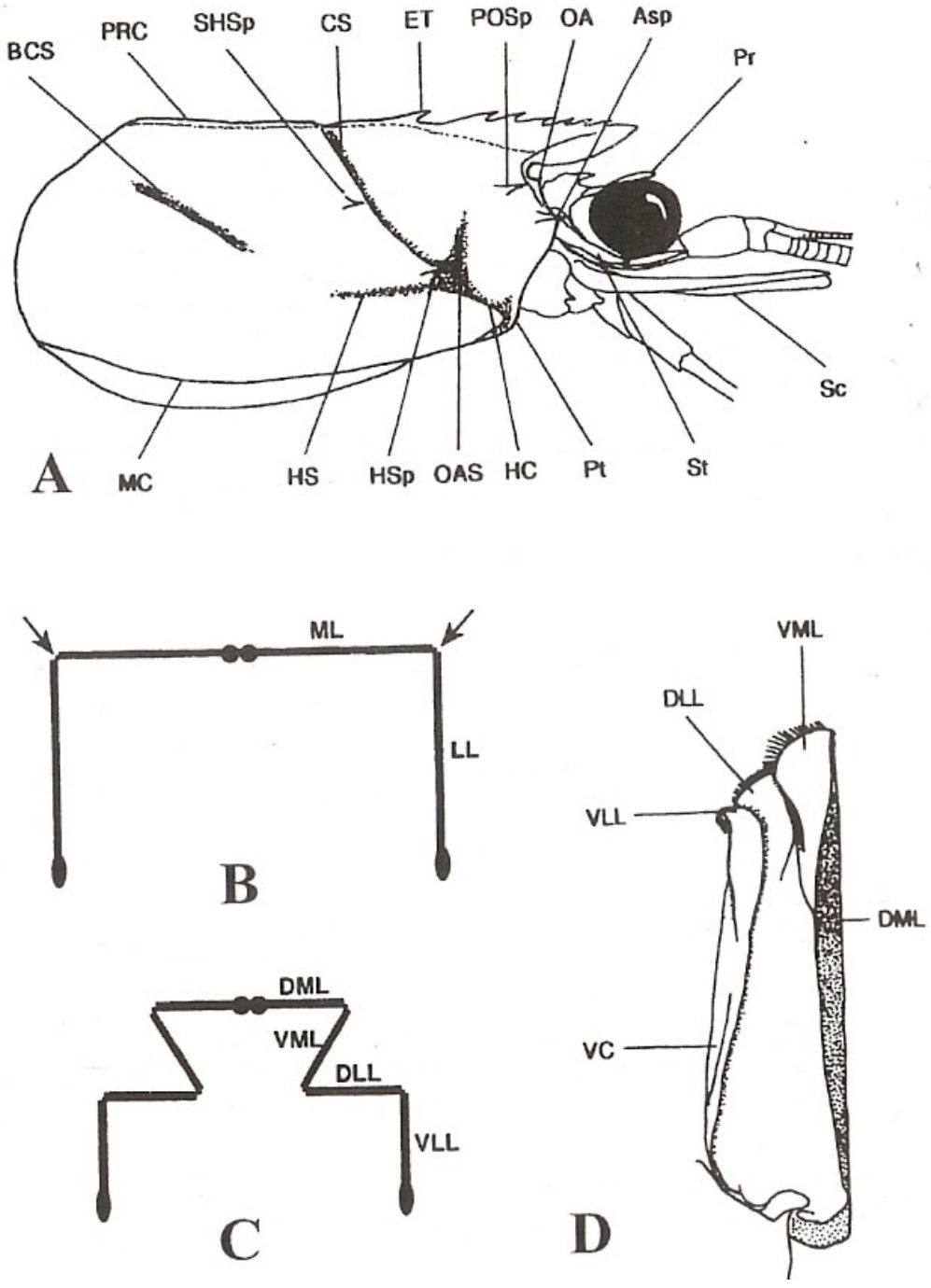


Fig.1.A. features of taxonomic importance on the cephalothorax of a Solenocerid.

Asp, Antennal spine ; BCS, branchiocardiac sulcus (a carina may also be present); Cs, cervical sulcus and carina; Et, epigastric tooth (next tooth is the first rostral tooth); Hc, hepatic carina; Hs, hepatic sulcus; HSp, hepatic spine; MC, marginal or submarginal carina; OA, orbital spine (may be only an angle); OAS, orbito antennal sulcus; POSp, post orbital spine; PRC, postrostaral carina, Pr, prosartema; Pt, pterigostomial angle (may be a spine), Sc, scaphosclerite; SHsp suprahepatic (post cervical spine); St, stylocerite.

B, diagrammatic cross section of an immature petasma before folding has taken place. The junction of the two halves of the cincinnuli is indicated by two solid circles; arrows indicate the direction of infolding; Ml, median lobe, LL, lateral lobe, C, cross section after folding is taken place; DML, dorsomedian lobule; VML, ventromedian lobule; DLL, dorsolateral lobule; VLL ventrolateral lobule; D, ventral aspect of the right half of a solenocerid petasma; Vc, ventral coasta;
(*Reproduced from,* Dall, 1999, Australian species of Solenoceridae (Penaeoidea: Decapoda), *Memoirs of Queensland museum* **43**(2) 553-587, Brisbane ISSN 0079-8835)

KEY TO THE GENERA OF THE SOLENOCERIDAE

1. Telson with three widely spaced pairs of moveable spines, which may be minute, anterior to a sub-apical fixed pair; with an accessory branchiocardiac carina dorsal to the sulcus …… 2

   Telson with a single pair of fixed sub-apical spines only, or with none; without an accessory branchiocardiac carina……. 3
2. Mid-dorsum deeply indented at its junction with the cervical sulcus; with a supra-hepatic (postcervical) spine. A podobranch on the 2nd thoracic somite only……. *Gordonella*

   Mid-dorsum with a shallow depression only in the region of the cervical sulcus; supra-hepatic spine absent. Podobranchs on at least the 2nd and 3rd thoracic somites…… *Haliporus*

3. **Dorsal and ventral antennular flagella lamellate and forming a respiratory tube; external ramus of uropod without a distolateral spine…… *Solenocera***

   Dorsal and ventral antennular flagella not forming a respiratory tube, but with the ventral flagellum sometimes flattened; external ramus of uropod with a distolateral spine……. 4

4. Ventral antennular flagellum strongly compressed proximally, orbital spine well developed…….. *Mesopenaeus*

   Ventral antennular flagellum more or less cylindrical,. Orbital spine absent or only a weak orbital angle present…….. 5

5. Epigastric tooth separated from the 1st rostral tooth by an interval not markedly different from that between the 1st and 2nd rostral teeth……. 6

   Epigastric tooth, or epigastric tooth and 1st rostral tooth separated from the remaining teeth by a relatively long interval…… 8

6. Rostrum low, with ventral margin straight or concave; submarginal carina present…….. *Pleoticus*

   Rostrum deep, with ventral margin markedly convex; submarginal carina absent…….. 7

7. Pterygostomian spine present, branchiostegal spine absent; postrostral carine well defined and almost reaching the posterior rim of the carapace …… *Cryptopenaeus*

   Branchiostegal spine present, pterygostomian spine absent; postrostral carina not extending much beyond the top of the cervical sulcus…….. *Hadropenaeus*

8. Post-cervical (supra-hepatic) spine absent. Epigastric and 1st rostral tooth separated from the remaining teeth by a relatively long interval……..…… *Hymenopenaeus*

   Post-cervical (supra-hepatic) spine present Epigastric tooth separated from the 1st rostral tooth by a relatively long interval…….. *Haliporoides*

Description of the Genus

Solenocera H. Lucas, 1849

DIAGNOSIS: Moderately robust, medium-sized prawns, with firm cuticle; pereopods well developed, pleopods not exceptionally long. Carapace glabrous except for the rostral area which is setose. Antennular flagella wide and when apposed forming a respiratory tube, often as long or longer than the carapace. Rostrum laterally compressed, usually deep and not exceeding the 1st segment of the antennular peduncle and with dorsal teeth only. Postorbital, antennal and hepatic spines present; branchiostegal and pterygostomian spines present or absent, but never with both. Cervical sulcus reaching to or almost to the dorsal midline. First and 2nd abdominal somites narrowing towards the dorsal mid-line so that the cephalothorax may be flexed almost at right angles to the abdomen. Exopods on thoracic somites 1 to 7. Telson usually armed with fixed

subapical spines, never with lateral moveable spines. Lateral ramus of uropod without a distolateral spine.

The species of this genus are inhabitants of the continental shelf and slope, from about 15 m down to several hundred metres, sometimes to greater depths. The body form suggests that they are predominantly benthic and environmental data for a few species indicate that soft substrates are preferred. The long respiratory tube and ability to flex the cephalothorax upwards almost 90° to the abdomen, indicates that they bury deeply in these soft sediments. It is by far the largest genus within the Solenoceridae, with at least 21 Indo-West Pacific species, mostly with similar facies.

Phylum	:	Arthropoda
Class	:	Crustacea
Subclass	:	Malacostraca
Series	:	Eumalacostraca
Superorder	:	Eucarida
Order	:	Decapoda
Sub-order	:	Dendrobrachiata.
Infraorder	:	Penaeidae
Superfamily	:	Penaeoidea
Family	:	Solenoceridae Wood-Mason & Alcock, 1891
Genus	:	*Solenocera* H. Lucas 1849

Solenocera crassicornis: Established as a regular fishery
S. choprai Nataraj, 1945: Established as a regular fishery
S. melentho deMan, 1907: Established as a regular fishery
S. hextii Wood-Mason & Alcock, 1891: Stray catches from a depth of 120 to 500 m off east and west coasts of India.
S. pectinata, (Bate): Stray catches.
Solenocera koelbeli Burkenroad, 1959: Stray catches
S. alticarinata Kubo, 1949: Stray catches
S. (Parasolenocera) annectens (Wood-Mason,1891),
S. indica Nataraj, 1945,
S. walterensis George& Muthu, 1970,
S. melentho deMan, 1907
S. subnuda Kubo, 1949.

KEY TO THE INDO-WEST INDO-PACIFIC SPECIES OF *SOLENOCERA* (Dall, 1999)

1. Pterygostomian spine present…… 2
   Pterygostomian spine absent…… 4

2. Postrostral carina distinct behind the cervical sulcus anterior part of the hepatic carina recurved posteriorly to form a quadrangular lobe 3

   Postrostral carina absent behind the cervical sulcus; anterior part of the hepatic carina almost straight……. *S. comata*

3. Cervical carina with a shallow notch about 1/3 its length above the hepatic spine …… *S. Africana*
   Cervical carina without a notch…….. *S. algoensis*

4. Postrostral carina reaching to, or almost to, the posterior border of the carapace and clearly defined along its length…… 5

   Postrostral carine extending little if any beyond the cervical sulcus, or poorly defined……. 13

5. Postrostral carina interrupted by a deep notch at the level of the cervical sulcus……. 6

   Postrostral carina not interrupted by a deep notch at the level of the cervical sulcus (often a shallow depression in this region)…… 8

6. Postrostral carina high and blade like; postrostral salcus feebly developed, less than 1/3 the length of the carina or absent…… 7

   Postrostral carina low along its length; postrostral sulcus more than ½ the length of the carina and widening posteriorly……. *S. koelbeli** (* probably a synonym for *S.alfonso*)

7. **Postrostral carina highest posteriorly, sloping steeply towards the posterior border of the carapace…….. *S.alticarinata***

   Postrostral carina highest anteriorly, tapering gradually towards the posterior border of the carapace……. *S. choprai*

8. **Telson without a pair of subapical fixed spines…… *S. crassicornis*****
   (**probably a synonym for subnuda)
   Telson with a pair of subapical fixed spines…… 9

9. Post-rostral carina behind the cervical sulcus distinctly humped in profile, with a median tooth or with a small median nodule; branchiocardiac sulcus and carina well defined, the former running from the posterior edge of the carapace almost to the hepatic sulcus……. *S. alfonso*
   Post-rostral carina behind the cervical sulcus only slightly and smoothly convex in profile and without a median tooth or nodule; branchiocardiac sulcus and carina feebly defined ……. 10

10. Anterior part of the hepatic carina slightly curved, but not bordering the ventral side of a clearly-defined shallow depression at its anterior end …. ….. *S. bifurcate*

    Anterior part of the hepatic carina distinctly curved and bordering the ventral side of a clearly-defined shallow depression at its anterior end… 11

11. Anterior part of the hepatic carina forming a shallow arc, much less than a semicircle, round the lower border of a shallow depression near the pterygostomian angle; ventral margin of rostrum convex…….. 12

    Anterior part of the hepatic carina forming a deep, upward-facing arc, almost a semicircle, round the lower border of a shallow depression near the pterygostomian angle; ventral distal margin of rostrum usually straight, sometimes slightly concave……. *S. melantho*

12. Postrostal sulcus a series of pits and not divding the carina into two posteriorly; north Australian seas…… *S. australiana*

    Postrostral sulcus consisting of long depressions and pits, usually dividing the carina into two posteriorly; Malaysia, Strait of Malacca……. *S. halli*

13. Anterior end of hepatic carina curving ventroposteriorly, blunt or forming a sharp, almost spinous point …….. 14

    Anterior end of hepatic carina not curving posteriorly, either straight or ending in an upward-facing are…….. 20

14. Anterior hepatic carina sharp or spinous……. 15
    Anterior hepatic carina blunt or forming an angle…… 18

15. Rostrum short, reaching about half the length of the cornea……. 16

    Rostrum reaching or exceeding the distal end of the cornea……*S.barunajaya*

16. Dorsal carina present on abdominal somite 3; maximum diameter of the eye equal to a or exceeding 0.18 the length of the carapace; prosartema not reaching as far as the eye……. 17

    Dorsal carina absent on abdominal somite 3; eye small, maximum diameter about 0.14 the length of the carapace; prosartema exceeding the distal end of the cornea…….. *S. faxoni*

17. Usually 7 rostral spines, including the epigastric; hepatic carina ending in a spine that just reaches the anterior border of the carapace; no spine on the basis of the 2nd pereopod…….. *S. spinajugo*

Usually 6 rostral spines, including the epigastric; hepatic carina ending in a prominent point that exceeds the antero-ventral borer of the carapace; a spine on the basis of the 2nd pereopod…… *S. moosai*

18. Rostrum short, not reaching as far as the distal end of the eye; anterior end of hepatic carina rounded…… 19
Rostrum long, well exceeding the eye, and reaching to about half the 2nd segment of the antennular peduncle; anterior end of hepatic carina almost angular…… *S. annectens*

19. Six or seven rostral teeth including the epigastric; inferior antennular flagellum with 39-53 segments……. *S. pectinulata*

Eight or nine rostral teeth including the epigastric; inferior antennular flagellum with 57-77 segments…….. *S. pectinata*

20. Rostrum slender, reaching about 1/3 the length of the cornea ……..…. *S. bedokensis.*
Rostrum deep, reaching at least ½ the length of the cornea……. 21

21. **Epigastric tooth well behind the level of the hepatic tooth; ventral margin of rostrum strongly convex; length of the superior antennular flagellum 1.3-1.43 times that of the carapace and the inferior flagellum with 55-59 segments…… *S. rathbuni***

Epigastric tooth at about the level of the hepatic tooth; ventral margin of rostrum slightly convex; length of the superior antennular flagellum 2.1-2.2 times that of the carapace; inferior flagellum with 89-109 segments……. *S. waltairensis*

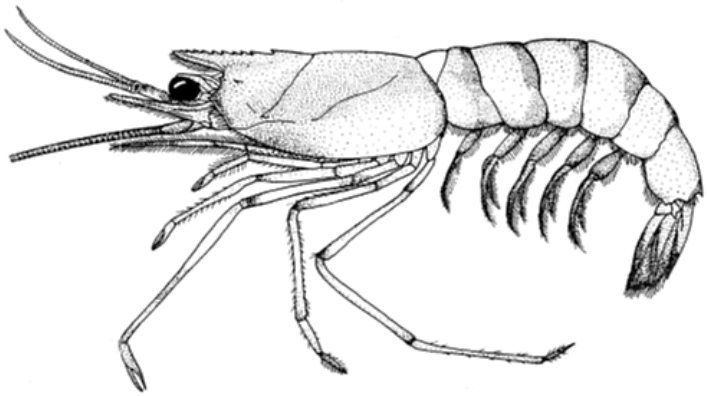
S. hexti: Although Alcock has not been included in Solenocera because Alcock (1901: 20) considers that the antennules could not form a respiratory tube, suggesting a *Mesopenaeus* species; also the flagella are shorter than the carapace, another *Mesopenaeus* feature. But in general conext it follows all other charecters of *Solenocera* and is included in *Solenocera* genus in the present text.

Solenocera species reported from Indian waters

Along northwest coast of India, *Solenocera crassicornis* was established as a regular fishery since long time and the presence of *S. choprai* in the landings was very rare and occasional. *S. crassicornis* was caught from a depth within 40 m and *S. choprai* from the ground beyond 50 m depth. Another species *S. hextii* was reported as stray catches from a depth of 120 to 500 m off east and west coasts of India. George (1966), Mohamed (1973) and Kurien and

Sebastian (1976) collected and described altogether ten species of shrimps belonging to *Solenocera* genus from Indian waters. The species collected were *S. pectinata*, (Bate), *S. koelbeli* de Man, *S. hextii* Wood-Mason & Alcock, 1891, *S. alticarinata* Kubo, 1949, *S. (Parasolenocera) annectens* (Wood-Mason,1891), *S. indica* Nataraj, 1945, *S. choprai* Nataraj, 1945, *S. walterensis* George& Muthu, 1970, *S. melentho* deMan, 1907 and *S. subnuda* Kubo, 1949.

Solenocera crassicornis (H. Milne Edwards, 1837)
Coastal mud shrimp

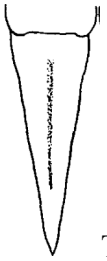


OTHER SCIENTIFIC NAMES STILL IN USE: *Solenocera indica* Nataraj, 1945
Solenocera subnuda Kubo,1949

DISTINCTIVE CHARACTERS:

Body hairless except at base of rostrum; rostrum reaching to distal margin of eye or little beyond, armed with 8 to 10 (12) dorsal teeth; its ventral margin slightly convex or straight; postrostral crest low and rounded, reaching posterior margin of carapace; cervical groove deep, reaching to, or nearly to, dorsal midline; postorbital spine present; suprahepatic and branchiostegal spines absent; pterygostomian angle unarmed; hepatic crest curved ventrally on anterior part, delimiting a broadly rounded loop slightly behind frontal margin of carapace; branchiocardic crest slightly sinuous and sloping anteroventrally.

Telson unarmed, not trifurcate; fifth pereopod without a coxal spine. Colour: body, pereopods and pleopods reddish-orange to red; posterior margin of each abdominal segment darker; antennae, pleopods and uropods uniform red.



Telson of *S .crassicornis*

DISTINGUISHING CHARACTERS OF SIMILAR SPECIES OCCURRING IN THE AREA:

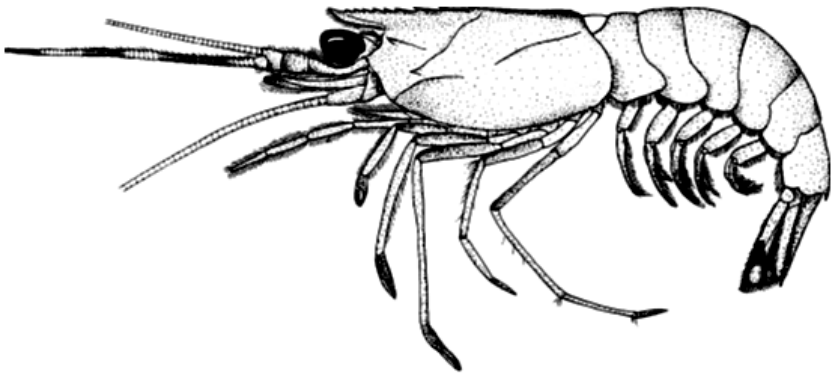
None of the other species of *Solenocera* possess the characteristic unarmed telson of *S. crassicornis.* Further distinguishing characters of these species are:

S. choprai: postrostral crest markedly elevated and laminose (low and rounded in *S. crassicornis)*; anterior part of hepatic crest differently shaped.

