The Pakistani coastal area is known to host a high diversity of marine habitats, flora/fauna yet a region that remains understudied in terms of crustacean symbionts as parasites and commensals. It is suggested that apparent rarity of these study of symbionts is probably a spurious phenomenon resulting from inadequate collecting methods. However, there is an infinite variety of associations between different species of aquatic animals like Crustacea and other organisms. The aim of present compendium is to update the information for the 270 symbiotic aquatic Crustacea from Pakistani area, according to recent taxonomic advances. It aims to bring together into one volume the disparate information of Pakistani marine/fresh water species. This study adds the inter-organismal relationships in symbiont taxa living together to 251 species known from Pakistan adding 19 new records and 7 species new to science. Identifications of hosts as cited in older literature are updated to current nomenclature. A result of study of crustacean parasites in the samples of galathoids collected by International Indian Ocean Expedition (IIOE) 1965-66 is added as separate chapter.

Prof Dr (Mrs.) Quddusi B. Kazmi: Specialization: Crustacean Taxonomy. Research/Administration 41 years. Ex-Director, MRCRC. Eminent Educationist, HEC. Gold medals/awards. Member National/International Organizations, Editorial boards of several journals. Guided M.Sc/MAS/M.Phil/Ph.D. 16 Books/monographs and over 150 Research articles.

978-3-330-00322-4

Symbiotic Crustaceans of Pakistan

Kazmi, Khatoon

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A Compendium of Crustaceans of Pakistani Waters Living in Partnership

Concise compilation of symbiotic crustaceans of Pakistan with all necessary information (with a chapter on IIOE samples)

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Impressum / Imprint
Bibliografische Information der Deutschen Nationalbibliothek: Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.

Bibliographic information published by the Deutsche Nationalbibliothek: The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

Coverbild / Cover image: www.ingimage.com

Verlag / Publisher:
LAP LAMBERT Academic Publishing
ist ein Imprint der / is a trademark of
OmniScriptum GmbH & Co. KG
Bahnhofstraße 28, 66111 Saarbrücken, Deutschland / Germany
Email: info@omniscriptum.com

Herstellung: siehe letzte Seite /
Printed at: see last page
ISBN: 978-3-330-00322-4

A Compendium of Crustaceans of Pakistani Waters Living in Partnership

QUDDUSI B. KAZMI
Marine Reference Collection and Resource Centre, University of Karachi
Assisted by
NASIRA KHATOON
Department of Zoology, University of Karachi

Dedication

To

my caring husband, Prof. Dr. M. Afzal Kazmi

whose unwavering support and patience have meant everything

to me.

Thank you for sharing my life, my dreams, and aspirations.

"Several of the species treat their fellow inhabitants of the sea with little ceremony, and make up for smallness of size by ferocity of behaviour. It is only to be hoped, as indeed it may be considered certain, that their living victims are immeasurably less sensitive to pain than ourselves.'' Thomas R. R. Stebbing A History of Crustacea, 1893.

CONTENTS

Extract from a single author is plagiarism that from two is comparative study and from three or more is research. (Unknown)

FOREWORD

In the field of research in biological sciences, there is dearth of authentic reference books. The information regarding specific groups of animals such as crustaceans is found scattered in national and international research journals. There was a strong need to compile and publish such data in the form of a reference book. This task has been completed by the author in the form of this invaluable publication.

In this contribution the author reports and discusses parasitism, commensalism and other associations in Pakistani crustaceans, both from marine and freshwater zones. These involve several new records and new species.

The compendium describes different groups of crustaceans symbiotic with marine algae, wood, invertebrates (polychaetes;corals;jelly fish; molluscs; caridean shrimps; crabs and crinoids etc), vertebrates(turtles, snakes and fresh and marine water fishes). In the result of the processing of the samples and compilation of literature in the country, 270 species are described, nineteen of them were found in Pakistan for the first time, and six are new for science species are described. For each species the localities and general distribution data, synonymy, hosts and for many species additional notes and descriptions (where necessary) are provided. The compendium is illustrated by line drawings text figures and plates with colour photographs of live specimens.