S. hextii: branchiocardiac crest very distinct and Lshaped (slightly sinuous in *S. crassicornis*); suprahepatic spine present (absent in *S. crassicornis*)

S. crassicornis ***S. choprai*** ***S. hextii***

Solenocera choprai Nataraj,1945
Ridgeback shrimp



OTHER SCIENTIFIC NAMES STILL IN USE: *Solenocera alticarinata* Kubo, 1949

DISTINCTIVE CHARACTERS:

Body hairless except at base of rostrum where it is distinctly pubescent; rostrum reaching middle to 3/4 of eye, convex on ventral margin and with 6 to 9 dorsal teeth; postrostral crest markedly elevated and laminose, reaching posterior margin of carapace and interrupted by a notch just ahead of cervical groove; the latter is deep and reaches or almost dorsal midline; postorbital spine present; suprahepatic and branchiostegal spines absent; pterygostomian angle broadly rounded and unarmed; hepatic crest curved downward anteriorly, with a sharp bending near its anterior end delimiting a round loop just behind frontal margin of carapace; branchiodardic crest oblique, its anterior part curving ventrally.

Telson trifurcate, with a pair of fixed distolateral spines; fifth pereopod with a coxal spine.

Colour: body, pereopods and pleopods red; antennae banded dark red and white; uropods dark red, except for some white areas. telson

Telson in *S.choprai*

DISTINGUISHING CHARACTERS OF SIMILAR SPECIES OCCURRING IN THE AREA:

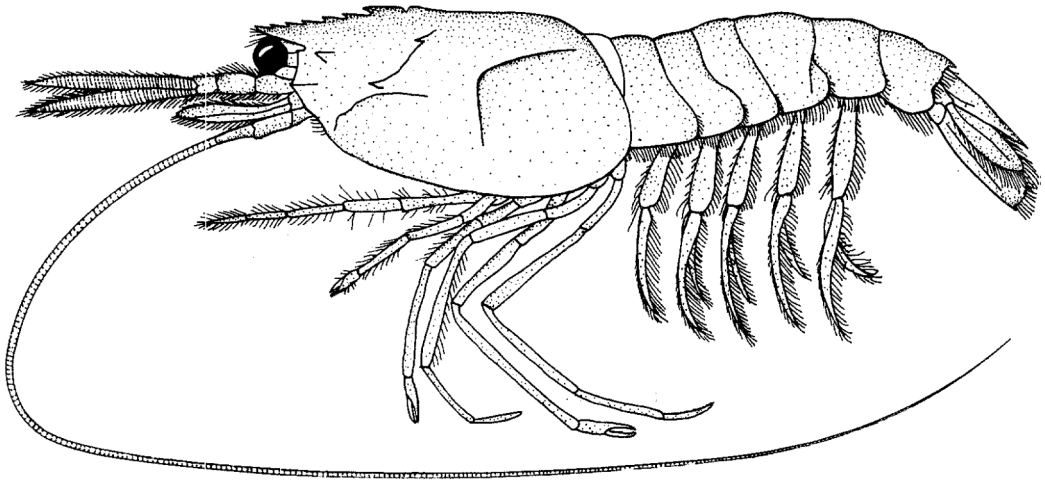
Solenocera crassicornis: postrostral crest low and rounded (markedly elevated and laminose in *S. choprai*); telson unarmed (with lateral spines in *S. choprai*); anterior part of hepatic crest differently shaped.

S. hextii: branchiocardiac crest very distinct and Lshaped (oblique in *S. choprai)*; suprahepatic spine present (absent in *S. choprai*)

Other species of *Solenocer*a: postrostral crest not laminose posterior to cervical groove.

S.crassicornis *S. choprai* *S.hextii*

Solenocera hextii Wood-Mason & Alcock, 1891
Deep-sea mud shrimp



DISTINCTIVE CHARACTERS:

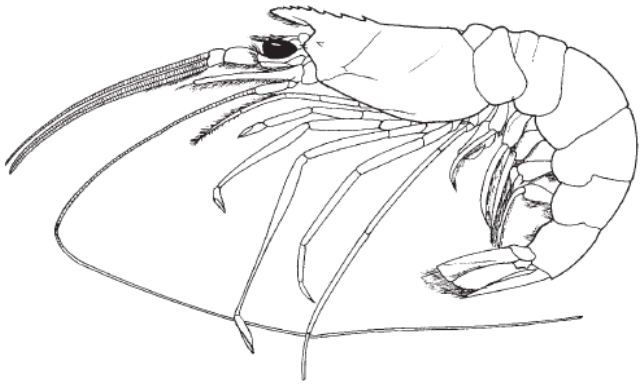
Body hairless, except, the rostrum; rostrum high, reaching to about distal margin of eye, armed with 6 to 8 dorsal teeth, its ventral margin nearly straight; postrostral crest elevated and laminose, reaching posterior margin of carapace and interrupted by a notch just in front of cervical groove (in small specimens, the crest is less developed and the notch may be absent); cervical groove deep, reaching to, or almost, to dorsal midline; postorbital and suprahepatic spines present; branchiostegal and pterygostomian spines absent; hepatic crest curved ventrally on its anterior part, with a sharp bending near its anterior end; branchiocardiac crest very distinct and L-shaped (its posterior half nearly horizontal its anterior half turning ventrally at right angle); telson with a fair of fixed distal lateral spines (trifurcate); fifth pereopod with a coxal spine. Colour: bright pink

DISTINGUISHING CHARACTERS OF SIMILAR SPECIES OCCURRING IN THE AREA:
None of the other species of Solenocera have a suprahepatic spine or the characteristic L-shaped branchiocardiac crest and groove of *S. hextii.*

S.crassicornis ***S. choprai*** ***S.hextii***

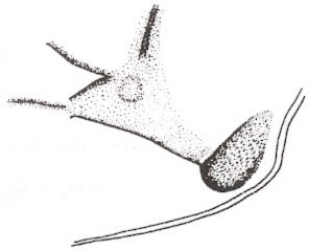
Apart from these species *S.melantho* is caught in good numbers from Indian waters especially from east coast.

Solenocera melantho de Man, 1907



DIAGNOSIS: Rostrum deep and reaching to about the extremity of the eye; with a total of 8-9 teeth, with the 4th, occasionally the 3rd above the orbital margin. Postrostral carina well defined and reaching almost to the posterior edge of the carapace; postrostral sulcus represented only 1-4 small pits, sometimes with none. Orbital angle sharp, antennal and hepatic spines of similar size, postorbital spine large; cervical sulcus reaching almost to the dorsum, which is only barely indented at this point. Posterior orbito-antennal sulcus deep, almost vertical and reaching the base of the postorbital spine.

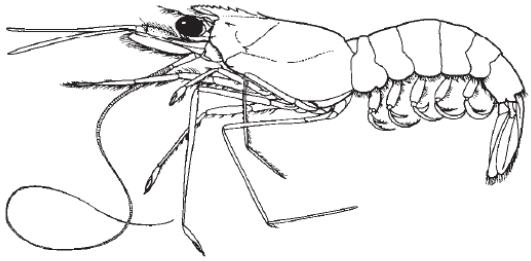
Anterior end of the hepatic carina curving ventrally around a deep depression at the pterygostomian angle, forming an arc, almost a semicircle (Fig)

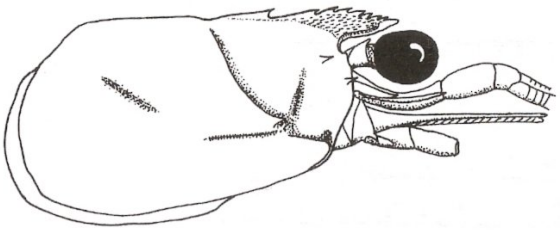


Hepatic sulcus extending posteriorly and almost joining an indistinct branchiocardiac sulcus, which nearly reaches the posterior edge of the carapace. Antennular flagella 0.9-1.25 the length of the carapace in females, longer in males and juveniles. Thelycal plate between the 5th pereopods sometimes with a low anterior median ridge, sometimes with none.

S. melentho differs from *S. choprai* in the nature of cervical groove, which in *S. choprai* cuts the post-rostral carina deeply whereas in *S. melentho* it does not.

Solenocera pectinata (Bate, 1880)





DIAGNOSIS: Dorsal edge of rostrum convex, with 8-9 small teeth including the epigastric; postrostral carina not extending past the top of the cervical sulcus; orbital angle blunt. Postorbital and hepatic spines of similar size, antennal spine small; cervical sulcus deep and ending just below the dorsum, which is slightly depressed at this point; posterior part of the orbito-antennal sulcus deep, its upper end reaching just above the level of the antennal spine. Anterior hepatic carina recurved, forming a blunt projection, raised above the carapace surface; the carina ending posteriorly at the tip of the hepatic tooth. Hepatic sulcus extending posteriorly to about the level of the top of the cervical sulcus; branchiocardiac sulcus barely defined. Inferior antennular flagella 1.13-1.24 the length of the carapace and with 57-63 segments. Distal third of the petasma pectinate, the ventrolateral lobe ending in a single tooth, accessory lobe with with 18-20 spinules. Trapezoidal plate of thelycum with a small anterior median boss, median sulcus poorly defined.

In comparison with *S. choprai* which is only having three to four teeth are present on the rostrum *S. pectinata* (Spence Bate, 1988) have a rostrum with 8 to 9 densely packed small upper teeth (Chan,1998).

S. alticarinata Kubo 1949 and ***S. koelbeli*** De Man, 1911

Like *S. pectinata* (Spence Bate, 1988), *S. alticarinata* Kubo 1949 and *S. koelbeli* De Man, 1911 also termed along with *S.choprai* in many instances. In the case of *S. alticarinata* Kubo, 1949, the posterior part of the rostral crest behind the cervical notch is distinctly higher than anterior part (Chan, 1998) (whereas in *S. choprai* height of the posterior part of the post rostral carina progressively decreases). *S. koelbeli* De Man, 1911, is distinguished (from most similar species, *S. choprai*) by its characteristic post-rostral crest. Post-rostral crest in *S. koelbeli* is continuous, uninterrupted by cervical furrow (Nataraj, 1945; Chan, 1998) whereas, in *S. choprai* it is plate like and is interrupted by a cervical groove.

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Chapter 8

Deep sea prawns

Rekhadevi Chakraborthy

Shellfish systematics is the most unique one in Fisheries Science in view of its importance and implications in diversity. The systematic zoology is the science that discovers names, determines relationships, classifies and studies the evolution of living organisms. It is an important branch in biology and is considered to be one of the major subdivisions of biology having a broader base than genetics, biochemistry and physiology. The shellfish includes two highly diversified phyla i.e. phylum ***Arthropoda*** and phylum ***Mollusca***. These two groups are named as shellfishes because of the presence of ***exoskeleton made of chitin in arthropods*** and ***shells made of calcium in molluscs***. These two major phyla are ***invertebrates***. They show enormous diversity in their morphology, in the habitats they occupy and in their biology. Phylum Arthropoda includes economically important groups such as lobsters, shrimps, crabs. Taxonomical study reveals numerous interesting phenomena in shellfish phylogeny and the study is most indispensable for the correct identification of candidate species for conservation and management of our fishery resources and aquaculture practices. On the whole taxonomic study on shellfishes furnishes the urgently needed information about species and it cultivates a way of thinking and approaching of all biological problems, which are much needed for the balance and well being of shellfish biology as a whole.

Shrimp resources are available both from inshore and from offshore waters. As the fish resource from inshore waters remained static during the last two decades, fishing pattern underwent several changes in the previous decade, leading to the exploitation of deep sea resources either with deployment of large sized vessels or modified medium/small sized vessels. Deepwater shrimps appear to have a world-wide distribution in tropical waters. They have been caught in surveys using baited traps in depths between 200 m and 800 m off continents and at 200- 500 m depth in the Indian Ocean.

Deep sea decapod crustaceans constitute one of the dominant high price groups of invertebrates in the marine fishery sector of Kerala although the structure and organization of their community are not well known as that of coastal penaeid prawns. In view of the

increasingly prominent role played by deep sea prawns and prawn products in the economy of the country, the taxonomic identity of various species exploited from the deep sea fishing grounds off Kerala is an essential prerequisite for the sustainable development and management of deep sea prawn wealth of Kerala. The deep sea prawns landed at various harbours of Kerala is an assemblage of wide array of species representing various families, the prominent being *Pandalidae, Aristeidae, Solenoceridae and Penaeidae* while family *Oplophoridae* contributes to only a minor portion of the deep sea trawl catches in Kerala.

Deep-sea prawn fishery

Sakthikulangara

During the first season (1999-2000) the fishing which started in November 1999 extended till June 2000. However, in the following seasons the fishing started earlier in September itself. The duration of deep-sea prawn fishery was between September and May during the next three seasons and between September and April during 2003-04 and 2004-05 seasons. During 2005-12 the fishing was carried out between September and June. The trawler units operated for deep-sea prawns varied between 5896 (2005-06) and 28,434 (1999-2000) with an average amounting to 12,009 units per season. The average annual trawling hours was 225,899 with minimum fishing hours (111,519) during 2004-05 and maximum (357,102) during 1999-2000.

About 72.8% of the deep-sea prawn catch from 'Quilon Bank' was landed at Sakthikulangara during 1999-2003. In the next three seasons during 2003-06 the contribution of Sakthikulangara was 84.2%. For the entire seven seasons between 1999 and 2006, an estimated catch of 83436 t deep-sea prawns was landed at Sakthikulangara (11919 t per season) which constituted 77.3% of entire prawn catch of 'Quilon Bank'. The trawler units operated for deep-sea prawns varied between 5896 (2005-06) and 28,434 (1999-2000) with an average amounting to 12,009 units per season.

The average annual trawling hours was 225,899 with minimum fishing hours (111,519) during 2004-05 and maximum (357,102) during 1999-2000. Trawling hours/boat which was only 12.6 at the beginning of fishery (1999-2000) increased steadily to 23 hrs in 2001-02 but declined slowly to reach 17.4 hrs in 2004-05. However, during 2005-06 the trawling hours/unit

increased to 36.1 hr mainly to have an extended fishery in order to save fuel. Maximum quantity of deep-sea prawns (18,129 t) was recorded during 2003-04 followed by a sharp decline during 2001-01 (6626 t) and 5978 t during 2009-2012. Maximum CPH (77 kg) was recorded during 2003-04 followed by (42.5 Kg) 2006-08, and 35 kg in 2000-01 while minimum (11%) was observed during 2009-12 season.

The deep-sea prawns contributing to the fishery in order of abundance during 1999-2006 based on average annual landings at Sakthikulangara were *H. woodmasoni* (3291 t; 27.6%), *M. andamanensis* (2884 t; 24.2%), *H. gibbosus* (2071 t; 17.4%), *P. spinipes* (1993 t; 16.7%), *A. alcocki* (1442 t; 12.1%), *S. hextii* (112 t; 0.9%), *P. martia* (89 t; 0.7 %) and *P. jerryi* (37 t; 0.3%). While the average estimated deep sea catch during 2006-2008 was 8571 t. The fishery was chiefly supported by seven species constituted by 4 non-penaeid and 3 penaeid. Among the non-penaeid species *Plesionika spinipes* (2402 t, 28%) forms the major catch followed by *Heterocarpus gibbosus* (1425 t, 17%) while the prime species in penaeid shrimp catch was contributed by *Metapenaeopsis andamanensis* (1987 t, 23%) followed by *Aristeus alcocki* (17%). During 2009-2012 further decline in the catch was observed 5978 t with a catch rate of 11.3 Kg/hr. The biological studies carried out with the samples collected from Sakthikulangara fishing harbour on three major samples indicated that females dominated the catch in case of *Heterocarpus gibbosus* (63% with a mean size of 103 mm, size range 66-135 mm, mode 101-105 mm), *P.spinipes* (36% with a mean size of 96.3 mm, size range 61-140 mm, mode 96-100 mm), *H. woodmasoni* (22% with a mean size of 104.7 mm, size range 111-115 mm, mode 111-115 mm.

Cochin Fisheries Harbour

The first season of deep-sea prawn fishery (1999-2000) started from November 1999 and extended till May, 2000, as in the case of Sakthikulangara Centre. In the subsequent seasons till 2003, the fishery started in September itself and continued till April of the following year during 2000-01 and 2001-02; till February during 2002-03 and up to March during 2003-04. In the following two seasons viz. 2004-05 and 2005-06 the deep-sea prawn fishery started, still earlier, in August itself and continued till March 2005 and April 2006, respectively. During 2007-2012 the deepsea fishing was observed during September to April with an estimated average landings

of 1345 t during 2006-2008 while an estimated landings of 1012 t during 2009-2012. The common species of prawns constituted the deep-sea catch were *P. spinipes* (27-33%), *H. woodmasoni*, (6%), *H. gibbosus* (6%), *P. martia* (11%), *A. alcocki* (14%), *S. hextii* (0.6%), *P. jerryi* (9%) and *M. andamanensis* (25%).

Size range in the fishery

Heterocarpus woodmasoni

Size range of *H.woodmasoni* along the Kerala coast was noticed as 46-100 mm (male) and 51-120 mm (female).

Heterocarpus gibbosus

Size range of *Heterocarpurs gibbosus* along the Kerala coast was noticed as 46-100 mm (male) and 51-120 mm (female).

Aristeus alcocki

Size range of ***Aristeus alcocki*** along the Kerala coast was noticed as 83-100 mm (male) and 75-140 mm (female). In *Aristeus antennatus* carapace length ranged from 12-62 mm for females and 9-45 mm for males and natural mortality rates ranged from 0.55 to 0.70 for females and from 0.62 to 0.79 for males.

Size Range of other deep Sea Shrimps

Plesionika martia : Males: 80 – 106 mm, Females : 87 – 106 mm

M.andamanensis : Males: 62 – 110 mm, Females : 62 – 140 mm

S.hextii : Males : 68 – 138 mm, Females : 62 – 140 mm

P.jerri : Males : 72 – 96 mm, Females : 82 – 111 mm

Biology

According to George (1969), the morphological variation shown by a species are basically used as taxonomic tool in the crustacean systematics and the characters generally often given due importance are nature of rostrum and its spines, carapace, carinae and sulcii, carination of abdomen, telson and appendages. Johnson (1973) expressed the view that changes in the shape and armature of 2nd cheliped due to simple allometric growth process may serve as a unique character in differentiation of closely related species. The linear measurement and function of different body parts, sexual dimorphism, sexual maturity, fecundity and changes in

the weightlength relationship etc. are a few of the processes that are studied through morphometric analysis (Hartnoll, 1985). Both conceptual and empirical aspects on various linear body measurements in crustaceans have been studied by a number of workers notably by Hartnoll (1974, 1978), Finney and Abele (1981), Huber (1985) and Blackstone (1986). Morphometric studies on the commercially important deep water shrimps are restricted to temperate waters by a few researchers based on very few number of morphometric characters of *H. reedi* and *A.antennatus* (Arana, 1970; Sarda *et al.,* 1995; Bas & Sarda, 1998). Whereas, no published information on the morphometric analysis of deep sea prawns have been made so far.

In the genus *Heterocarpus,* 24 morphometric parameters were observed since the 2nd pair of pereopods are unequal in total length. The parameters so examined are total length, carapace length, rostral length, 1st ,2nd ,3rd ,4th and 5th cheliped lengths, length of podomeres in the second cheliped viz. ischium, merus, carpus, propodus and dactylus, 2nd pleural length, depth and breadth and length of telson and Uropod as indicated in the above figure. For the species belonging to the genus *Heterocarpus,* the measurements of both short and long 2nd chelipeds were recorded. Total length was taken as the length between tip of the rostrum to tip of the telson whereas carapace length and rostral length were measured from posterior margin of orbit to the posterior most margin of the carapace and tip of the rostrum to the base of the last rostral spine respectively. Telson was measured from its proximal margin to the distal tip and the pleural width was measured at the widest part of the pleural wall of the 2nd abdominal segment. Total length of the chelipeds and walking legs were taken along their extended length from the proximal base of the ischium to the distal end of the dactylus.

Food and Feeding:

The study of food and feeding habits of an animal is very essential in understanding the various aspects of biology namely growth, development, reproduction, migration and seasonal variation in the body condition. Further, knowledge on natural diet of an animal is important in fundamental community analysis for studies of food webs, trophodynamics resource partitioning and ecological energetic (Ivlev, 1961; Landenberger, 1968). An understanding of the relationship between animals and food organism especially the favorite food items and their seasonal distribution may help to locate the potential feeding grounds provide clue for the prediction and

exploitation of the resources (Muthiah, 1994). As food being the major factor regulating the abundance, growth and movement of animals, any information in this regard will add to the existing knowledge needed for better management of prawn stock. Many authors have discussed the food and feeding habits of deep sea prawns 11 many parts of the world ever since exploratory commercial fishing being for these crustaceans. One of the earliest works on feeding habits of deep sea prawns was by Murie (1903) on the Pink shrimp *Pandalus montagui.* The most significant contributions in the food and feeding on the pandalid prawn *Pandalus borealis* Kroyer the principal species supporting the cold-water fisheries of Northern Atlantic and NorthernPacific waters were that of Alien (1959).

Notable contribution on the food and feeding habits were made by Bullis (1956), Bullis and Rathjen (1959), Bul/is and Thompson (1959). Thompson(1967). Klima (1969) and Anderson and Lindner (1971) on the Royal red shrimp *Hymenopenaeus robustus* Smith from the south east coast of United States and of Burukovsky (1978) on *Aristeus varidens* HoIthuis from the west coast of Africa.

Nevertheless in the Indian Ocean, only very little is known on the food and feeding habits of deep sea prawns, though similar information on coastal Penaeid prawns are aplenty (Gopalakrishnan, 1952; Panikkar, 1952: George, 1959; Kuttyamma. 1974; Kunju. 1967). Suseelan (1985) conducted a preliminary study on the gut contents of *Heterocarpus gibbous* and H *woodmasoni* collected during the exploratory surveys off south west coast of India.

Susee1an (1985) reported that 73% of the stomachs of *H.woodmasoni* are empty while the crustacean remnants predominated followed by foraminifers, fish remnants and sand particles in the remaining 27%. Whereas in *H. gibbosus,* crustaceans constiMed the major element (54%) and foraminifers (37%) appeared as the second major component. From the nature of food consumed and the presence of high proportion of detritus and crustacean remnants though in varying quantities, it can well be inferred that both the species are typical bottom feeders.

Reproductive Biology

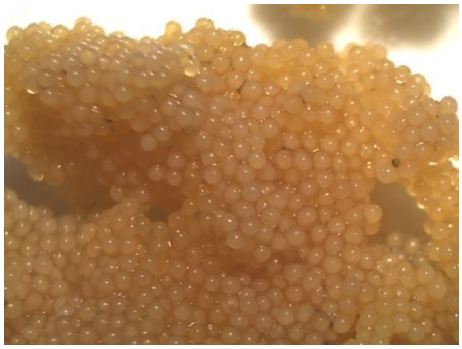
A thorough knowledge of the reproductive biology of any given species is an essential prerequisite for stock assessment of wild popuIations, sustainable exploitation and successful fishery management. The reproductive traits include aspects such as size at first maturity, size dependent fecundity, sex ratio, and nature of gonads, frequency and season of spawning

(Wootton, 1984). Information on these aspects is essential for sustainable exploitation and management of fish stocks.

The patterns of deep-sea reproductive biology length of breeding period, brood size, egg size-have been studied in the last 2 decades, mainly with reference to seasonality (Tyler 1988, Gage & Tyler 1991). Based on the hypothesis that the deep-sea is a physically seasonless environment Orton (1920) hypothesised that the breeding period of deep-sea species ought to be continuous throughout the year. Depth represents multicomponent factor related one of the major biotic and abiotic gradients found the oceans. Light, temperature, pressure, food ability and predator density are some of the factors which influence species distribution and life-histories. Three stages of egg development were defined based on ovigerous females: eggs of recent spawning with intense colour and no embryor pigmentation visible, early stage (1) pale egg colour with slight embryo eye pigmentation, middle stage (2) total loss of egg colour with embryo eye pigmentation well visible and embryo well developed, late stage(3).

Description of maturity stages

There were glaring differences in the colour and shape of the ovaries, though the variation in gonad Structure was not prominent in males. In females, seven stages of maturity were identified of which four stages (immature, maturing, head roe, spent) were defined according to the relative intensity of color and dimension of ovary in the cephalothorax while the later three stages of maturity were defined on the basis of the color of embryo and ovigerous females. In males also, the maturity stages could be assigned to three stages based on external macroscopic examination.

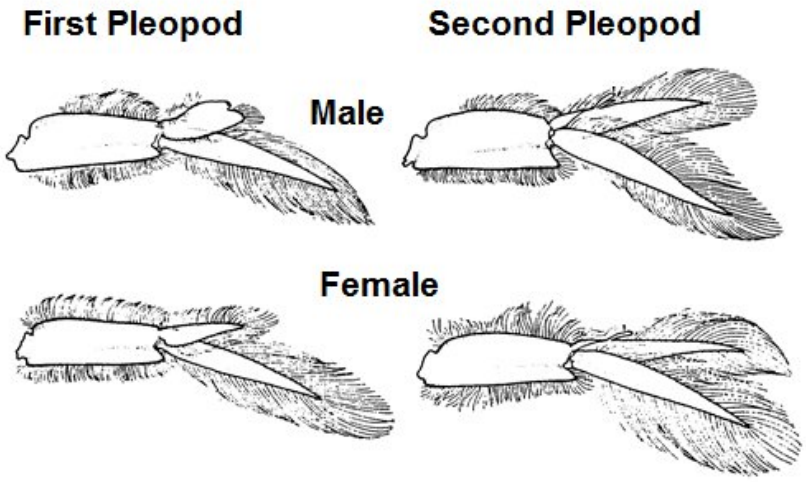


***Plesionika spinipes* egg**

One of the most important aspects of the reproductive biology of penaeid shrimps is the study of the histological basis of ovarian maturity and the spawining seasons, which is required

for the management of the stock as well as for aquaculture. It is well-established fact that most of the penaeid shrimp species migrate to offshore when they attains sexual maturity.

Tropical caridean shrimp were originally thought to be protandrous hermaphrodites (Clarke, 1972; Wilder, 1977), as are temperate-water pandalids which change from males to females after the first few years of life. Subsequent studies revealed that tropical deepwater carideans have separate sexes (King and Moffitt, 1984; Moffitt and Polovina, 1987). The sex of caridean shrimps can be determined by an examination of the shape of the endopods of the first pleopods (swimming legs); the endopod in males is broader and more leaf-shaped than in females. A mature male also possesses an appendix masculina situated between the appendix interna and the endopod of the second pleopod. Eggs are carried externally on the pleopods of ovigerous females, and brood sizes (the number of eggs carried) may exceed 30,000 on the larger *Heterocarpus* species (King and Butler, 1985). The mean sizes of reaching sexual maturity in females (defined as the size where 50 per cent of the female population is ovigerous) are given for several species in King (1986). Female *Heterocarpus laevigatus* reach sexual maturity between 40 and 43 mm carapace length which corresponds to a relative age of 4 to 4.6 years (King, 1983; Dailey and Ralston, 1986; Moffitt and Polovina, 1987)



Key to the deepsea prawns of Penaeidae, Pandalidae and Oplophoridae

Penaeidae

1. Inner border of the antennular peduncle with a setose scale; Podaobranchiae absent…….2

No setose scale on the inner border of the antennular peduncle; podobranchiae present; pleurobranchia on 10-13 segments reduced to mere papillae…..***Aristeus alcocki***

2. Exopodite of the external maxillipeds large, absence of a brachio-cardiac sulcus in the branchiostegal region ……3
3. Symmetrical petasma; no basal spine at 3rd maxilliped ……4
4. A long fissure on either side of the carapace throughout the entire length; rostrum not glabrous and less then 1/3rd the length of carapace……....***Parapenaeus investigatoris***

   No fissure on carapace wall; rostrum glabrous,as long as carapace….***Penaeopsis jerryi***

Pandalidae

1. Carapace hard and rigid with longitudinal carinae; 2nd pair of pereiopods unequal…….***Heterocarpus***…….3

   Carapace smooth without a longitidinal carinae; 2nd pair of periopods Carapace equal…2
2. 3rd abdominal somite unarmed or with fixed postero-medial tooth; terminal segment of 2nd maxilliped broader than long, attached strip like to penultimate segment with its longer side……***Plesionika***……5
3. 3rd abdominal tergum without spines, length of 6th abdominal segment less than 5th…4

   3rd abdominal tergum ends in a sharp spine dorsally; 6th segment more than double the length 5th……..***Heterocarpus woodmasoni***
4. Only one tooth present anterior to orbit; dorsal carapaceal ridge not prominent …… ***Heterocarpus laevigatus***

   More than two teeth anterior to the orbit; dorsal carapaceal ridge very prominent ……..….***Heterocarpus gibbosus***
5. Posterior 10 ventral rostral teeth corresponding to 8or fewer dorsal teeth, penultimate segment oh 3rd maxilliped usually less than 1.5 times as long as terminal segment……***Plesionika quasigrandis***

   Posterior 10 ventral rostral teeth corresponding to more than 8 dorsal teeth, penultimate segment of 3rd maxilliped more than 1.5times as long as terminal segment……6
6. Dactylus of 3rd pereiopod less than 1/7 times, as long as propodus, posterior 10 ventral rostral teeth usually corresponding to more than 13 dorsal teeth……..***Plesionika spinipes***

   Dactylus of 3rd pereiopod more than 1/7 times, as long as propodus, posterior 10 ventral rostral teeth usually corresponding to 13or fewer dorsal teeth……..***Plesionika grandis***
7. Rostrum armed with a series of closely packed spines ventrally; distinct ocellus……8

   Rostrum armed with distantly placed spines; ocellus absent……***Plesionika alcocki***
8. 3rd abdominal tergum posteriorly protrudes as a sharp dorsal spine….***Plesionika ensis***

   3rd abdominal tergum without spines but protrudes as a wavy margin...***Plesionika martia***

Oplophoridae

1. Rostrum with atleast as many dorsal as ventral teeth; abdomen with 4th and 5th somites usually armed with posteromesial tooth; left mandible with incisor process not tapering sharply toward opposable margin, armed with 9-14 subacute teeth …..***Acanthephyra***
2. Abdomen with 6th somite shorter than 5th (not including posteromesial spine); telson simply pointed posteriorly, not terminating in spinose endpiece; 3rd maxilliped and 1st pereiopod with broadly compressed rigid exopods……..***Oplophorus***
3. Carapace without carina supporting branchiostegal spine; abdomen with posterior margin of 3rd somite distinctly excavate either side of posteriomedian tooth…..***Acanthephyra armata***

   Carapace with strong carina extending from branchiostegal spine to branchial region; abdomen with posterior margin of 3rd somite not distinctly excavate either side of posteromedian tooth…. ***Acanthephyra fimbriata***
4. Abdomen with posteromedian tooth on 4th and 5th somites; telson armed with four pairs of dorsolateral spines…….. ***Acanthephyra sanguine***
5. Rostrum distinctly overreaching antennal scale; posterior extension of upper lateral rostral carinae on carapace subparallel in dorsal aspect;pleuron of 1st abdominal somite armed with small tooth on ventral margin;antennal scale unarmed on only distal 1/6 of lateral margin..***Oplophorus gracilirostris***

   Rostrum rarely overreaching antenna scale; posterior extension of upper lateral rostral carinae on carapace converging posteriorly in dorsal aspect; pleuron of 1st abdominal somite unarmed; antennal scale with distal ¼ of lateral margin unarmed…….***Oplophorus typus***

Penaeid shrimps

***Aristeus alcocki* Ramadan 1938** (Red ring)
Family Aristeidae

Diagnostic characters: Large size red abdominal rings. Rostrum in female long and slender upper margin curved downwards till distal end of 2nd segment of antennular peduncle. Rostrum in males much shorter and seldom surpassing tip of antennular peduncle, armed with three teeth above orbit; **and no teeth on ventral side, lacks hepatic spine, upper antennular flagellum very short, Eyestalk with a tubercle.** Petasma simple, membranous, right and left halves united with each other along the whole length of dorsomedian with a papilla-like projection directed posteromedially. Thelycum represented by a shield shaped plate directed anteroventrally bordered by an oblique ridge on either side.

Colour: Pink with reddish bands on the posterior border of all abdominal segments.

Fishery & Biology: The catches were mainly composed of females and their size ranged from 78 mm to 188 mm in total length. The size distribution showed unimodal pattern with majority in size groups 146-165 mm. The males, which were very poorly represented in the catches were relatively smaller in size and their total length varied from 67 mm to 110 mm.

Distribution: Indian Ocean; Arabian Sea and Bay of Bengal, at depth of 350-450 m off Quillon and Alleppey.

***Plesiopenaeus edwardsianus* Johnson, 1868** (Scarlet shrimp)
Family: Aristeidae

Diagnostic characters: Rostrum very long in females and young males but becoming considerably short in adult males, with three or more dorsal teeth; carapace without postorbital spine; eye stalks with a tubercle on inner border; upper antennular flagella very short and flattened almost throughout their length; endopods of second pair of pleopods in males bearing

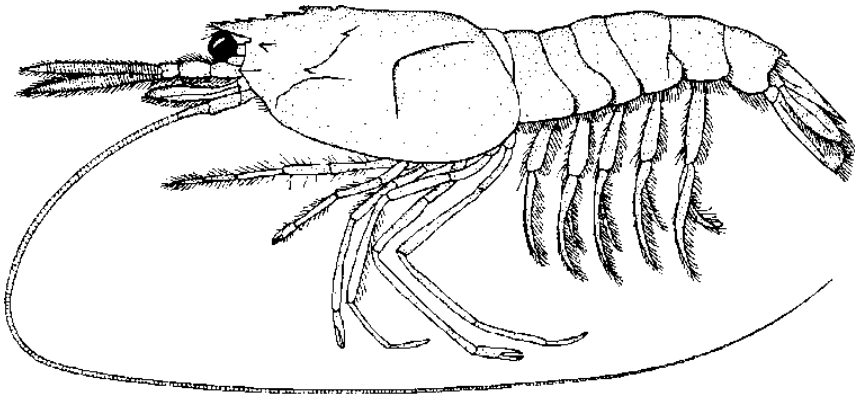
appendix masculine and appendix interna; third and fourth pairs of pleopods biramous; telson armed with 1 or 4 movable spines on each side; two well developed arthrobranchs on penultimate thoracic segment.

Colour: Deep pink

Fishery & Biology: Three female specimens ranging in total length from 207 to 245 mm (rostrum partly broken in all specimens) and carapace length from 79 to 96 mm obtained in Bobbin Trawl at 876-976 m depth.

Distribution: During one of the deep-sea trawling operations of FORV *Sagar Sampada* a few specimens of prawns, which were unusually large in size, were taken from about 900 m depth off Trivandrum on the southwest coast.

***Solenocera hextii* Wood-Mason & Alcock, 1891** (Deep sea mud shrimp)
Family: Solenoceridae



Diagnostic characters: Flatenned rostrum with 7 teeth on dorsal side and no teeth on ventral side of the rostrum. Postrostral carina sharp but not laminose. Antennular flagella with red and white bands. The spines on the cervical groove situated ventral to the posteriormost rostral tooth which is well developed. The characteristic 'L' shaped groove on either side of the branchiostegal region is also clearly defined.

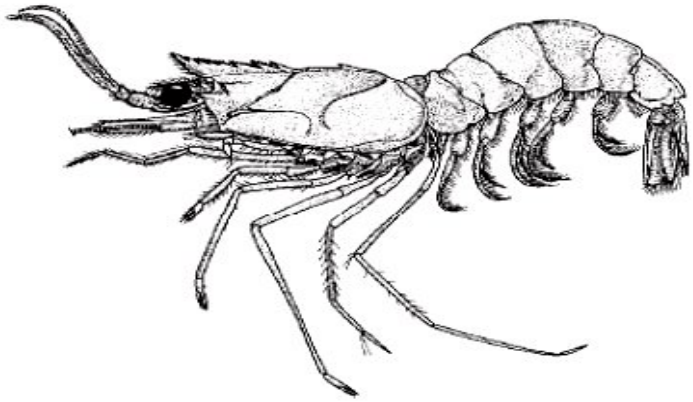
Colour: Pink to red

Distribution: Found all along the east and west coast of India at depths between 250 to 547 m.

Solenocera alfonso Perez Farfante, 1981
(Deep water mud shrimp)

Diagnostic characters: Antennular flagella flattened and tube like, rostrum horizontal, exopod of uropod without distolateral spine (family character). Telson armed with lateral spines; post

rostral crest elevated but not plate like. The postrostral crest is not separated from postrostral teeth by a distinct notch but postrostral crest behind cervical groove sometimes with an upper



tooth. Posterior part of hepatic groove and anterior part of branchiocardiac groove both very distinct and strongly curving downward; median part of first abdominal segment very narrow and dorsal crest of second abdominal segment distinct.

Colour: Pink to red

Distribution: Found at depths between 176 to 547 m. Though an Indo-West Pacific species, earlier records were only from Philippines, Indonesia and Northwestern Australia. In 2011, the species was recorded from Tuticorin, southeast coast of India from a depth of 250 to 350 m.

Metapenaeopsis andamanensis **(Wood-Mason, 1891)**
(Rice velvet shrimp)
Family: Penaeidae

Diagnostic characters: Rostrum more or less horizontal and straight with 6 to 7 teeth on dorsal side and no teeth on the ventral side. Lower antennular flagellum longer than the upper, much longer than the entire antennular peduncle but 0.7 times the carapace length. 3rd pereopod surpass the rostrum by the length of the entire chela. Assymetrical petasma. 3rd maxilliped and 1st pereopod with a basal spine, distal fixed pair of spines on telson.

Colour: Pale pink to red

Fishery & Biology: The total length of males varied from 67 mm to 115 mm and that of females from 68 mm to 130 mm.

Distribution: A penaeid prawn commonly encountered in the trawl catches at all depths ranges upto 400 m and was obtained from all areas.

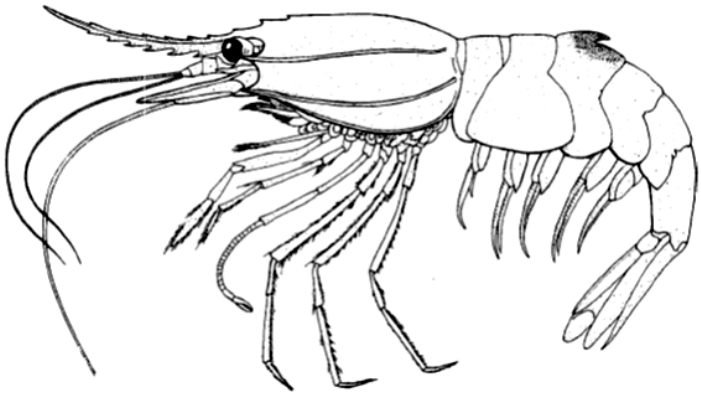
Penaeopsis jeryii **(** Dagger shrimp)
Family: Penaeidae

Diagnostic characters: Dagger shaped rostrum with teeth on dorsal side of the rostrum. Specimen appears to be pale red in color with white bands on the body. Cervical groove very prominent, antennal scale as long as rostrum. Thelycum trilobed and sub elliptical in structure.

Fishery & Biology: Size range of female specimens ranged from 74-115 mm and males ranged from 70-110 mm.

Distribution: All along the southwest coast of India particularly off Cochin, Quillon and Alleppey at depth of 275-350 m

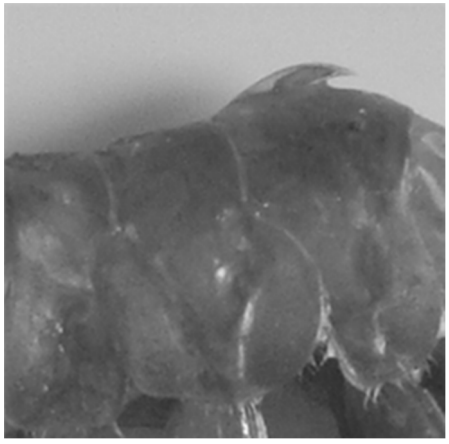
Heterocarpus woodmasoni Alcock, 1901 (Indian Nylon Shrimp)
Family : Pandalidae

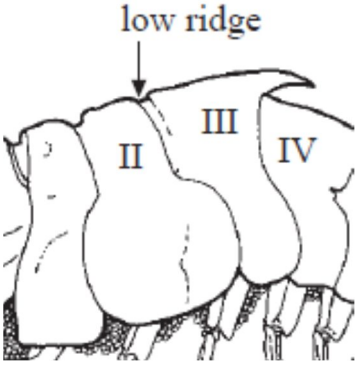


Diagnostic characters: Carapace with 2 longitudinal crests on each side, extending over full length of carapace – post antennal crest and branchiostegal crest. A conspicuous elevated, sharp tooth at middle of dorsal crest of 3rd abdominal segment, telson bears 5 pairs of dorsolateral spinules besides those at the tip.