This volume increases the knowledge about the crustacean fauna of Northern Arabian Sea in general, but in particular the information about the crustaceans of Pakistan has been greatly enhanced. This compendium represents a valuable tool for the sampling of these animals and observations regarding their associations in particular habitat.

I am sure this reference book will go a long way to facilitate the researches in the particular field of Carcinology for future scholars.

Syed Iftikhar Husain Jafri
Ex-Chairman
Department of Freshwater Biology and Fisheries
Sindh University, Jamshoro,
Pakistan

PREFACE

The Pakistani water bodies especially the coastal area is known to host a high diversity of marine habitats, and flora and fauna yet a region that remains understudied in terms of crustacean symbionts as parasites and commensals. It is suggested that the apparent rarity of these study of symbionts here is probably a spurious phenomenon resulting from inadequate collecting methods. However, there is an infinite variety of associations between different species of aquatic animals like the Crustacea and other organisms. The symbiotic life style is one of the greatest environmental adaptations of crustaceans. The aim of the present compendium is to update the information for the 270 symbiotic aquatic Crustacea from the Pakistani area, according to the recent taxonomic advances. It aims to bring together into one volume the disparate information of Pakistani marine and fresh water species, incorporating recent literature.

This study adds the inter- organismal relationships in symbiont taxa living together to the 251 species previously known from Pakistan adding 19 new records and 7 of the species new to science. Identifications of hosts as cited in older literature are updated to current nomenclature.

A result of study of crustacean parasites in the samples of galathoids collected by the International Indian Ocean Expedition (IIOE) 1965-66 is added as separate chapter.

Key words: Pakistani symbiotic Crustacea (Maxillopoda, Peracarida, Eucarida), taxonomy, known species, new records, new species, hosts, marine and fresh water.

QUDDUSI B. KAZMI
Former Director, Marine Reference Collection and Resource Centre and Professor Department of Zoology.

ACKNOWLEDGMENTS

I wish to show my enduring and deep gratitude my mentor, supervisor and caretaker, late Dr. Prof. Nasima M. Tirmizi, who always helped me elucidate my ideas about the systematics and behavior of the crustaceans of Pakistan.

Drs. D.L. Adkison (current address unknown), J. Markham (Arch Cape Marine Laboratory) and C.B. Boyko (American Museum of Natural History, New York) were kind enough to spare some of their valuable times in helping with the identifications of Pakistani bopyrids and remedying my errors and omissions. Dr. Hans-U Dahms, Universität Oldenburg, Oldenburg, Federal Republic of Germany for identifying *Parategastes* specimen, Dr. R. Bourdon, Station Biologique, Roscoff, Finisterre, France for sending his identified bopyrids for reference material. Dr. Jens T. Hoeg, Marine Biology Section, Department of Biology, University of Copenhagen helped in rhizocephalan identification, Dr. Torben Wolff, Zoological Museum, University of Copenhagen, Denmark helped in asellotan isopod identification. I am thankful to Dr. F.A. Siddiqui of MRCC for identifying the hermit hosts.Dr. I.H. Jafri (Sindh University, Jamshoro) is acknowledged for sharing his papers on freshwater species not available to me, Mr. Moazzam Khan (WWF-Pakistan), Safia Khanum (CEMB) and Dr. Zafar Iqbal (The Punjab University) for providing photographs of associated crustaceans. I appreciate Mr. Muhammad Shamim of M.A.H. Qadri Biological Research Centre, University of Karachi in formatting the material used for this compendium. Few photographs are taken by Mr. Abrar Ali (MRC). Some of the photographs are taken by Ms. R. Naushaba (MRC) who is not a professional photographer, but they may be interesting, not necessarily scintillating.

GENERAL INTRODUCTION

An animal community is bound together by the network of interaction that species have with one another. Several types of interactions occur. One interaction- symbiosis has for a long time attracted the attention of biologists because such interspecific interactions are essential for the foundation of many species, in shaping the social behaviour of aquatic benthic communities (Baeza, 2007; Thomsen *et al.*, 2011). The term symbiosis was coined by de Bary in 1879. Symbiosis means living together. Traditionally the term has been used for the mutually beneficial relationship between two partners which are separate species, and as such it is still used in many textbooks.