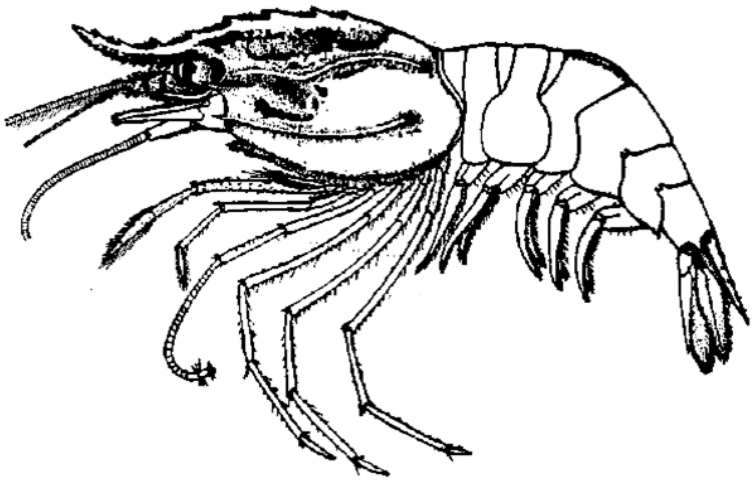
Fishery & biology: Size in the catches ranged from 72 to 135 mm in total length but dominated by 111-120 mm size groups in both the sexes. The fertilized eggs on the pleopods and the head-roe are light orange and this colour stands out in contrast with the pink colour of the prawn. The berry becomes greyish in advanced stages of development.

Distribution: Andamans, Southwest of India off Cochin and Alleppey at depths of 250-400 m





Heterocarpus gibbosus Bate, 1888
(Humpback nylon shrimp)



Diagnostic characters: The teeth on the dorsal crest and the rostrum together vary from 8 to 10. Teeth on the rostrum proper varying from 2 to 4 and 13-15 on ventral side. The dactyli of the 3 posterior legs short, median carination of the 3rd abdominal tergum is quite prominent. Carapace with 2 longitudinal crests on each side, extending over full length of carapace- post-ocular crest and branchiostegal crest. Post antennal crest very short.

Fishery & biology: The size of the individual prawn varied from 67 to 140 mm in total length and the catches were represented by all groups of the females. Males are mostly in 90-100 mm size groups. The colour of the berry is light **orange** and turns dirty grey as embryo develops.

Distribution: Southeast and Southwest coast off Cochin, off Alleppey at depths of 250-400 m. immature specimens were found in greater numbers in shallow waters while the bigger prawns seemed to prefer deeper grounds beyond 350 m.

***Heterocarpus sibogae* de Man, 1917**

Diagnostic characters: Integument tomentose formed by lanceolate scalelike spines, rostrum about 2/3 as long as carapace, gradually recurved upwards, armed dorsally with 8 teeth followed by 6 on postrostral crest of which the first one placed behind middle of two small ones situated closely on distal part; a dark reddish spot covering almost the entire width of 3rd abdominal

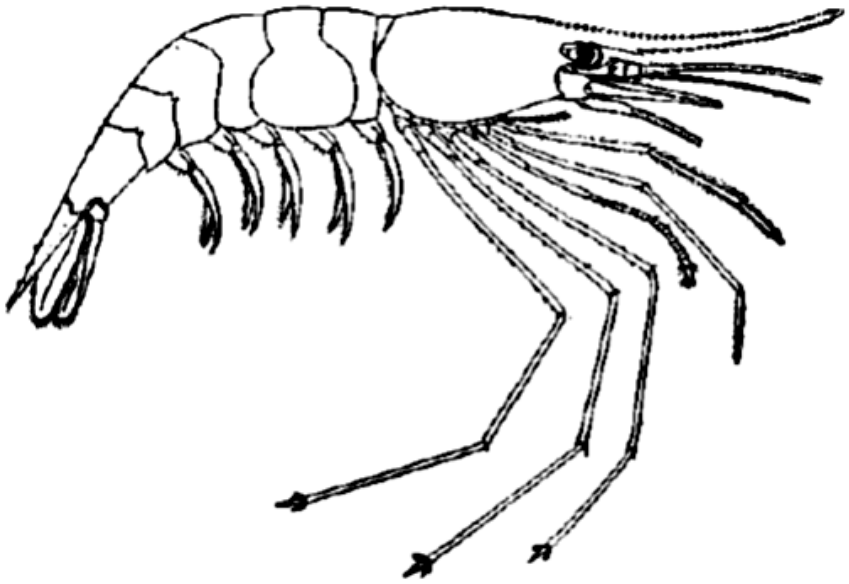
somite on either side appears to be characteristic; tip of rostrum, orbital margin, carinae of 1st and 2nd abdominal terga, distal portion of spines on 3rd and 4th terga, tip of dorsal antennular flagellum and perepods and the entire pleopods reddish; telson long, nearly as long as uropods, armed with 5 small dorsolateral movable spines on right side and 4 on left side in addition to 3 pairs at distal end; antennular flagella about the same length of carapace, stylocerite pointed and reaching middle of second segment of antennular peduncle; scaphocerite narrower distally, reaching 3/4 of rostrum; distolateral spine projecting well beyond anterior margin.

Colour: Fresh specimen apears pink

Fishery: One female, total length 114 mm, carapace length 34 mm; off Quilon at 310 320 m.

Distribution: Southeast and Southwest coast of India

***Plesionika spinipes* (Bate, 1888)** (Oriental Narwal Shrimp)
Family- Pandalidae



Diagnostic characters: Rostrum upturned at the tip. Rostrum is armed with 46 teeth on the dorsal side and 31 teeth on the ventral side., very long slender legs, Telson is double the length of the 5th abdominal somite. Lower antennular flagellum longer than the upper and about 5.4 times the carapace length. 3rd maxilliped extends beyond the antennal scale by the length of its dactylus. Second pereopod exceeds the tip of antennal scale by its chela and 1/8 length of carpus. Minute tubercle on the dorsal surface of the carapace at about 1/6th of its length from the hinder

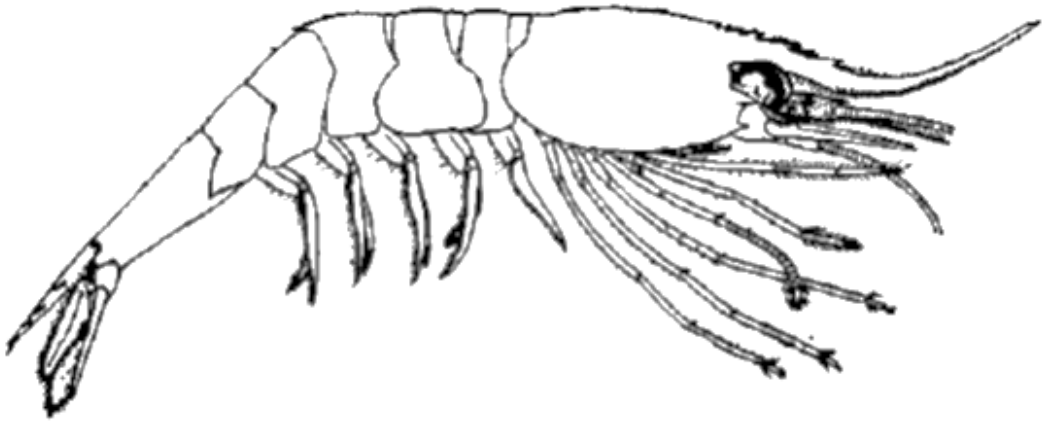
edge which corresponds in position to the small blunt median spine which is present in all the specimens.

Colour: Body pale red in colour

Fishery & biology: The size of this prawn in the catches ranged from 63 to 125 mm but the size groups 95-110 mm in both sexes predominated. Berry is greenish-blue in colour with ovoid shape of fertilized eggs.

Distribution: In Indian waters this species is known to occur in south-east and south-west coast of India abundantly noticed from Quilon and Mangalore regions from the depth of 250-400 m.

***Plesionika martia* (A. Milne-Edwards, 1883)**
(Golden Shrimp)

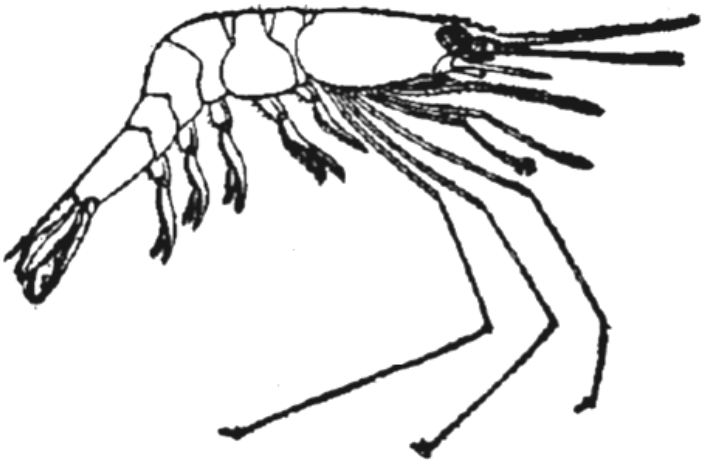


Diagnostic characters: Rostrum very long pointed with 7-9 dorsal teeth including 2-5 teeth on carapace posterior to the level of orbital margin while ventral margin of the rostrum is armed with 34-56 teeth.

Fishery & biology: The size of this prawn in the catches ranged from 71 to 120 mm in males and 80 to 130 mm in females. The modal lengths for males and females were at 90-95 mm and 96-100 mm respectively. Berry is deep blue in colour in the early stages and to light grey in advances stages of development.

Distribution: In Indian waters this species is known to occur along the south-west coast particularly through out the Kerala coast abundantly noticed from Quilon and Alleppey regions from the depth of 200-450 m.

***Plesionika ensis* (A. Milne-Edwards, 1881)**



Diagnostic characters: Rostrum long, moderately slender, having a double curve with the apex pointing upwards and reaching a good deal above the level of the dorsal surface of the carapace. It surpasses the scaphocerite by half or more its length in young specimens and less than half in adults. In both the sexes there are 5 to 6 (usually 6) proximally placed teeth on its upper margin ; the first 4 of which are placed close together above the orbit while the succeeding ones are isolated. The first tooth is movable and very small, hardly visible to naked eye. The sizes of the succeeding teeth show gradual increase until the fifth which is the largest of all. The fifth or the sixth tooth may be occasionally wanting. The ventral margin of the rostrum carries a row of 34-46 fixed teeth which are relatively smaller and sharp. The telson 9/11 length of 6th somite and is armed with 3 pairs of terminal spines and an equal number of small movable spines dorso-laterally. The 1st and 2nd pereopods are almost equal in length reaching the end of scaphocerite. The number of carpal joints in the 2nd pereopods varied between 15 and 17 in both the sexes. The last three pairs of pereopods are longer than the first two. The third pereopod, which is the longest of all, is a little more than 1.25 times the first and surpasses the end of scaphocerite.

Colour: body is pinkish throughout.

Fishery & biology: The individual size varied from 58-120 mm in total length and the size groups 91-110 mm dominated in the catches. The eggs on the pleopods are deep blue but colour fades gradually as the embryos develop.

Distribution: Reported from many parts of the world but its distribution in Indian Ocean was hitherto known from only 2 specimens collected by Alcock (1901) from the Andaman Sea.

Suseelan and Mohamed (1969) reported its occurrence in large numbers from off Quilon and Alleppey at 250-400 m.

Plesionika adensameri: A new distributional record of *Plesionika adensameri* (Balss, 1914) was recorded from southwest coast of India (Shanis et al., 2012).

***Plesionika williamsi* Forest, 1963**

Diagnostic characters: Body covered with lanceolate scales implanted in small pits; rostrum long, extending far beyond scaphocerite, about 1.5 times as long as carapace, curved downwards upto middle of antennular peduncle and thereafter gradually ascending, armed with 11 dorsal teeth arranged closely on basal crest, proximal 3 or 4 placed behind orbit, first tooth microscopic and movable, next 2 or 3 of medium size and remaining ones larger and of uniform size, telson as long as 6th somite, armed with 4 pairs of small movable spines dorsolaterally and 3 pairs on distal extremity; eyes large with distinct ocellus; stylocerite reaching near to distal border of basal segment of antennular peduncle, 3rd - 5th pereopods excessively long surpassing beyond scaphocerite by whole or greater part of carpus; propodus of 4th leg slightly longer than carpus and 15 -16 times as long as dactylus; 5th leg longest, about 4.5 times the length of carapace; appendix interna with small coupling hooks on distomedian surface; endopod of uropods reaching tip of telson.

Fishery and biology: *2* berried females, total length 144 and 145 mm, carapace length 28.5 and 30.0 mm; Off Quilon at 335 - 357 m, November, 1970. 1 berried female, total length 115 mm, carapace length 23 mm; off Quilon at 320 m, March, 1979.

Distribution: Arabian sea, Andamans off Quilon and Alleppey at 250-400 m

Family : Ophlophoridae

Antennal scale sharply serrated; exopod of 1st pair of pereopods foliaceous….*Ophlophorus typus*

Antennal scale smooth without any serrations. Exopod of 1st pereopods not foliaceous…….*Acanthephyra*

Ophlophorus gracilirostris Alcock, 1901

Diagnostic characters: Carapace with dorsal carina extending to the posterior margin. Rostrum very long almost equal in length to the carapace. Branchiostegal spine quite distinct, with a well-

defined keel, spine on the 3rd abdominal tergum very much longer than those on the 4th and 5th. In the male the anterior border of the first abdominal somite is bilobed with the posterior lobe more pronounced and angular.

Distribution: Arabian Sea, Bay of Bengal, Andaman Sea and Hawaiin Islands, Southwest of Cochin, off Alleppey 300-450 m

***Acanthephyra armata* A. Milne-Edwards, 1881**

Diagnostic Characters: The carapace is without a straight ridge or carina running on the entire length of the lateral surface i.e., from the hind margin of the orbit to the posterior edge of the carapace. Rostrum long, upcurved with 5 to 6 teeth on the dorsal side and only one tooth on the ventral side of rostrum. Dorsal carina of 3rd to 6th abdominal somites ending in pointed spines. Sometimes the posterior spine on the sixth somite may be absent. Telson generally more or less truncated at the tip and laterally it is armed with spines. Eyes are well pigmented. Incisor process of the mandible is provided with teeth throughout the entire length of its cutting edge. Pereopods are not abnormally broad and flattened. Exopods of the third maxilliped and all pereopods are neither foliaceous nor rigid.

Distribution: Southeast and Southwest coast of India

Acanthephyra sanguinea Wood-Mason, 1892

Diagnostic Characters: Rostrum longer than carapace with 7 dorsal and 5 ventral teeth, extending much beyong the tip of the antennal scale. Branchiostegal spine small, forming a small projection on frontal border of carapace and without a carina. Surface of carapace finely pitted as in all the species of the purpurea group. Dorsal carinae of 3rd to 6th abdominal somites ending in pointed spines, that of 3rd somite the longest and of 4th and 5th of equal size and smallest. Four pairs of dorsolateral spines present on the telson.

Distribution: Southeast and Southwest coast of India

List of Deep sea shrimps from Indian waters

	Species	**Common name (English)**	**Distribution**
Family	**Sicyoniidae Ortmann,1898**	Rock shrimps	
	1Genus, 4Species		
	Sicyonia H.Milne Edwards,1830		
	Sicyonia fallax De Man,1907a*		India
	Sicyonia lancifer (Olivier,1811)*	Knight rock shrimp	Southwest &Southeast
	Sicyonia longicauda Rathbun, 1906*		India
	Sicyonia parajaponica Crosnier,2003*		Southwest & Southeast
Family	**Pandalidae Haworth,1825**		
	Heterocarpus A.Milne-Edwards,1881b		
Genus	***Heterocarpus ensifer*** A.Milne		

	Edwards,1881b* ***Heterocarpus gibbosus*** Spence Bate,1888 ***Heterocarpus laevigatus*** Spence Bate,1888* ***Heterocarpus longirostris*** Macgilchrist,1905 ***Heterocarpus tricarinatus*** Alcock &Anderson,1894* ***Heterocarpus woodmasoni*** Alcock,1901 ***Heterocarpus sibogae*** De Man,1917	Armed Nylon shrimp Smooth Nylon shrimp Scarred Nylon shrimp Indian Nylon shrimp Mino Nylon shrimp	Southeast & west coast Southeast & west coast A & N Islands Arabian sea Bay of Bengal Arabian Sea, Lakshadweep Southeast & West coast, Andaman Southeast & West coast, Andaman's
Genus	**Plesionika Bate, 1888** ***Plesionika martia*** (A.Milne-Edwards, 1883) ***Plesionika spinipes*** Spence Bate, 1888	Golden Shrimp Oriental Narwal	East & West coast West &south east coast, India
Family Genus	Aristeidae Wood-mason, 1891 Aristeus Duvernoy, 1840 ***Aristeus alcocki*** Ramadan, 1938	Aristeid shrimps Arabian Red shrimp	Southeast, southwest, lakshadweep sea
Family Genus	**Solenoceridae** Wood-Mason, 1891 **Solenocera** Lucas, 1849 ***Solenocera alfonso*** perez farfante, 1981* ***Solenocera hextii*** Wood-Mason and Alcock, 1891b	Solenocerid shrimps Deepwater Mud shrimp Deepwater Mud shrimp	Off Tuticorin East & West coast
Family Genus	**Penaeidae** Rafinesque, 1815 **Metapenaeopsis** Bouvier, 1905 ***Metapenaeopsis andamanensis*** (Wood-Mason in Wood-Mason & Alcock, 1891a)*	Penaeid Prawns Rice velvet shrimp	Southwest, Southeast & Andamans
Genus	**Parapenaeus** Smith, 1885b ***Parapenaeus investigatoris*** Alcock &	Explorer Rose Shrimp	Southwest, SE & A &

	Anderson, 1899		NIslands
Genus	**Penaeopsis** spence Bate, 1881 ***Penaeopsis jerryi*** Perez Farfante, 1979	Gondwana Shrimp	Southwest,SE &A & N Islands
Family Genus	**Oplophoroidae** Dana, 1852a **Acanthephyra** A. Milne-Edwards, 1881b ***Acanthephyra sanguinea*** Wood-Mason in Wood-mason &Alcock, 1892* ***Acanthephyra armata*** A.Milne-Edwards, 1881		Off kerala, West coast Off kerala, West coast

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Chapter 9

Non-penaeid prawns

V.D. Deshmukh

The non-penaeid prawns constitute a characteristic fishery resource along the northwest coast of India bordering Maharashtra and Gujarat states, which accounts for nearly 90% of their landings in the country. The resource comprises the tiny epiplanktonic shrimps occurring in coastal waters. They are predominantly caught by the bag nets ('*dol* nets') operated in the sea where strong tidal currents enable the bag nets to sustain horizontally and catch them along with other pelagic resources of the region such as Bombay-duck, Golden anchovy and Ribbonfishes.

Major species contributing to the non-penaeid prawn fishery are *Acetes indicus*, *Nematopalaemon tenuipes* and *Exhippolysmata ensirostris*. The epipelagic prawns belonging to the genus *Acetes* are represented by four species namely *A.indicus*, *A. johni*, *A. japonicus* and *A. sibogae* in Maharashtra. *Exopalaemon styliferus*, a species close to *N. tenuipes*, occurs in estuarine waters and forms small percentage of non-penaeid prawns in the inshore. They are distributed all along the Indian coasts but commercially exploited along the northeast and the northwest coasts.

Acetes indicus H.Milne Edwards, 1830
(Jawala Paste Shrimp)

Only one large and curved clasping spine with serrated inner margin on the lower antennular flagellum of adult males; basal segment of antennular peduncle in females about the same length as that of the two distal segments put together; in males the second segment more slender than in females; third segment elongated, much longer than the first; in male third maxilliped reaches a little beyond the tip of 3rd pereiopod, in female, much beyond end of antennular peduncle; a large procurved tooth between the bases of the 1st pleopods in both sexes; each half of petasma with a more or less crescent shaped outer lobe with its antero-external border strongly thickened; telson with sharply pointed apex, reaching well beyond the middle of inner uropod. Outer uropods with a prominent tooth on the external border separating the ciliated and non-ciliated portion.

Acetes johni Nataraj, 1947

Two small clasping spines on the lower antennular flagellum of adult males; serrated margins on distal inner surface of clasping spines less prominent; presence of thumb like projection in the segment preceding the one with the clasping spine; In females the external maxillipeds reach the tip of third antennular peduncle; fourth thoracic sternite acutely pointed at ends with median margin broadly grooved; telson less than half length of inner uropod; tip of telson with two spinules at the corners; red mark on ventral side of last abdominal segment; when fresh eyestalk yellow in colour.

Acetes japonicus Kishinouye, 1905
(Akiami Paste Shrimp)

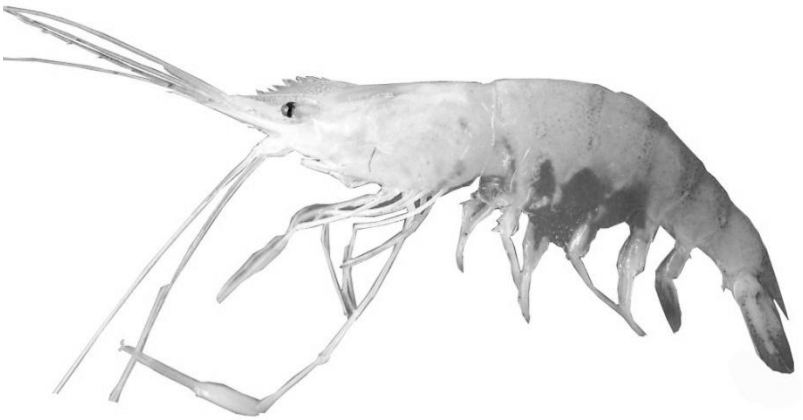
Two small clasping spines on the lower antennular flagellum of adult males; prominent serrated margins on distal inner surface of clasping spines; in females the lower antennular flagellum is 11 to 14 segmented.; in males the lower antennular flagellum is 10 to 12 segmented; distal part of the capitulum of petasma is expanded like a bulb and has numerous hooks; ppendix masculina has 2 hooks; endopod of the uropod has 1 red spot on the proximal part in both females and males.

Nematopalaemon tenuipes (Henderson, 1893)
(Spider Prawn)

Rostrum straight and longer than carapace with an elevated basal crest of 4-7 teeth on the dorsal side; teeth present both in the ventral and dorsal side; branchiostegal spine present but branchiostegal groove absent on the carapace. Second abdominal segment overlaps first and third segments. Only first two pereiopods chelated; 2nd pair of pereiopod longer then 1st pair and

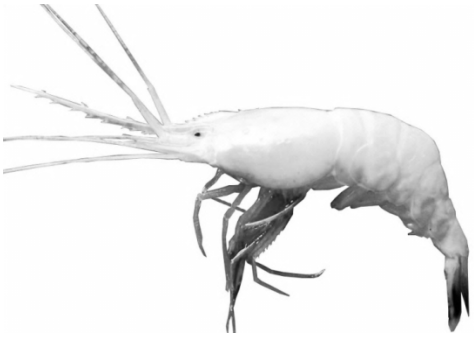
carpus not subdivided; dactyla of the last 3 pair of pereiopod longer than propodus; distal part of rostrum dark reddish brown; a reddish brown spot on bases of uropods.

Exopalaemon styliferus (H. Milne Edwards, 1840)
(Roshna Prawn)



Rostrum with 5-7 teeth on basal crest, 6-10 ventral teeth; antennular peduncle with distolateral spine on basal segment barely over reaching adjacent distal margin of segment; posterior four abdominal somites not sharply carinate in dorsal mid-line; distal part of rostrum dark reddish brown and some darker spots on tips of uropods and telson.

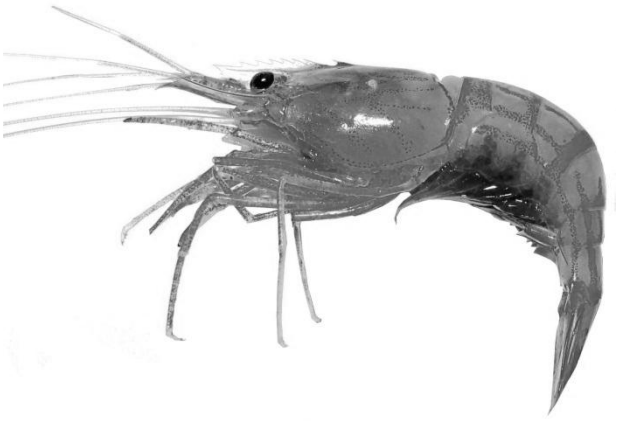
Exhippolysmata ensirostris (Kemp, 1914)
(Hunter Shrimp)



Rostrum straight, longer than carapace with an elevated basal crest of 7-12 teeth on dorsal side; antennal and pterygostomian spines present on carapace; pleura of the 5th abdominal segment sharply pointed; teeth present both in the ventral and dorsal side; 2nd pair of pereiopod with small pincers and carpus subdivided into more than 7 articles; dactyla of the last 3 pair of

pereiopod much shorter than propodus; lateral margin of telson concave; apex of telson sharply pointed without any spines.

Lysmata vittata (Stimpson, 1860)
(Indian Lined Shrimp)



Rostrum shorter than carapace without elevated crest; antennal and pterygostomian spines present on carapace; teeth present both in the ventral and dorsal side; dactyla of the last 3 pair of pereiopod much shorter than propodus; lateral margin of telson convex; apex of telson blunt with a pair of spines.

Key to species of family ***Sergestidae***

1. Procurved spine present between 1st pair of pleopods……2
   No procurved spine between 1st pair of pleopods……3

2(1) Basis of 3rd pereiopod with teeth on inner free margin; petasma without membraneous coupling folds……***Acetes indicus***

Basis of 3rd pereiopod without tooth on inner free margins; petasma with a pair of folded coupling membranes armed with hooks…….....***Acetes erythraeus***

3(1) External antennular flagellum in male with two clasping spines; apex of telson rounded or truncated…… ……4

External antennular flagellum in male with single clasping spine; apex of telson triangular……***Acetes sibogae***

4(3) Segment preceding the one bearing the clasping spines with angular process pointing backwards; apex of telson truncated and with a tooth at each corner…..***Acetes serrulatus***

Segment preceding the one bearing the clasping spines without any process; apex of telson round and third thoracic sternite produced posteriorly as large plate in female……..5

5(4) Ciliated and non ciliated portions of external border of exopod of uropod not separated by a tooth; distal portion of pars externa without tubercles…….. ***Acetes japonicas***

Key to species of family ***Hippolytidae***

1. Dentate crest in midline at base of rostrum. Telson tapering rather regularly to sharp posterior point……***Exhippolysmata***

   Without dentate crest in midline at base of rostrum. Telson not tapering regularly to sharp posterior point…….2

2. Prominent epipods on 4 anterior pairs of pereiopods……***Lysmata***

3. Colour semitransparent with numerous fine red longitudinal lines……***Lysmata vittata***

4. Rostrum armed with 7-16 ventral teeth. Carapace not noticeably uneven or coarsely pitted…… ***Exhippolysmata ensirostris ensirostris***

   Rostrum armed with 17-23 ventral teeth. Carapace with longitudinal furrows on anterior portion of branchiostegite and dorsal to branchiostegite, causing dorsal flattening of posterior 1/3 of carapace and coarse, dense pitting on branchiostegite……***Exhippolysmata ensirostris punctate***

Key to species of family ***Palaemonidae***

Dactylus of last three pereiopods very long and slender, 4th and 5th pair excessively long, flagelliform with dactylus much longer than carapace; pleopods very long; 1st pair much longer than carapace, carpus of 2nd pereiopod much more than half as long as palm; basal crest of rostrum with almost seven teeth…….***Nematopalaemon tenuipes***

Dactylus of last three pereiopods not abnormal in length than 3rd scarcely ½ length of propodus and that of 5th almost 1/3 length of propodus. Pleopods normal in length; one or more subapical dorsal teeth on rostrum. Last four abdominal somites bluntly carinate dorsally……***Exopalaemon styliferus***

Chapter 10

Lobsters

E.V.Radhakrishnan

Lobsters are the most highly priced crustaceans in all parts of the world. They have great demand in the domestic market as a delicacy and is a foreign exchange earner for the country. The estimated total landing of lobsters in 2012-13 is 1546 t. In the monumental work of Holthuis (1991), a detailed account was provided for almost all the living marine lobster species up to 1991. The taxonomy of marine lobsters underwent dramatic changes with the application of newly developed molecular markers in phylogenetic analysis concluding that lobsters are indeed a monophyletic group, if the thalassinideans are excluded.(Tsang *et al*., 2008).

The suborder Macrura Reptantia has four infraorders: Astacidea, Glypheidea, Achelata and Polychelida. Chan (2008) provided a checklist of the currently recognized six families, 55 genera and 248 species (with four subspecies) of living marine lobsters. Although Caroli Linnaeus himself described the first marine lobster in 1758, the discovery rate of marine lobsters remains high to this day (Chan, 2008). Although the catalog of marine lobsters of the world by Holthuis (1991) had encompassed almost all the species known at that time, there have been many new discoveries in the last two decades. Nearly, 11.7% (29 species) of marine lobsters were only described in the last decade (since 2000). Few new records have also been added to the Indian list of marine lobsters due to the expansion of commercial fishing activities to deeper areas.

The synonyms still used in taxonomic literature after 1960 are given. If the original name given for a taxon is different from its current generic allocation and/or usage (or recent usage for synonyms), the original name is provided at the end of the name in square brackets (Chan, 2008). It is important to point out that some species still have unsettled taxonomic and nomenclatural issues.

The taxonomy of known species of lobsters from Indian coast and the two island systems is described here. The current list includes 5 families, 3 subfamilies, 16 genera and 30 species.

Taxonomic status

Phylum : Arthropoda
Subphylum: Crustacea
Class: Malacostraca
Subclass: Eumalacostraca
Superorder: Eucarida
Order: Decapoda
Suborder: Macrura Reptantia

Infraorder: Achelata Scholtz & Richter, 1995
Family: Palinuridae Latreille, 1802 [Palinurini]

Key to Families (after Holthuis, 1991)

Antennal flagellum long and consisting of numerous small articles, whip-like or spear-like. Rostrum absent or visible as a small spine on anterior margin of carapace. Carapace with a pair of frontal horns above the eyes, and usually with spines on the dorsal surface; hairs on carapace, if present, few and scattered …….Palinuridae

Key to genera occurring in the area

Two distinct widely separated tooth-like frontal horns, between which the anterior margin of the carapace is visible; antennal flagella quite flexible; flagella of antennules long, whip-like, longer than peduncle of antennules; antennular plate and stridulating organ present……..*Panulirus*

Frontal horns with a single tooth on anterior margin; pleura of second to fifth abdominal segments ending in two about equally strong teeth, antennular plate and stridulating organ present; carapace strongly ridged……..*Puerulus*

Frontal horns fused to a quadrangular median process, with 2 points placed over bases of eyes; antennal flagella straight, inflexible……..*Linuparus*

Antennular plate narrow, unarmed; Major supraorbital processes terminating in a blunt crenulated margin; two spines on anterior straight margin of carapace between the supraorbital processes; first peduncular joint of antennae extending beyond end of peduncle of antennules……..*Palinustus*

There are 11 genera in this family. *Jasus, Justitia,* ***Linuparus****, Nupalirus, Palibythus, Palinurus,* ***Palinustus****,* ***Panulirus,*** *Projasus,* ***Puerulus****, Sagmariasus* (those in bold letters are represented in India)

Genus ***Panulirus*** White, 1847
George and Main (1967) recognize nineteen species within this genus in tropical and subtropical waters of the Indian, Pacific and Atlantic oceans. Six of these occur along the Indian coast.

Key to species of *Panulirus* recorded off the Indian coast and the Island groups, Andaman Nicobar Islands and the Lakshadweep Islands

1 Abdominal segments 2-5 with transverse grooves ……..2
Abdominal segments 2-5 without transverse grooves or with indistinct grooves in juveniles only …… 4

2 Margin of transverse abdominal grooves with squamae varying from well developed and even in size to minute and irregular in size. Overall colour ranges from brownish-red in specimens with large squamae to olive green in specimens with minute squamae …… ***P. homarus***
Margin of transverse abdominal grooves with no trace of squamae…….3

3 Antennular plate (between the stridulating organs) with 2 pairs (4) of subequal principal spines, fused at their bases. Supraorbital horns rounded in cross-section. Overall colour olive-black……..***P. penicillatus***
Antennular plate with 1 pair (2) of equal principal spines; supraorbital horns flattened bilaterally. Overall colour purplish-red with abdomen covered with conspicuous white spots……***P. longipes***
Antennular plate with 1 pair of equal spines; white band on each abdominal segment. Legs with white spots. Colour Olive green…….. ***P.polyphagus***

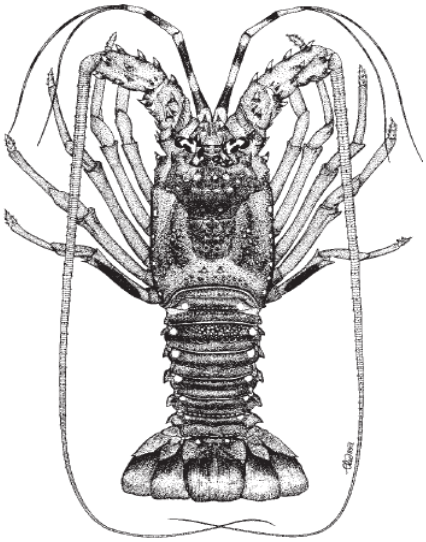
4 Conspicuous transverse white band posteriorly on each abdominal segment. Legs with longitudinal white stripes. Juveniles have whie antennae. Overall colour black and green ……***P. versicolor***
No transverse white band on abdominal segments but above each pleural spur is a conspicuous white spot. Legs with irregular transverse mottling, no longitudinal stripes. Overall colour bluish green……***P. ornatus***

Panulirus homarus (Linnaeus, 1758) [*Cancer homarus*]
Panulirus dasypus (H. Milne Edwards, 1837)[*Palinurus dasypus*]
Panulirus burgeri De Haan, 1841)[*Palinurus burgeri*]
English name: Scalloped spiny lobster

Diagnosis: Carapace without a rostrum; antennae enlarged, cylindrical, longer than body; Anterior margin of carapace with two frontal horns; antennular plate with 4 equal, large well-separated spines, arranged in a square; pleura of second to fifth abdominal segments ending in a strong tooth with denticles on posterior margin. Each abdominal segment with a transverse

groove interrupted in the middle; its anterior margin formed into shallow scallops. Colour dark greenish to blackish with numerous very small white spots; legs with indistinct spots and stripes of white. Specimens with this morphology are called microsculpta form.

There are three subspecies: *Panulirus homarus homarus* (Linnaeus, 1758), *P. homarus rubellus* (Berry, 1974) and *P. homarus megasculpta* (Pesta, 1915) [*Panulirus burgeri megasculpta*]. The subspecies in India is *P. homarus homarus,* which is the microsculpta form and no other subspecies is present along the Indian coast (Jeena, 2013). *P. homarus rubellus* is the southern *megasculpta* form found along the coast of Southeast Africa, Mozambique to Natal and southeast Madagascar. *P. homarus megasculpta* is the northern megasculpta form which is known from the Arabian coast.



Range distribution: The *P. homarus homarus* subspecies has a broad geographic range extending from East Africa to Japan including Indonesia, Australia, New Caledonia and the Marquesas Archipelago (Holthuis, 1991). Northwest, southwest, southeast coast of India, A & N Islands and Lakshadweep Islands.

Habitat and ecology: The species is commonly found in very shallow water (1-15m), although can be found to depths of 90m. It inhabits rocky reefs for shelter (Holthuis, 1991).

Biology: Maximum total length 31 cm, carapace length 12 cm. Average total length 20 to 25 cm. Major fisheries are on the southeast and southwest coast of India. The commercial fishery at Muttom, Kanyakumari district was found *to* be largely supported by 1st and 2nd year animals. At

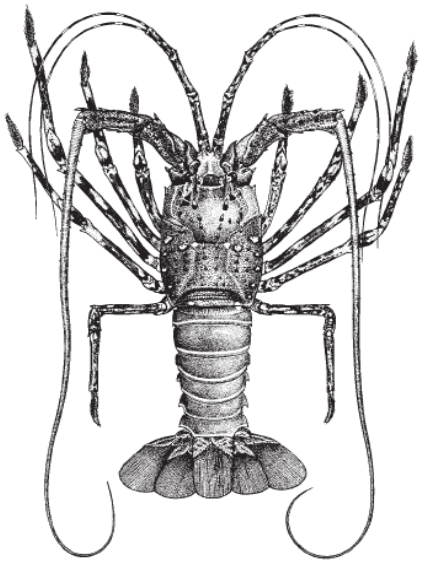
a given carapace length females are heavier than males. Females attain functional maturity at a carapace length (CL) of 55 mm. Males attain maturity at 63 mm CL on the basis of allometric growth of III walking leg. Peak breeding season is from November to December.

Panulirus polyphagus (Herbst, 1793) [*Cancer (Astacus) polyphagus*]
Panulirus fasciatus Fabricius, 1798 [*Palinurus fasciatus*]
Panulirus orientalis Doflein, 1900

Diagnosis: Abdominal somites smooth, without transverse groove. Surface of abdominal somites naked and smooth. Exopod of third maxilliped absent; antennular plate with two strong spines; colour grayish-green, abdominal somites 2 to 5 with transverse white bands along the posterior margin. Legs irregularly spotted.

Range distribution: This species has a broad range from Pakistan and India to Vietnam, the Philippines, Indonesia, northwest Australia and the Gulf of Papua (Holthuis, 1991).

Habitat and ecology: The species is commonly found in coastal waters on muddy and rocky substrates to a depth of 40 m, although it is occasionally seen at 90 m and is often seen near the river mouth (Holthuis, 1991).

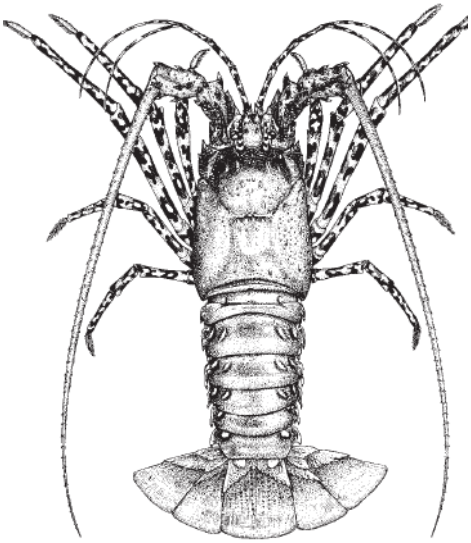


Biology: This species is the most important commercial species contributing to nearly three-fourth of the total lobster catch of the country. Major fisheries are on the northwest coast of India. The size in the fishery ranged from 75 mm to 385 mm total length (TL), those between 160 mm and 230 mm TL forming the mainstay of the fisheries in Maharashtra. Juveniles of both sexes showed identical growth rate and measured 85 mm TL in the first year, 145 mm TL in the

second year and 205 mm TL in the third year. Males demonstrated faster growth rate. Females attained 50% maturity at 175 mm TL. Peak breeding is in September. High exploitation ratio of 0.85 and 0.82 in males and females, respectively has resulted in recruitment overfishing in Mumbai waters (Radhakrishnan *et al*., 2007). Exported in whole-cooked frozen form.

Panulirus ornatus (Fabricius, 1798) [*Palinurus ornatus*]
English name: Ornate spiny lobster

Diagnosis: Abdominal somites smooth and naked; colour of abdomen brownish or greenish-grey with utmost minute indistinct speckles. The usually large eyespot in the anterior half near the base of the pleura is accompanied by an oblique pale streak placed somewhat median of the eyespot. Legs not streaked, but with very sharply defined irregular dark spots of bluish or brownish colour, which often form incomplete rings around the various segments. Antennal flagella distinctly ringed.



Range distribution: Tropical Indo-Pacific. It ranges from Natal in South Africa, along the coast of East Africa and the Red sea to southern Japan, the Solomon Islands, Papua New Guinea, Australia, New Caledonia and Fiji (Holthuis,1991). Forms fishery along the southeast coast of India.

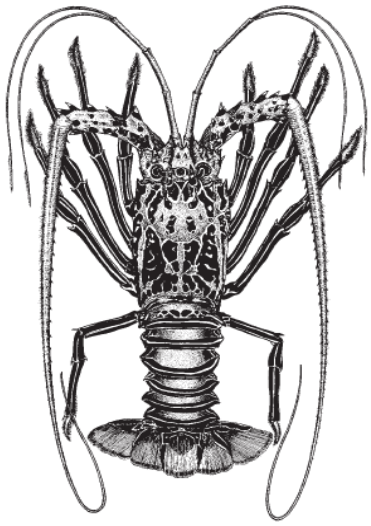
Habitat and ecology: In shallow, sometimes slightly turbid coastal waters; from 1 to 8m depth, with a few records from depths as great as 50m; on sandy and muddy substrates and sometimes

on rocky bottom often near the mouth of the rivers, but also on coral reefs. The species has been reported as solitary or as living in pairs, but has also been found in larger concentrations.