Some crustaceans have lifelong relationships with others. These relationships involve phoresy, parasitism, inquilinism, parasitoidism, commensalism, predation and mutualism. Mutualism and commensalism are different outcomes of parasitism. When a parasite lives with another organism, this can cause commensalism which is defined as two organisms that co-exist in the same space/area/location and one of the organisms benefit from the other while neither harming nor helping the other organism. Parasitism may also be related to mutualism which is non-lethal because both organisms benefit rather than one organism benefiting more than the other organism. The parasitism is "positive and negative" symbiosis. The relationship may be very intimate, the smaller partner may live on as an ectoparasite or as mesoparasite or an endoparasite– in the other, who provides "boarding and lodging". The smaller partner is termed parasite, the larger one the host. The relationship is positive for the parasite, negative for the host. The parasite is completely dependent on the host, but the host can live quite happily without parasites Association may be (a) obligate associates found associated only with definite species of hosts (b) facultative associates may occur with more than one group of hosts or substrates, and (c) incidental associates are found only occasionally with hosts (Figs. 1-3).

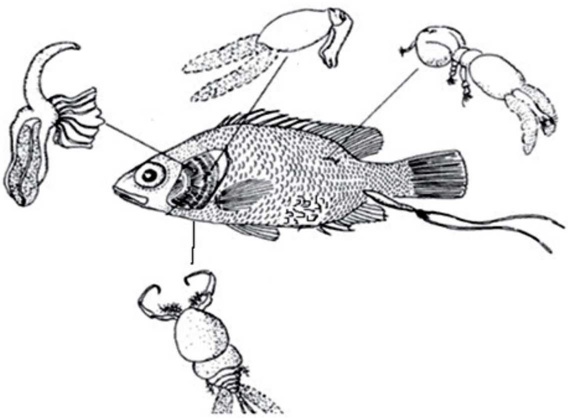


Fig. 1. Crustacean parasites on fish.

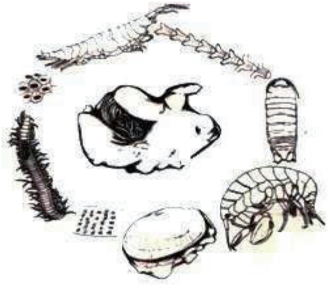
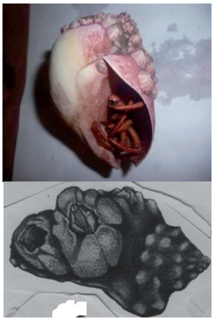


Fig. 2. Crustacean epibionts and an ascidian basibiont.



3a

3b

Fig. 3a. Barnacles as epibiont on *Babylonia* harbouring a hermit crab. (Courtesy of Safia Khanum).3b.same on another shell.

In phoresy the lesser partner, phoront, may get a free ride on the larger one. In inquilinism the lesser partner may seek shelter with or in the larger partner.

Epibiosis is an association of two organisms; the epibiont and the basibiont (Wahl, 1989). The term ‘‘epibiont’’ includes organisms that, during the settlement of their life cycle, are attached to the surface of a living substratum, while the ‘‘basibiont’’ lodges and gives support to the epibiont (Threlkeld *et al*., 1993).

Two or more unrelated species with a close ecological relationship that evolve together, such that one species adapts to the changes of the other; thereby affecting each other’s evolution is called coevolution. Another factor determining symbiotic group sizes and movement patterns is predation. When predation outside the protecting host is high, symbiotic movement between hosts is reduced (Knowlton, 1980; Baeza and Thiel, 2007).

There are much more interactions among marine species due to the absence of the greatest predator which is man. Marine species interact in a myriad of ways for protection, shelter, food, and more. Associations, competitions, symbiosis, commensalism, and parasitism are all categories in which these interactions occur having radical relationships in crustaceans from the shallowest to the deepest waters of our world. In marine systems the term ‘plant associates’ means the fauna associated with macroalgae and sea grasses and is usually called the phytal habitat. Some crustaceans prefer stranded seaweed rather than fresh ones.