Biology: This is the largest of the *Panulirus* species and can attain a total body length of about 50cm, but usually is much smaller (25-30 cm).Mainly form fishery along the southeast coast of India. *P. ornatus* is caught both by trawlers and gillnets. *P. ornatus* forms major component of the trawler catch. *P. ornatus* appears throughout the year, but highest catch is in May at Tuticorin. The size of lobsters in the fishery ranges from 113 to 233mm TL in males and 128-452 mm TL in females with 41% falling in the size range of 181-190 mm TL, which are juveniles. At Tuticorin the inshore fishery for juvenile *P. ornatus* is detrimental to the stock. Occasionally found along the west coast of Kanyakumari district and form a small fishery at Tikkoti, Calicut. Occurrence of adult and egg bearing population at 40-60 m depth indicates that the species breeds probably at relatively deeper areas. This is a fast growing spiny lobster among the tropical species. Females mature at 90 mm CL. The fecundity in specimens caught along the Chennai coast (104.4mm to 145.1 mm CL) ranges from 5, 18,181 to 19, 79,522 eggs.

Panulirus versicolor (Latreille, 1804) [*Palinurus versicolor*]
English name: Painted spiny lobster

Diagnosis: Antennular plate with 4 strong spines arranged in a quadrangle. Carapace whitish with well-defined, sharply delimited area of bluish black; antennal peduncles pink; antennal flagella white; abdominal somites 2 to 5 with white transverse bands; legs with streaks of white lines.



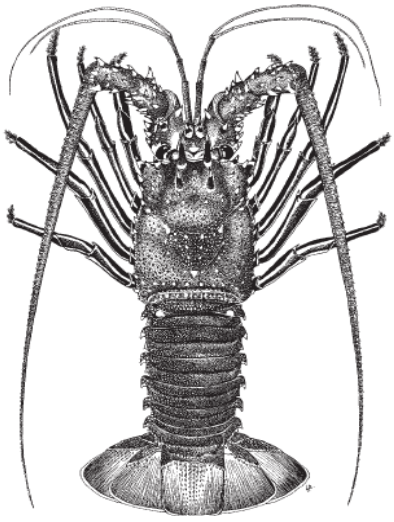
Range distribution: This species is known throughout the Indian ocean (east coast of Africa and the Red sea) east to Japan, Micronesia, Melanesia, Polynesia and northern Australia (Holthuis, 1991). Along the Indian coast the species has been reported from southeast, southwest, A&N Islands and Lakshadweep.

Habitat and ecology: This species is found in areas of coral reef, most often on the seaward edge of the reef plateau, where it utilizes the reef and rocks for shelter. It is found in shallow waters to a maximum depth of 15m (Holthuis, 1991). Furthermore, they are nocturnal and they only aggregate in very small numbers.

Biology: Fishery of lower magnitude reported along the Chennai, Mandapam and Trivandrum coasts. In A&N Islands, *P. versicolor* formed 26% of total landings (0.12 t) in 1999-2000 (Kumar *et al*., 2010). The fecundity of *P. versicolor* (66.0 to 95.0mm CL) from Chennai coast was estimated to range from 1, 70,212 to 7, 33,752.

Panulirus penicillatus (Olivier, 1791) [*Astacus penicillatus*]
English name: Pronghorn spiny lobster

Diagnosis: Body greenish or reddish, ranging from yellowish-green through brown-green to blue-black. Antennular plate with 4 strong spines which are fused at the base forming a single bunch of 4 diverging points, the anterior pair shorter than the posterior. Transverse grooves over the abdomen uninterrupted.



Range distribution: This species has the widest distribution of any of the spiny lobsters. It occurs in the Indo-west Pacific and East Pacific regions (Holthuis, 1991), South from the Red sea to South and East Africa; Madagascar and surrounding islands, through the Indian Ocean and

South China sea to Japan, the Philippines, Indonesia, Hawaii, Samoa, northern and eastern Australia and as far as east as the Islands of north west coast of US and Mexico. Along the Indian coast, the species is distributed along the southeast and south west coast, Lakshadweep as well as in A&N Islands.

Habitat and ecology: This nocturnal species commonly inhabits depths of 1 to 4m (maximum16m), on rocky substrates (Chan, 1988). It is often found in the outer reef slopes, subtidal zone or surge channels, and as such can occur on small islands or near arid coasts (Holthuis, 1991). In the Western Pacific, females seem to be reproductive all year round (Chan, 1998).

Biology: Little information is available on the biology of the species as there is only occasional capture of the species from Indian coast. The species has been successfully cultured in the laboratory (Nelson *et al*., 2006). There is little demand for the species in the live lobster export market.

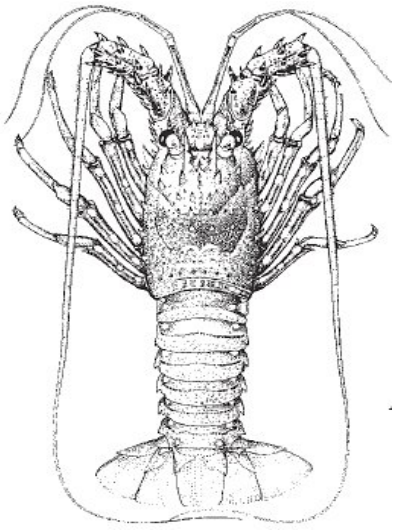
Panulirus longipes (A. Milne Edwards, 1868) [*Palinurus longipes*]

English name: Longlegged spiny lobster

This species is comprised of two subspecies *Panulirus longipes longipes* (A.Milne Edwards, 1868) and *P. longipes bispinosus* Borradaile, 1899. The species found along the Indian coast is *P. longipes longipes.*

P. longipes longipes *(*A. Milne Edwards, 1868*)*

Diagnosis: Body or especially the abdomen covered with numerous distinct round spots; legs with light longitudinal streaks; abdomen dark purple. No pubescent area on the abdominal somites behind the transverse groove; exopod of third maxilliped present.



Range distribution: Indo-west pacific; East Africa to Thailand, Taiwan, the Philippines, Indonesia and India. Along the Indian coast the species was reported from the southeast and south west coast and the A&N Islands.

Habitat and ecology: The species lives in clear or slightly turbid water at depths of 1-18 m (also reported from 122 m), in rocky area and coral reefs. The animals are nocturnal and not gregarious (Holthuis, 1991).

Biology: As this is not a commercial species and occasionally landed as single specimens, not much information is available on the biology of the species from Indian waters. Maximum total body length 30 cm, average length 20 to 25 cm. The smallest ovigerous female has a total length of 14 cm.

Genus ***Puerulus*** Ortmann, 1897

Four species have been recognized so far in this genus, all deepwater forms. *P.sewelli* forms a commercially important fishery along the south west and southeast coast of India.

Key to species (after Berry, 1969)

1.Two teeth between frontal horns and the cervical groove

1a. Median keel of carapace with 5 post-cervical and 2 or 3 intestinal teeth. Fifth pereiopod of male not chelate……*P. sewelli*

Puerulus sewelli Ramadan,1938

Diagnosis: Median keel of carapace with 5 post-cervical and 2 or 3 intestinal teeth. Fifth pereiopod of male not chelate.

Range distribution: Western Indian Ocean; Somalia, Gulf of Eden, off Pakistan, southwest (Quilon Bank, Mangalore) and southeast (off Mandapam and Tuticorin, Gulf of Mannar) of India, and A&N Islands.

Habitat and ecology: Known from depths between 180 and 300 m on a substrate of coarse sand hard mud and shells (Holthuis, 1991).

Biology: Maximum total body length 20 cm, maximum carapace length about 8 cm. Average total length about 15 cm. The species was commercially exploited along the southwest and southeast coast of India. A catch rate of 200-300 Kg/hr was reported from vessels operating off Mandapam. January to April is the peak period of abundance. During 1998-2000, 524 t were

landed at Sakthikulangara, Kollam, Kerala. The sizes of *P. sewelli* ranged from 76-80 mm to 176-180mm TL in males and from 81-85mm to 176-180 mm in females. 26% of females were found in mature/berried stage. Due to coincidence of peak breeding and the fishery, the breeding population has been heavily exploited. The species has been overexploited and the current landing is around 2 tonnes/annum from Quilon bank.

Genus ***Linuparus*** White, 1847

The genus *Linuparus* has three recent species and only one species is present in Indian waters.

Key to recent species

Submarginal posterior groove of carapace much wider medially than laterally; vestigial pleopods present on first abdominal segment of female…. *Linuparus somniosus*

Linuparus somniosus Berry and George, 1972

English Name: African spear lobster

Diagnosis: Submarginal posterior groove of carapace much wider medially than laterally; vestigial pleopods present on first abdominal segment of female.

Range distribution: Off the East coast of Africa from Kenya to Natal, South Africa, A& N Islands

Habitat and ecology: Depth range from 216 to 375 on rough substrate and mud.

Biology: Maximum total body length about 35 cm, carapace length 14 cm; average carapace length about 10 cm. For more information on the species from A&N Islands refer Ali *et al.,* 1991.

Genus ***Palinustus*** A. Milne Edwards, 1880

This genus is characterized by the shape of the frontal horns, that do not end in a sharp point but in a broad, bluntly truncated to that sometimes is crenulated; s strong spine is present on the outer margin of each horn.

Key to species

No median spine on anterior margin of carapace. Epistome with tubercles or spinules an anteromedian margin; anterolateral corner with a small spine or unarmed.

Anterior margin of carapace as well as inner margin of the frontal horns with several distinct spines; Shallow water form, 0 to 180 mm. Indo west Pacific region (India, Thailand, Philippines, Japan)…….*Palinustus waguiensis*

Palinustus waguiensis Kubo, 1963

English name: Japanese Blunthorn lobster

Diagnosis: Anterior margin of carapace as well as inner margin of the frontal horns with several distinct spines.

Range distribution: Holthuis (1991) opined that the species *P. mossambicus* described by George (1965) is believed to be *P. waguiensis*. The occurrence along the Indian coast was first reported from southwest coast. However, deep sea trawling along the southeast coast of India landed small quantities of the species at Chennai and bottom-set-gillnet at Cuddalore. Few numbers have also been reported from bottom-set-gillnets operated at 5-10 m along the Chennai coast.

Habitat and ecology: Reported from shallow waters in Japan and India. The species has also been caught from depths of 72 and 84 m in India and Philippines (Holthuis, 1991).

Biology: Total body length 5 to 10 cm. At Chennai, specimens from bottom-set-gillnets measured 48-70 mm CL.

Family : Scyllaridae Latreille, 1825

Key to identification of the family

Antennal flagellum reduced to a single, flat plate which forms the sixth and final segment of the antenna. The shovel-like appearance of the antennae is responsible for the name shovel-nosed lobster for the animals of this group……..**Scyllaridae**

The family scyllaridae includes 19 genera which are distributed in 4 subfamilies, Arctidinae Holthuis, 1985, Ibacinae Holthuis, 1985, Scyllarinae Latreille, 1825 and Theninae Holthuis, 1985 (Chan, 2010). A single species coming under the subfamily Theninae alone is of commercial importance along the Indian context. The subfamily Arctidinae contains two genera Arctides Holthuis, 1960 and Scyllarides Gill, 1898. Two species under the genus Scyllarides have been reported from Indian coast.

Subfamily **Arctidinae** Holthuis, 1985

Genus ***Scyllarides*** Gill, 1898

First abdominal somite without a transverse groove dorsally; carapace with postorbital spine. Abdominal somites with a distinct sculpturation on either side of the median line. 14 species have been so far reported from this genus.

Scyllarides elisabethae (Ortmann, 1894) [*Scyllarus elisabethae*]
English name: Cape Slipper lobster
Diagnosis: Lateral margin of carapace with distinct cervical and postcervical incisions. Anterior margin of the carapace between the eye and the antero-lateral angle evenly concave.
Range distribution: Indo-west Pacific region; Known from southeast Africa and Vizhinjam, Southwest coast of India.
Habitat and ecology: Depth range from 37 to 380m (mostly less than 100 m) on substrate of fine sediments mud or fine sand. The animals seem to dig into the mud.
Biology: A single female specimen measuring 120 mm CL, 330 mm TL and weight 740 g was caught off Vizhinjam coast from a depth of 50 m by trammel net.

Scyllarides tridacnophaga Holthuis, 1967
English name: Clamkiller slipper lobster
Diagnosis: Cervical groove narrow and shallow in its median area; the cardiac knob thereby little pronounced. Pregastric tooth distinctly two-topped. Median ridges on second to fourth abdominal somite sharp and distinctly set off from the rest of the surface. Central spot on first abdominal somite sharply defined, as distinct as the laterals.
Range distribution: Indo-west pacific region. Red sea, East Africa (Somalia, Kenya), Gulf of Aden, Pakistan, west coast of Thailand, south
Habitat and ecology: Depth range from 5 to 112 m; the species has been observed to open *Tridacna* shells.
Biology: Total body length upto 30 cm; carapace lengths reported vary between 6 and 12 cm.

Genus ***Parribacus*** Dana, 1852
Dorsal surface of the body coarsely squamose-tuberculate, without postrostral or branchial carinae. Distance between the orbits more than twice as long as the distance between each orbit and the anterolateral angle of the carapace. Fifth abdominal somite without posteromedian spine. Mandibular palp two-segmented.
The genus contains 6 species. One species occur in Indian waters.

Parribacus antarcticus (Lund, 1793) [*Scyllarus antarcticus*]
English name: Sculptured mitten lobster

Diagnosis: The transverse groove which separates the anterior from the posterior part of the abdominal somites and which in the fully stretched animal forms the anteriormost part of the visible portion of the somites is wide and naked bearing at most a few hairs and tubercles in the median area. The anterior part of the second to third abdominal somites, situated before the just-mentioned groove, bears distinct tubercles. The median carinae of the second and third abdominal somites are elevated. The lateral margin of the fourth segment of the antenna as a rule bears six teeth. The two lateral teeth before the cervical incision are of almost equal size.

Range distribution: Indo-west pacific region. Along the Indian coast recorded from Minicoy and Gulf of Mannar.

Habitat and ecology: taken at depths from 0 to 20 m. in coral or stone reefs with a sandy bottom. The species is nocturnal and in the daytime hides in crevices, sometimes in small groups.

Biology: There is no commercial fishery. Carapace lengths between 2 and 9 cm; maximum total length 20 cm. Tastes very good. It is sold as fresh or cooked.

Subfamily: **Scyllarinae** Latreille, 1825
There are 14 genera under this subfamily. More than 40 species are known. Most species are small and of no economic value. The family is represented by 5 genera in India.

Genus ***Biarctus*** Holthuis, 2002
Two species are reported from India. Earlier they were included in the genus *Scyllarus*.

B. sordidus (Stimpson, 1860) [*Arctus sordidus*]
Range distribution: Indo-Pacific; along the Indian coast reported from west coast.

Scyllarus tutiensis Srikrishnadhas, Rahman and Anandasekaran, 1991
The species name has been retained as such as its taxonomic identity is yet to be finalised.

Range distribution: Southeast coast of India (Tuticorin)

Genus ***Bathyarctus*** Holthuis, 2002
One species is known from Indian coast

B. rubens (Alcock and Anderson, 1894) [*Arctus rubens*]

Scyllarus rubens (Alcock and Anderson, 1894)[different generic combination]
Range distribution: West coast of India
Genus ***Petrarctus*** Holthuis, 2002

P. rugosus (H. Milne Edwards, 1837) [*Scyllarus rugosus*]
English name: Hunchback locust lobster
Range distribution: Indo-west pacific; reported from southeast coast of India (Chennai, Pondicherry)
Diagnosis: The carapace has the median teeth before the cervical groove blunt and inconspicuous; the rostral tooth is reduced to a tubercle; the gastric tooth is most conspicuous. The surface of the carapace is quite uneven and the tubercles are high. The abdomen shows a distinct median longitudinal carina on somites 2 b to 5, that of somite 3 is the highest; in each somite there is a wide transverse groove. The dorsal surface of the body is grayish or purplish brown with darker spots. The first abdominal somite shows dorsally often a dark blue colour.
Habitat and ecology: inhabits depths from 20 to 60 m.
Biology: Total body length reported is 2.5 to 6 cm.

Genus ***Eduarctus*** Holthuis, 2002

E. martensii (Pfeffer, 1881) [*Scyllarus martensii*]
English name: Striated locust lobster
Diagnosis: Carapace with two distinct teeth in the median line before the cervical groove, the rostral tooth is absent and replaced by an inconspicuous tubercle. The region between the postrostral and branchial carinae shows many tubercles; the abdomen has a conspicuously elevated longitudinal median carina on somites 2 to 5, that of somite 2 shows as an inverted v-shaped ridge when looked at dorsally; somite 1 shows a complete transverse groove behind which there are about 16 straight, parallel longitudinal unbranched grooves, which are quite characteristic for the species. The body is yellowish or reddish brown. A darker brown transverse band may be present on the third abdominal somite.
Range distribution: Indo-west Pacific; West and southeast coast of India
Habitat and ecology: The species has been found in depths between 6and 79m, mostly between 10 and 50 m. The substrate that it inhabits is smooth, sometimes with shells. The total body length is 2 to 4 cm.

Genus ***Scammarctus*** Holthuis, 2002

S. batei batei (Holthuis, 1946) [*Scyllarus batei*]
English name: Soft locust lobster

Diagnosis: Carapace with 2 distinct teeth in the median line before the cervical groove; the rostral tooth is absent. Abdomen with a distinct sharp median carina on somites 1 to 5. Somite 1 with the transverse groove interrupted in the middle by the median carina; The fourth segment of the antenna has a single, distinct oblique median carina; no median tubercles on the sternites; dactyl of legs 3 to 5 with dorsal fringes of hair; body pale brown with the ridges and tubercles pale purple or reddish; first abdominal somite brick red in the anteromedian area.

Range distribution: Indo-west pacific; southwest and southeast coast of India. Depth range from 160 to 484 m on sandy and muddy substrates

Biology: Maximum body length about 7 cm.

Subfamily: **Theninae** Holthuis, 1985

This monotypic family was recently revised by Burton and Davie (2007). There is only one genus *Thenus* in the subfamily. Five species has been identified using both morphology and molecular methods. The species so far described as *Thenus orientalis* from most part of Indian coast is *T. unimaculatus* (Radhakrishnan *et al.,* 2013*)*. *T. indicus* is also presumed to exist along the southeast coast of India (Jeena, 2013).

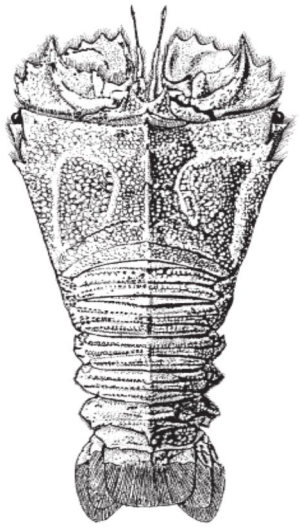
Genus: ***Thenus*** Leach, 1816

Diagnosis: Orbits on the anterolateral angle of the carapace. Body strongly depressed. Lateral margin of the carapace with only the cervical incision. No teeth on the lateral margin of the carapace, apart from the antero-lateral and postcervical. Fifth leg of female without a chela.

Thenus unimaculatus Burton & Davie, 2007
English name: Slipper lobster/Sand lobster

Diagnosis: Purple to black pigmentation blotch on inner surface of merus of second and sometimes third legs, usually large but variable in extent and may be reduced to a narrow streak; purple pigmentation occasionally surrounding eye socket on carapace; outer phase of propodus of P2 having upper-most longitudinal groove bearing obvious setae over atleast proximal half. Merus of third maxilliped with a small spine proximally on inner ventral margin; inner margin of ischium prominently dentate along the entire length. No single morphometric ratios that fall outside the following maximum and minimum values; carapace width (CM1) greater than 1.29

times carapace length (CL); length of propodus of pereiopod 1 (PL1) less than 0.23 times carapace length (CL); length of propodus of pereiopod 2 (PL2) greater than 0.39 times carapace length (CL); width of propodus of pereiopod 1 (PW1) greater than 0.35 times length (PL1).



Range distribution: Indo-west Pacific region. In India, the species is distributed along the northwest, southwest, southeast and the northeast coasts. Forms commercial fishery in Saurashtra region, Kollam and Chennai.

Habitat and ecology: Depth range from 8 to 70 m, usually between 10 and 50 m; on soft substrate, sand or mud.