A few species have been found associated only with decaying wood; these also may be included in the phytal fauna. However, the phytal fauna is little different from the true benthos, most of the species do not show obvious morphological adaptations to the phytal habitat. But some show adaptations usually to enable the animal to attach itself more effectively to the plant. Many genera that contain species found among algae have other species living on or in the adjacent benthic sediment, many species are found equally often among algae and in sediments without associated plant growth, also, it is known that many of the species washed from samples of macroalgae and sea grasses are actually associated with the sediment and detritus that becomes trapped in the interstices of the plant and thus are really part of the sediment fauna. Even many of the truly phytal species that do show adaptations to that environment have been shown to leave the plant for mating; this may partially explain the relative rarity of males in collections of these species. In phytal environments, harpacticoid copepods are regularly dominant taxa. Other groups are tanaids, isopods, amphipods, ostracods, cumaceans mysids and decapods (Sadiq, 1993; Baig and Zehra, 2006) (Fig. 4).

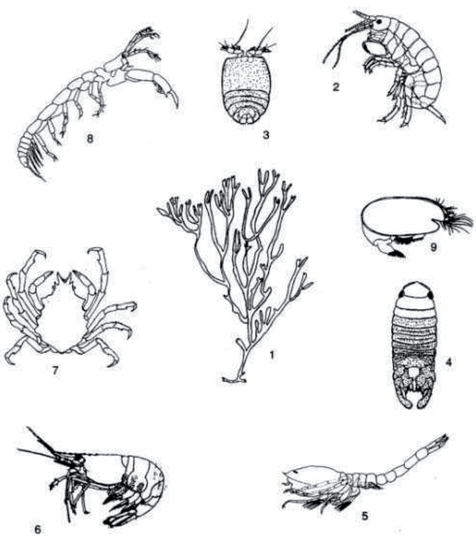


Fig. 4. Sea weed associated crustaceans: 1) Sea weed. 2) Amphipod. 3) Copepod. 4) Isopod. 5) Cumacean. 6) Caridean. 7) Brachyuran. 8) Tanaidacean. 9) Ostracod.

The subphylum Crustacea is the largest group of aquatic arthropods made up of approximately 67,000 species. Recent studies using DNA sequences suggest that the subphylum Crustacea is paraphyletic, unranked clade, supported by several molecular studies comprising all crustaceans and hexapods (Oakley *et al*., 2013). This new classification is not being commonly used since the exact relationships of the Crustacea to other taxa are not completely settled till recently.

In traditional classification the subphylum is divided into 6 classes: Branchiopoda, Remipedia Cephalocarida, Maxillopoda, Ostracoda and Malacostraca. Of all the metazoans, the crustacean parasites are diverse and ubiquitous; these animals include some of the world's strangest and even most disturbing parasitic arthropods. It is the crustaceans that probably form more associations with other classes than any other marine animals (Ross, 1983).

Pakistani marine biologists were aware that the sea provides us with many examples of associations and partnerships. Over the last two decades different patterns have been studied randomly at the Marine Reference Collection and Resource Centre (MRC), University of Karachi (see References). Symbiotic crustaceans show a great variation in social structures, from solitary and pair-living to living in large groups (Wirtz, 1997; Thiel *et al*., 2003; Baeza and Thiel, 2007; Baeza, 2008). The same species may differ in social structure, depending on its host (Dellinger *et al*., 1997). It appears to be the size and density of the host species that determines the social structure of the symbiont (Dellinger *et al*., 1997; Thiel and Baeza, 2001; Wirtz and d'Udekem d'Acoz, 2001; Thiel *et al*., 2003).Very small hosts harbour single animal, larger but defendable hosts are often occupied by a pair of associates (Knowlton, 1980; Dellinger *et al*., 1997; Baeza, 2008). When the hosts live in high densities, the symbionts may switch hosts easily in search of mates (Diesel, 1986).

No parasitic Branchiopoda are known and in the class Ostracoda, none are definitely known to be parasitic. The line dividing commensalism from parasitism is definitely crossed by some groups. Among them, the copepods are dominant. They are the most speciose group of metazoan ectoparasites of fishes and a wide range of marine invertebrates, in every available phylum in the marine environment from the sponges and cnidarians up to the echinoderms and chordates, including sea squirts, fishes and even mammals. They occupy a similarly wide range of microhabitats on their hosts, both as ectoparasites and as endoparasites.

Among the branchiurans mostly occurring in fresh water, a few species of the genus *Argulus* are ectoparasites on the skin of marine fish infesting estuarine and coastal marine fishes but they do not occur in oceanic waters. Infestations with *Argulus* have been reported from marine fish farming .These animals cling tightly to fish scales with a set of antennae modified into huge, barbed suckers. Branchiurans feed on its blood and external tissues. They have rasping mandibles, which scrape tissues into the opening at the tip of the tubular sucking mouth.

Among the Maxillipoda, the rhizocephalans which parasitize other crustaceans, are particularly fascinating because of their extreme sexual dimorphism, the extreme reduction of morphological complexity in the parasitic female, and their ability to change the behaviour of the host which benefits the parasite. Several barnacles live as associates.

Among the malacostracans the Amphipoda is the order, according to most biology textbooks free-living , with some old and invariably cited exceptions such as the whale-lice on whales, *Hyperia* species on medusae and some Dexaminidae in sponges and tunicates, the Hyperiids, most of them are obligate symbionts of gelatinous zooplankton including medusae, ctenophores, siphonophores, heteropod mollusc, and salps, among the Gammaridea and Senticaudata a large number of species live in association with algae and a wide spectrum of invertebrates, fish or even sea turtles. Other associations have in the past been largely overlooked or looked upon as incidental, because amphipods generally become easily dislodged from their host on capture. Now reports of associations are published on Amphilochidae, Caprellidae and starfish, corals and anemones.

In Leptostraca the unusual marine rotifer *Seison* is often found epizoic. None has yet been discovered in Pakistan but it would be worth checking local *Nebalia* to ascertain their presence or absence.

Although the great majority of mysids are strictly free-living, a small proportion of species exhibit diverse types of associations with other macro-invertebrates. A wide range of ecto- and endoparasites have been reported in Mysidacea. Choniostomatid copepods and epicaridean isopods, particularly of the family Dajidae, are common ectoparasites. Juvenile and small male dajids live in the host's marsupium among the developing larvae. Sponges, cnidarians, gastropod shells and echinoderms are described as the main hosts of mysids in the literature; many can form dense concentrations among rocks and algal beds. Marine species can be found intertidally amongst coralline algae, crevices, holdfasts, and in rock-pools.

The tanaids are either free-living, tube-dwelling, burrowing, or live in association with other organisms in a variety of relationships transporting the gastropod as hermit crab. Some live as epifauna on weeds and solitary corals (Sieg and Zibrowius, 1988), colonial corals and hydroids (Bacescu, 1981), live scallops (Brown and Beckman, 1992), oysters (Bamber, 1990), barnacles (Reimer, 1975), and even sea turtles (Caine, 1986). Some species are true symbionts, living together with gastropods (Howard, 1952; (Kazmi and Siddiqui, 2001), tube-dwelling sea cucumbers (Larsen, 2005), in the canals of sponges (Hassack and Holdich, 1987), and as cleaning commensals on mobile bryozoan colonies. Only a few species of tanaids are considered to be parasitic but none are obligate parasites.

Another order of the Malacostraca-the Decapoda exists in a variety of relationships with other organisms-the corals, weeds, fish, anemones etc. The existence of biotic interaction between the crustaceans and Cnidarians has been known for a longtime (Guinot *et al*., 1995) Many diverse groups of decapods harbour parasites, other are themselves the parasites, the pinnotherid crabs enter their hosts as larvae and remain there as they feed and grow in rectum may serve as host for bopyrids. Hosts are most commonly mussels such as oysters, but other species may make their homes in the body cavities of echinoderms such as sea urchins or sea cucumbers, the shells of gastropods, the tubes of certain worms or even the gills of sea squirts. The eumedonid crabs live with sea urchins. The crab *Libinia spinosa* of Epialtidae live in Scyphozoan Rhizostomeae.The xanthid crab and coral relationship is defined as obligate ectoparasitisim. The thalasinids live with commensal copepods. Some squat lobsters have adopted symbiotic lifestyle and other colonizes chemo-synthetic communities in the deep sea, some 42 species have putative partnerships with invertebrates.