Biology: Maximum total body length about 25 cm; often appears as bycatch in trawls; also caught in gillnets. At Kollam, Kerala peak fishery was observed from November to February. Total length varied between 61-230 mm in males and 46-250 mm in females. Length at recruitment (Lr) was 48mm. Absolute fecundity varied from 14750 to 33250 mature eggs (Radhakrishnan *et al*., 2013).

T. indicus Leach, 1816

Diagnosis: No spots on the pereiopods and telson; pereiopods slender; dorsal profile slightly concave; rostral processes sharp and directed anteriorly and upward; second anetennal segment has five teeth; third maxiliped with a spine on the merus and dentition on ischium; morphometric ratio ML3/CL -> 0.45; MW1/CL- < 0.07.

Range distribution: Indian Ocean; east coast of India

Habitat and ecology: Inhabitant of relatively shallow, inshore waters with muddy sediment; most abundant between 10 and 30 m.

Infraorder : Polychelida Scholtz & Richter,1995
Family: Polychelidae Wood-Mason, 1875
There are six genera under this family. No commercially important species. The family is represented by two species in India.

Genus ***Stereomastis*** Bate, 1888
Stereomastis phosphorus (Alcock, 1894) [*Pentacheles phosphorus*]
Polycheles phosphorus (Alcock, 1894) under different generic combination
Range distribution: Bay of Bengal, India

S. nana (Smith, 1884) [*Pentacheles nanus*]
Polycheles nanus (Smith, 1884) [different generic combination]
Polycheles anadamanensis (Alcock, 1894) [*Pentacheles andamanensis*]
Stereomastis andamanensis (Alcock, 1894) [*Pentacheles andamanensis*]
Stereomasts grimaldii (Bouvier, 1905) [*Polycheles grimaldii*]
Range distribution: A& N Islands

Infraorder :Astacidea Latreille, 1802
Superfamily: Enoplometopoidea Saint Laurent, 1988
Family: Enoplometopidae Saint Laurent, 1988
Genus: ***Enoplometopus*** A. Milne Edwards, 1862
There are twelve species; two species known from Indian coast

E. occidentalis (Randall, 1840) [*Nephrops occidentalis*]
English name: Hawaiian Reef lobster
Range distribution: Hawaii. Mandapam, Gulf of Mannar, southeast coast of India (Radhakrishnan and Jayasankar- in press)

E. macrodontus Chan & Ng, 2008
Range distribution: Philippines, Ponnani (South west coast of India) (Radhakrishnan *et al*., 2012)
Superfamily: Nephropoidea Dana, 1852
Family: Nephropidae Dana, 1851 [Nephropinae]
There are 14 genera under this family. This family is represented by two genera along the Indian coast.

Genus ***Acanthacaris*** Bate, 1888
Only one species is known from Indian waters.
A. tenuimana Bate, 1888

English name: Prickly deep sea lobster

Diagnosis: A rather large lobster. Body cylindrical, completely covered with small spines and sharp tubercles; carapace with a well developed median rostrum which is laterally compressed with dorsal and ventral, but no lateral teeth. Eyes very small, lacking pigment; antennae long and whip-like; antennal scales well developed. Tail powerful, with a well developed tail fan. First three pairs of pereiopods ending in true chelae. The first pair equal, very slender, longer than the body, covered with sharp spinules and ending in elongate and slender fingers with long teeth on cutting edges, but without hairs. Fingers of first cheliped 1.5 to twice as long as palm. Second pair of pereiopods very much longer and less spiny than third pair.

Range distribution: Lakshadweep islands, India

Genus ***Nephropsis*** Wood-Mason, 1871

Five species reported from Indian waters.

N. carpenteri Wood- Mason, 1885

English name: Ridgeback lobsterette

Range distribution: Bay of Bengal

N. stewarti Wood-Mason, 1872

English name: Indian Ocean lobsterette

Range distribution: Indo-West Pacific from Eastern Africa to Japan, the Philippines, Indonesia and Northwestern Australia from 170 to 1,060 m depth (Chan, 1998). Southwest coast (Mangalore, Cochin), southeast coast of India (Chennai), A& N Islands (Ross Island)

Habitat and ecology: Depth 250-500 m; Forms small scale fishery at Mangalore. During 2000-2006, the average annual landing of the species was estimated at 23.3 t with the highest landing in 2001 (51 t) and the lowest in 2005 (9 t).

Biology: Fishery was constituted by the length range 58-158 mm. Females < 80 mm (total length) were found to be immature. Highest percentage (33% of immature females was found during November.

N. sulcata MacPherson, 1990

English name: Grooved lobsterette

Range distribution: Indo-Pacific; Southwest coast of India

N. ensirostris Alcock, 1901

English name: Gladiator lobsterette

Range distribution: North of Lakshadweep, Arabian sea

N. suhmi Bate,1888

English name: Red & White lobsterette

Range distribution: Aru Islands, Indonesia, West coast of India

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Chapter 11

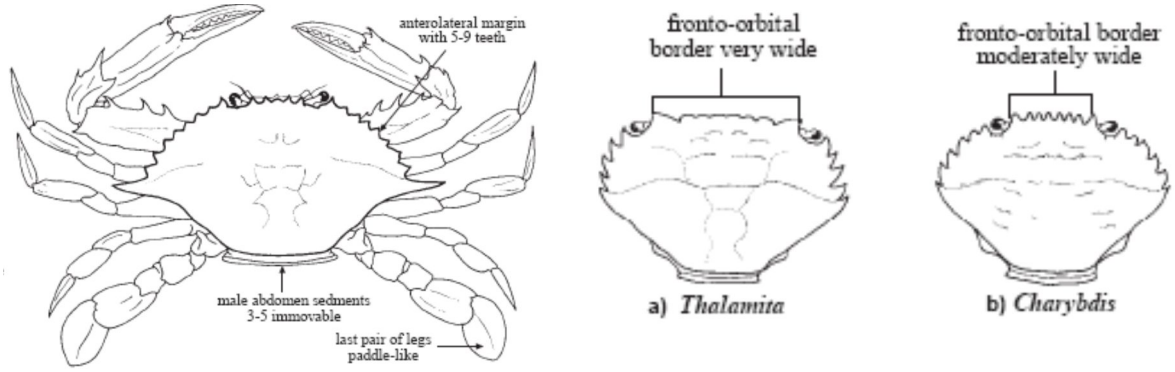
Brachyuran Crabs

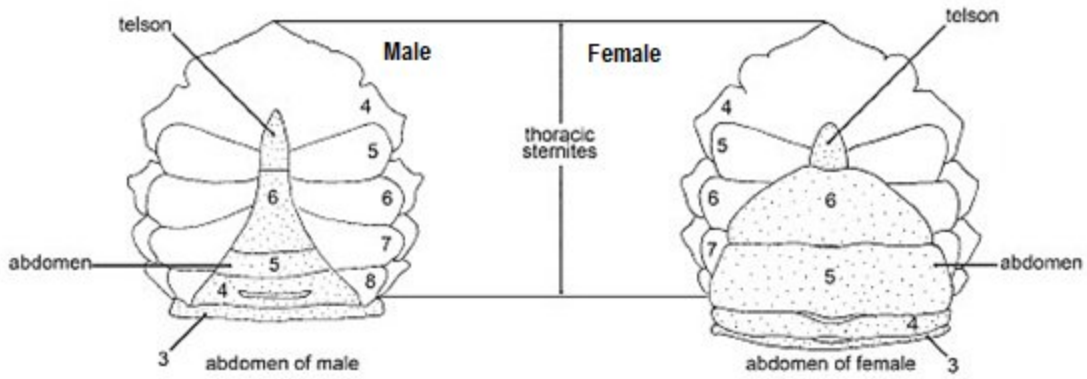
Josileen Jose

Most of the edible crabs caught from marine and brackish water environments belong to the family Portunidae. In the Indian Ocean, the crab fauna of Portunidae family is included under sub families, Podophthalmidae (Borradaile), Catoptrinae (Sakai), Portuninae (Rafinesque), Caphyrinae (Alcock), Carcininae (Macleay) and Polybiinae (Ortmann). Most of the edible crabs caught from marine and brackishwater environments belong to the sub family Portuninae. 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 contribute to the commercial crab fishery Commercially important species are *Scylla* spp. (Mud crabs), *Portunus pelagicus (blue swimmer crab)*, *P. sanguinolentus (three spotted crab), Charybdis feriatus (crucifix crab), C. lucifera* (Yellowish brown crab), *C.natator* (line crab) and *Podophthalmus vigil* (long eye-stalk crab; sub fly., Podophthalmidae).

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.





thoracic sternum and abdomen (ventral view)

Shape of abdomen in male and female (different stages) **crabs**

Key to species of interest to fisheries occurring in the area

1a. Carapace with 2 anterolateral teeth; eyes very long, reaching lateral edge of carapace (Fig. 1) . . . . . ***Podophthalmus vigil***

1b. Carapace with more than 2 anterolateral teeth; eyes normal in size . . . . . □***2***

2a. Carapace rounded; ventral surface of palm with stridulatory (sound-producing) ridges (Fig. 2a) . . . . . ***Ovalipes punctatus***

2b. Carapace transversely ovate; palm without any stridulatory (sound-producing) ridges (Fig. 2b) ***3***

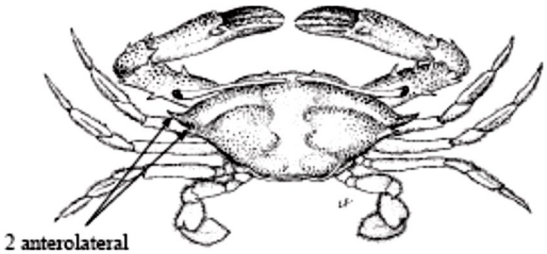


Fig. 1 *Podophthalmus vigil*

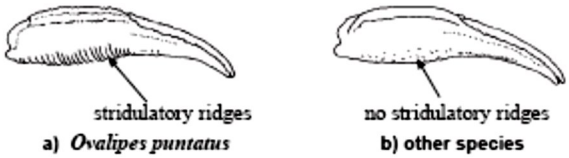


Fig. 2 chela in ventral view

3a. Five to 7 teeth on each anterolateral margin (Fig. 3a-c) . . . . . □ ***4***
3b. Nine teeth on each anterolateral margin (Fig. 3d) . . . . . □ ***12***

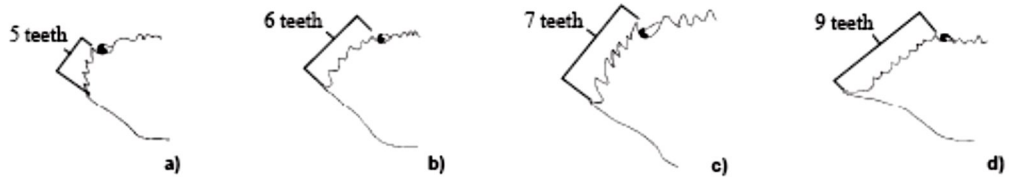


Fig. 3 lateral margin of carapace (dorsal view)

4a. Width of frontal-orbital border not much less than greatest width of carapace; 5 teeth on each anterolateral margin (first tooth sometimes with accessory denticle) (Fig. 4a) . . . . . □ ***5***
4b. Width of frontal-orbital border distinctly less than greatest width of carapace; 6 or 7 teeth on each anterolateral margin (Fig. 4b) ***6***

5a. Basal antennal segment with a smooth or granulated ridge (Fig. 5a) . . . . . ***Thalamita crenata***
5b. Basal antennal segment with several sharp spines (Fig. 5b) . . . . . ***Thalamita spinimana***

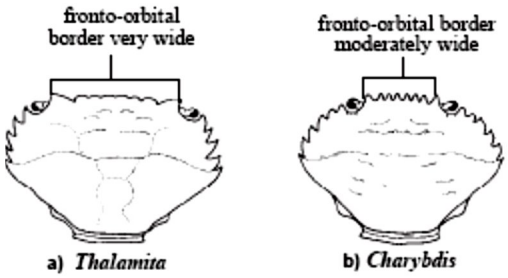


Fig. 4 carapace (dorsal view)

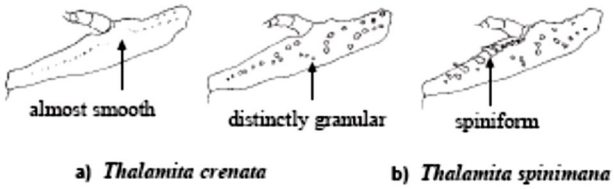


Fig. 5 basal antennal segment

6a. Posterior border of carapace forming an angular junction with posterolateral border (Fig. 6a); merus of cheliped without distal spine on posterior border . . . . . ***Charybdis truncate***
6b. Posterior border of carapace forming a curve with posterolateral border (Fig. 6b);merus of cheliped with distal spine on posterior border *7*

7a. Carapace with distinct ridges or granular patches behind level of last pair of anterolateral teeth (Fig. 7a) . . . . . ***Charybdis natator***
7b. Carapace without distinct ridges or granular patches behind level of last pair of anterolateral teeth (Fig. 7b) ***8***

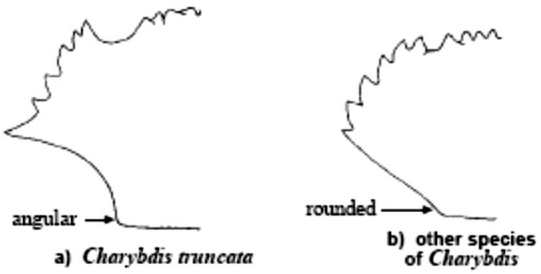


Fig. 6 left side of carapace (dorsal view)

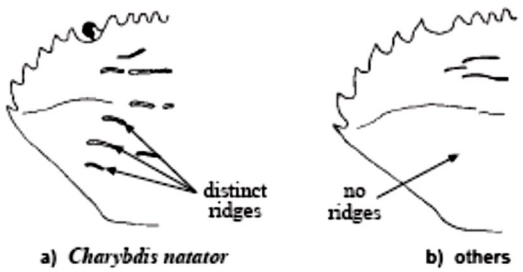


Fig. 7 left side of carapace (dorsal view)

8a. Merus of cheliped with 2 spines on anterior border; palm with 2 spines on upper surface (Fig. 8a) . . . . . ***Charybdis anisodon***
8b. Merus of cheliped with 3 or 4 spines on anterior border; palm with more than 2 spines on upper surface (Fig. 8b) ***9***

9a. First anterolateral tooth not truncate or notched (Fig. 9a) . . . . . ***Charybdis annulata***
9b. First anterolateral tooth truncate or notched (Fig. 9b) ***10***

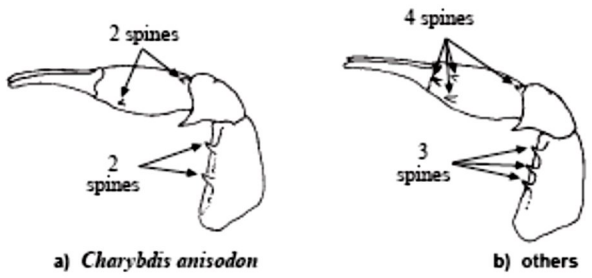


Fig. 8 right cheliped (dorsal view)

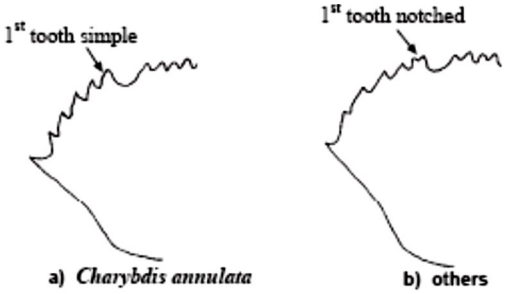


Fig. 9 lateral margin of carapace (dorsal view)

10a. Palm of cheliped with 4 spines on upper surface (Fig. 10a); male abdominal segment 4 keeled (Fig. 11a) . . . . . ***Charybdis feriatus***
10b. Palm of cheliped with 5 spines on upper surface (Fig. 10b); male abdominal segment 4 not keeled (Fig. 11b) ***11***

Fig. 10 right cheliped (dorsal view)

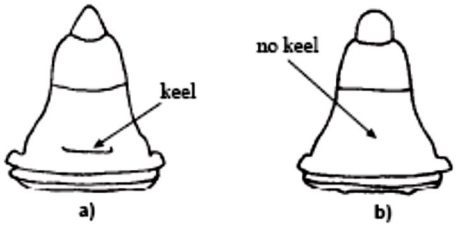


Fig. 11 male abdomen

11a. Palm with well-developed spines (Fig. 12a); male abdominal segment 6 with convex lateral borders (Fig. 13a); last anterolateral tooth smallest and spiniform, not projecting beyond preceding tooth (Fig. 14a) . . . . . ***Charybdis japonica***
11b. Palm with poorly developed spines (Fig. 12b); male abdominal segment 6 with lateral borders parallel in proximal half (Fig. 13b); last anterolateral tooth elongate, projecting laterally beyond preceding tooth (Fig. 14b) . . . . . ***Charybdis affinis***

12a. Last anterolateral tooth subequal in size to others (Fig. 15a) . . . . . □ ***13***
12b. Last anterolateral tooth at least 2 times larger than others (Fig. 15b) ***16***

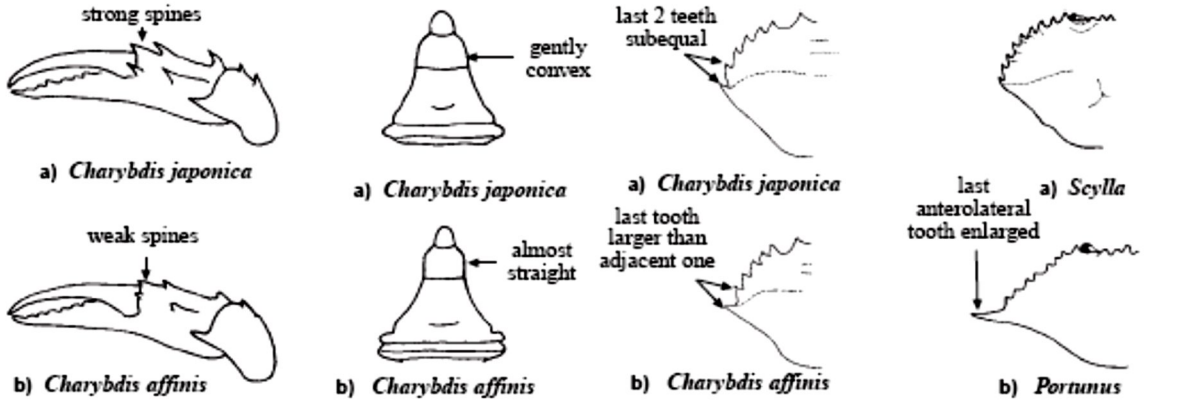


Fig. 12 right cheliped **Fig. 13 male abdomen** **Fig. 14 anterolateral teeth** **Fig. 15 anterolateral teeth**

13a. Carpus of cheliped with only 1 low to very low granule on outer surface, never spiniform (Fig. 16a); colour of palm usually with at least some patches of orange or yellow in life ***14***
13b. Carpus of cheliped with 2 distinct spiniform or sharp granules or spines on outer surface (Fig. 16b); colour of palm in life green to purple ***15***

14a. Frontal margin usually with sharp teeth (Fig. 17a); palm usually with distinct, sharp spines (Fig. 18a) . . . . . ***Scylla paramamosain***
14b. Frontal margin usually with rounded teeth (Fig. 17b); palm usually with reduced, blunt spines (Fig. 18b) . . . . . ***Scylla olivacea***

15a. Frontal margin usually with rounded teeth (Fig. 19a); sharp granules on palm and carpus never spiniform; colour in life: carapace usually very dark green to black, outer surface of palm purple and never with marbled pattern, last legs marbled only in males . . . . . ***Scylla tranquebarica***
15b. Frontal margin usually with sharp teeth (Fig. 19b); sharp granules on palm and carpus often spiniform; colour in life: carapace usually green to olive-green, outer surface of palm green and often with marbled pattern, last legs marbled both in males and females . . . . . ***Scylla serrata***

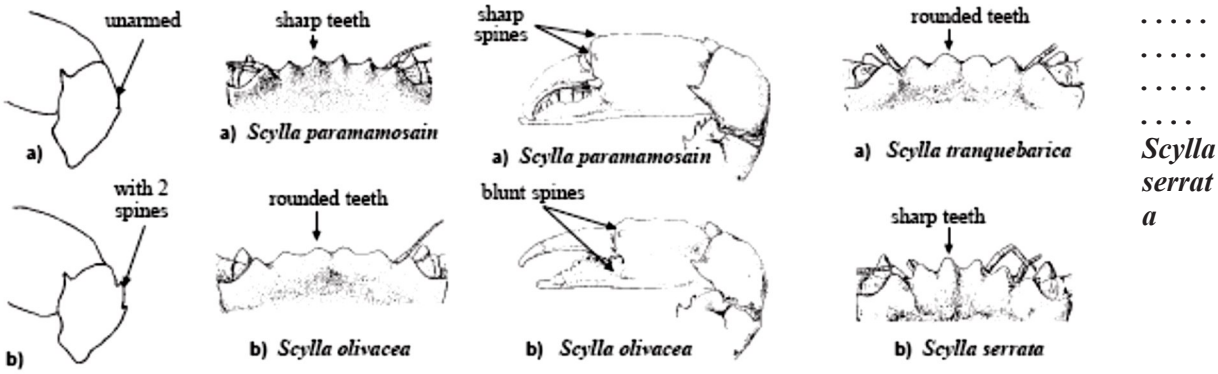
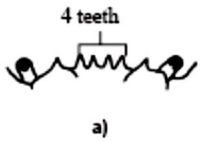


Fig. 16 carpus of cheliped **Fig. 17 frontal margin of carapace (dorsal view)** **Fig. 18 right cheliped** **Fig. 19 frontal margin of carapace (dorsal view)**

16a. Carapace with 3 purple to red spots on posterior half. . . ***Portunus sanguinolentus***
16b. Carapace marbled or with uniform coloration *17

17a. Front with 4 teeth (Fig. 21a); inner margin of merus of cheliped with 3 spines (Fig. 22a)
. . . . . ***Portunus pelagicus***
17b. Front with 3 teeth (Fig. 21b); inner margin of merus of cheliped with 4 spines (Fig. 22b)
. . . .***Portunus trituberculatus***



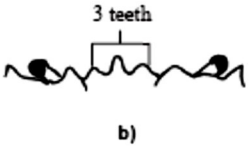
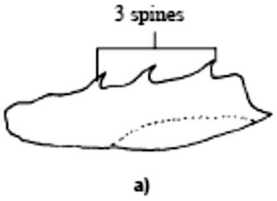


Fig. 21 frontal margin of carapace (dorsal view)



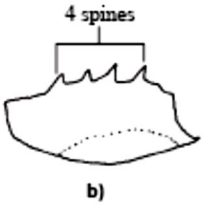


Fig. 22 merus of cheliped (inner margin)

Key – P.K.L.Ng .1998. FAO species identification guide for fishery purposes – Crabs –Portunidae .

Portunus pelagicus (Linnaeus, 1758) (Flower 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.
Colour: males with blue markings, females dull green/greenish brown.

Portunus sanguinolentus (Herbst, 1783) (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.

Charybdis feriatus (Linnaeus, 1758) (Crucifix crab)

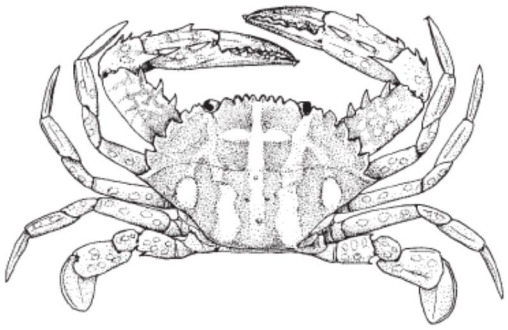
Carapace ovate; 5 distinct teeth on each anterolateral margin.
Colour: distinctive pattern of longitudinal stripes of maroon and white, usually with distinct white cross on median part of gastric region; legs and pincers with numerous scattered white spots.
Charybdis natator (Herbst, 1789) (Ridged swimmimg crab)

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.

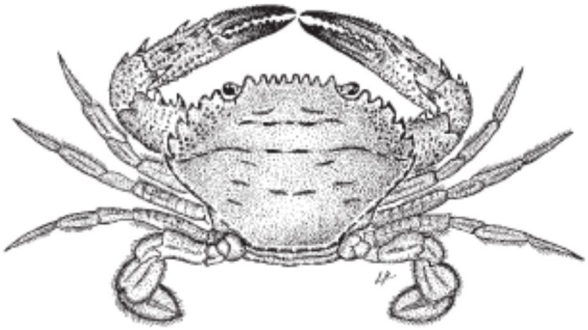
Podophthalmus vigil (Fabricius, 1798)

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 green; chelipeds and parts of legs violet to maroon in adults.

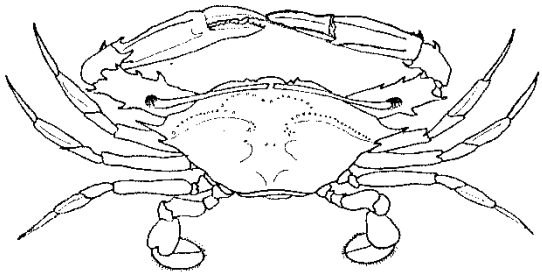
Charybdis feriatus (Linnaeus, 1758)



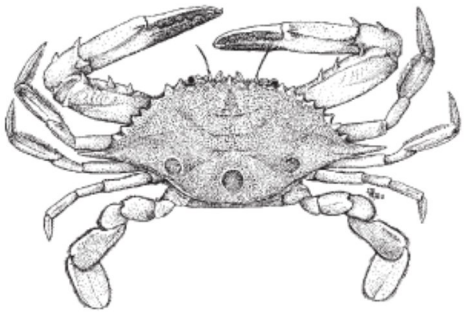
Charybdis natator (Herbst, 1789)



Podophthalmus vigil (Fabricius, 1798)



Portunus sanguinolentus (Herbst, 1783)



Portunus pelagicus (Linnaeus, 1758)

***Scylla* spp.**

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*.

Scylla serrata (Forsskål, 1775) (Giant mud crab)

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.

Scylla tranquebarica (Fabricius, 1798) (Purple mud crab)

Colour varies from brown to almost black in coloration, and has very well-developed spines on the outer surfaces of the chelipedal carpus and the palm (as seen in *S. serrata*). It differs from *S. serrata*, however, by having the frontal teeth more acutely triangular, the median pair projecting slightly forwards of the lateral pair, and the anterolateral teeth gently curving anteriorly, giving the carapace a less transverse appearance.

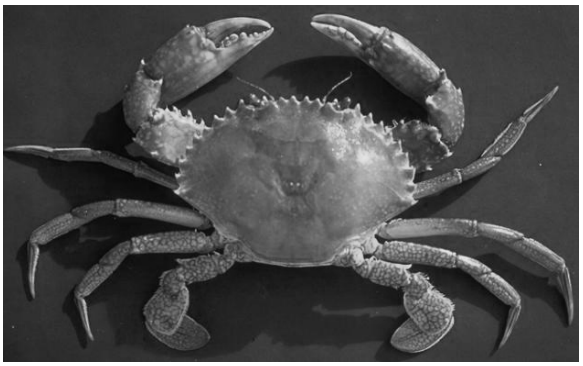
Scylla olivacea (Herbst, 1796) (Orange mud crab)

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.

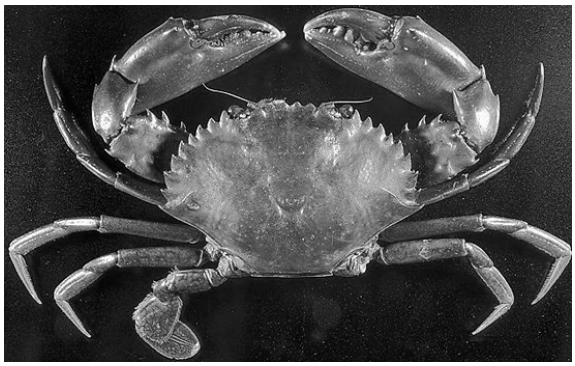
Scylla paramamosain Estampador, 1949 (Green mud crab)

Carapace usually green to light green, palm green to greenish blue with lower surface and base of fingers usually pale yellow to yellowish orange. Frontal margin usually with sharp teeth, palm usually with distinct, sharp spines.

Scylla serrata (Forsskål, 1775)

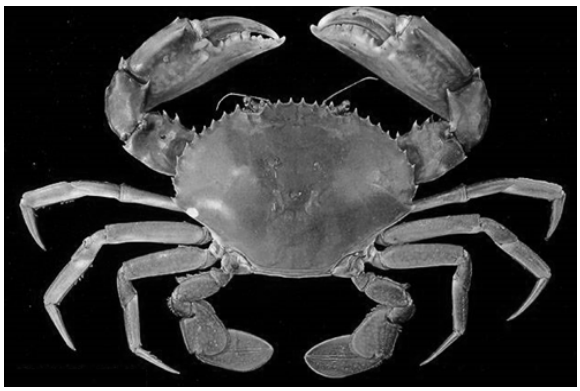


Scylla tranquebarica (Fabricius, 1798)



Scylla olivacea (Herbst, 1796)

Scylla paramamosain Estampador, 1949



Biology

Sexuality

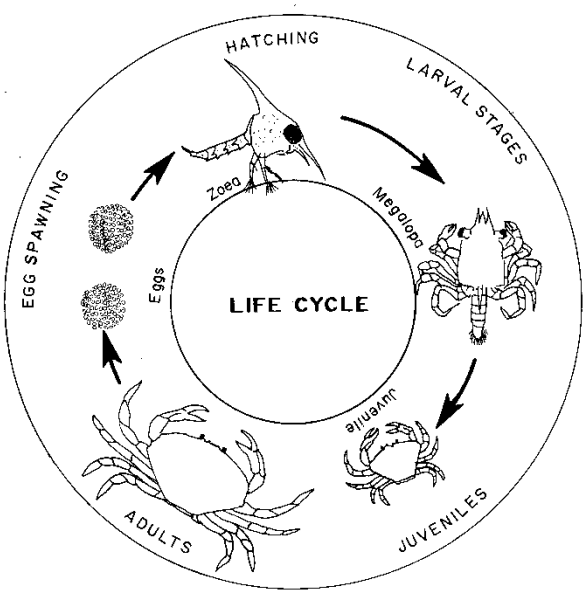
In crabs sexes are separate and sexes can be distinguished from the shape of the abdomen. In males the abdomen is narrow, inverted 'T' shaped and in addition mature males have larger and broader chelae. The first and second abdominal appendages (pleopods) are highly modified to form an intromittant copulatory organ. Females possess a broad abdomen, conical/oval in shape (according to the stage of maturity) and bear four pairs of pleopods.

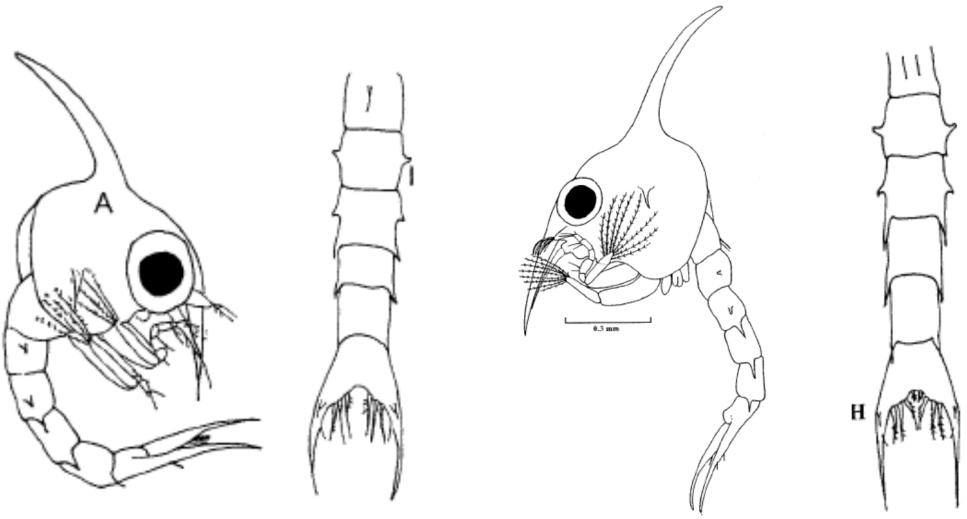
Mating and spawning

Like in shrimps, mating takes place as soon as the female crab moults. The sperms are transferred and stored in the spermatheca. After the spawning the eggs are attached to the endopodites of the pleopods and females carry the 'berry' till hatching. The embryonic development takes 8-12 days in tropical species and the period is considerably long in other species. Hatching generally takes place during early morning hours.

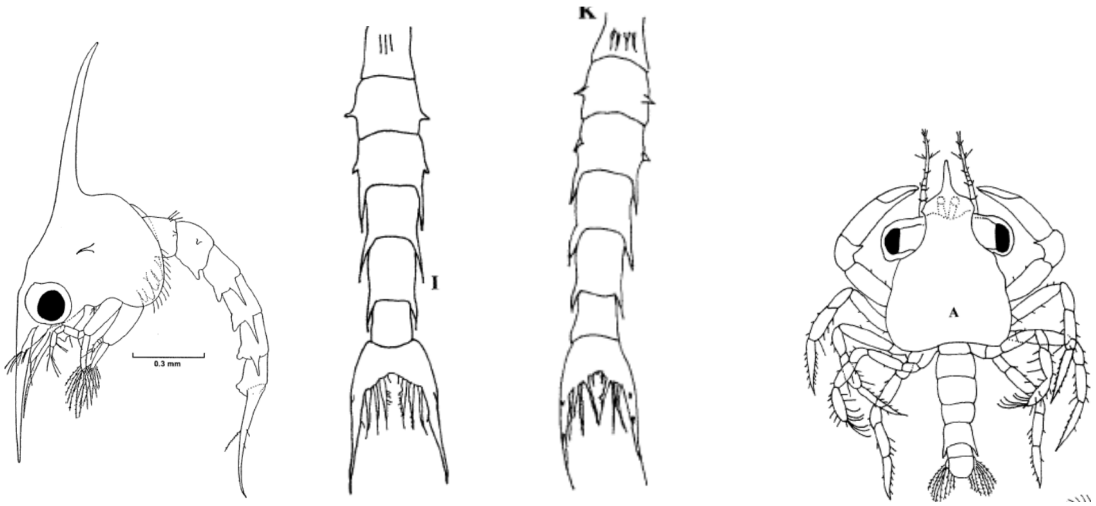
Life cycle & Larval stages

The larva passes through zoea (no. vary according to the species) and megalopa stages and moult to crab instar. For example *P. pelagicus* has four zoeae & a megalopa stage and *Scylla* spp. have five zoeae & a megalopa stage.





Zoea-I **Zoea-II**



Zoea-III **Zoea-IV** **Megalopa**

A- Carapace, I- Abdominal segment, H- Telson,
K- First abdominal segment with spines

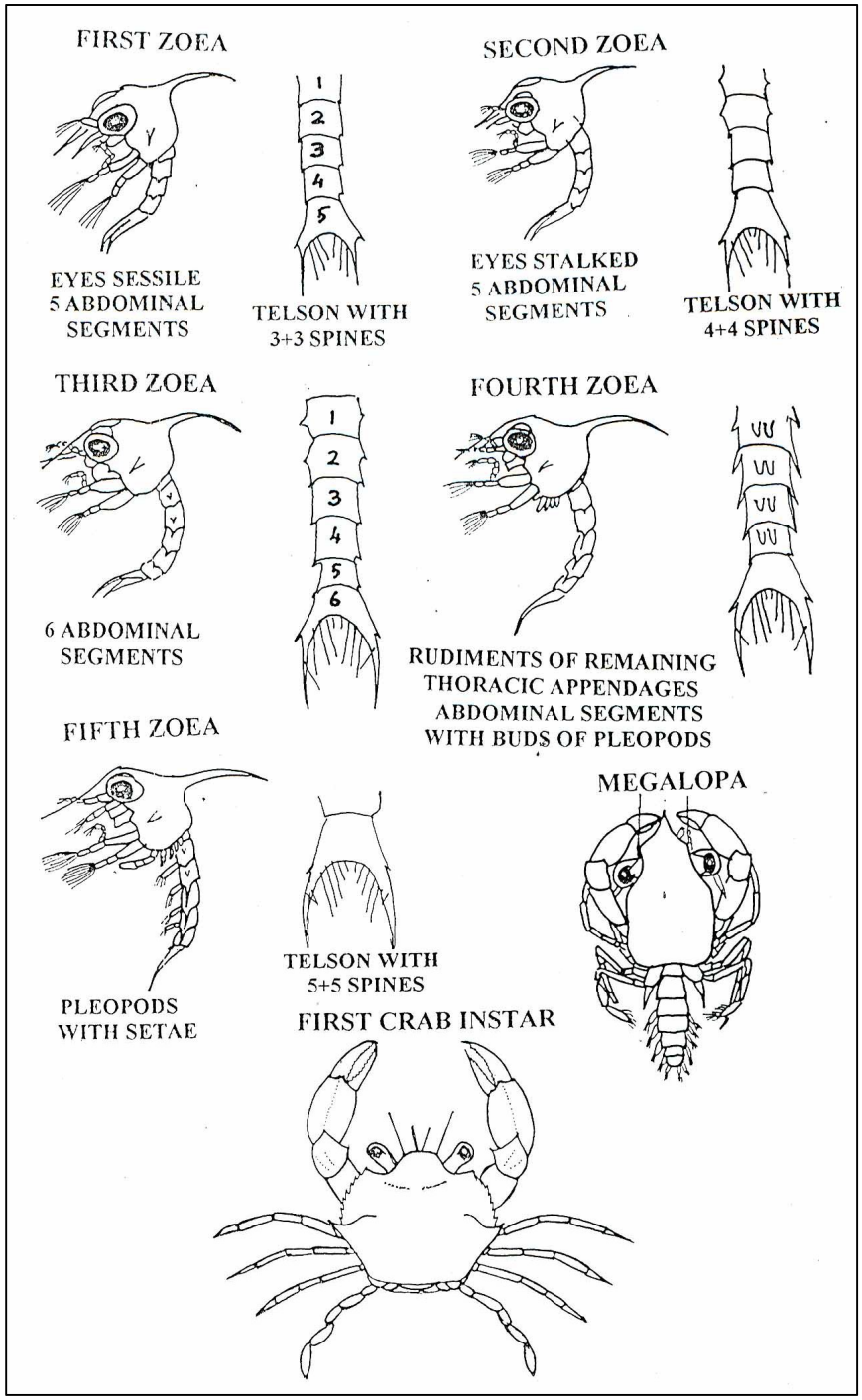
***Larval stages of the marine crab, *Portunus pelagicus* (Linnaeus, 1758)**

***** For details refer **Josileen, J**. and N. G. Menon. 2004. Larval stages of the blue swimmer crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura). **Crustaceana** 77 (7): 785-803.

Mud Crab, *Scylla* Spp.

Larval development

The different *Scylla* spp. pass through 5 zoeal stages and a megalopa stage before it moults to the crab stage, taking 21-25 days for the entire cycle.



Scylla **Larval stages (Zoea 1- 5 & megalopa)**

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Institute, Cochin
Fisheries Division
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केंद्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान, कोचीन
Central Marine Fisheries Research Institute, Cochin
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August 20-24, 2013

Sitting (left to right)
Dr. E.V.Radhakrishnan, Shri. K.Chellappan, Shri. C.K.Sajeev, Dr. Rekhadevi Chakraborty, Dr. S. Laksmi Pillai, Shri. Rahul kumar, Dr. Josileen Jose, Dr. A.Gopalakrishnan (Director), Dr. G. Maheswarudu, Dr.V. D. Deshmukh, Dr. A.P. Dineshbabu, Dr. Raju, M.K., Dr. Balu. S.,

Standing (left to right)
Smt. P.K. Usha, Smt. K.V.Sajitha, Smt. Shiny P.S., Ms. Shary Rajan, Dr. Shiny K.J., Smt. Sangeetha K.R., Dr. Bindu Bhaskaran, Ms. Sandhya K.S., Ms. Helna A.K., Ms. Apsara S.Krishnan, Ms. Sumedha Arya, Shri P.K.Baby, Shri. Devkate A. Dattatrya, Shri. Arshad Keethadath, Shri. Subal Kumar Roul, Shri. Trivedi Jigneshkujar. N., Dr. A. Maharajan, Dr. K.K. Prajith, Dr. P.S. Sivaprasad, Shri. Sibi T. Baby, Shri. Saneer N.S., Shri. Purushothman P., Shri Mahesh.C.M., Shri G. Kuberan, Shri M. Radhakrishnan.