The malacostracan order Stomatopoda is known to have a commensal bivalve in their burrows.

A number of important standard works and databases on crustaceans now include the pentastomids or Ichthyostraca as members of the subclass Maxillopoda. Pentastomids live in the upper respiratory tract of fish, reptiles, birds and mammals, where they lay eggs (Barnes, 1982).

The special communities and relationships in Pakistani crustaceans are dealt herewith. Many of the references are antiquated, my efforts, therefore, are vital to preserve the available Pakistani scientific history of epibionts/symbionts.

Table 1. Crustacean groups that contain symbiont species.

Group	Example	Association	Hosts/associate
Branchiopoda	Cladocera	Ectoparasites	Hydra
Maxillopoda	Copepoda	Endo/Ectoparasite	other invertebrates and fish
Maxillopoda	Branchiura	Ectoparasites	Fish
Maxillopoda	Cirripedia Rhizocephala	Endoparasite	Crabs and shrimp
Maxillopoda	Cirripedia Ascothoracians	Ectoparasites	Echinoderms and anthozoans
Maxillopoda	Tantulocarida	Ectoparasites	Deep-sea crustaceans
Maxillopoda	Pentastomida	Endoparasites	Fish, reptiles, birds and mammals
Malacostraca	Isopoda	Endo/Ectoparasite/commensal	Fish
Malacostraca	Amphipoda	Endo/Ectoparasite/commensal	Salps, whales
Malacostraca	Decapoda	Endo/Ectoparasite /commensal	Invertebrates and fish
Malacostraca	Stometopoda	Commensel	Bivalves

LAYOUT OF THE COMPENDIUM

This is an attempt to bring together all available published records on all Pakistani species of the crustaceans living in partnership and my new work arranged in phylogenetic order. Thus the elaboration of the compendium of the crustacean species of parasites, symbionts, and commensals reported from Pakistan was based on information collected from two sources. Firstly, using published records and papers derived of literature was sourced from both Pakistan and overseas. Secondly, through the fresh sampling. Synonymies are abbreviated, and for full synonymies work is sometimes referred in this way -for example- see Markham, 2010, for complete synonymy. The existing information on the Pakistani species recorded so far is compiled, presenting for each group an introductory note, for each species the alternate names and the names used in the Pakistani record, followed by the reports, if any, in recent most literature. Taxon authorities are omitted from the "Literature Cited', included are the references pertinent to identification of a species, including all references from the Pakistani waters. For all the collated species, included are illustrations as well as description or redescriptions as needed, some are partially or completely described, sometimes it seemed unnecessary to reiterate the description or figure. Local host, if known and those known outside Pakistan are mentioned. For fish hosts, fish nomenclature is according to Fish Base (Froese and Pauly, 2000). An updated classification of Crustacea by Ahyong *et al*., (2011) is followed here, published subsequent to the classifications of Crustacea given by Bowman and Abele in 1982 and Martin and Davis (2001). I have used published illustrations of other authors, sometimes modifying them; the sources are credited. Additional figures/photos of the reported species are added to contribute to their identification by future workers. As the data were gathered from the literature since 1892 (Alcock, 1892), online sources, and my personal records, it is inevitable that some references will have been missed.

Abbreviations used for hierarchic presentation certain main levels are used consistently throughout. They are abbreviated as below in the taxonomic part. Class (CL.), subclass (S.CL.), infraclass (I.CL.), superorder (SUP.O.), order (O.), suborder (S.O.), section (S.), subsection (S.S.), superfamily (SUP.F.), family (F.), subfamily (S.F.) and genus(G.).

The abbreviation Ov. indicates an ovigerous female. The size of the parasite/commensal is given when available as the total length (TL) from the anterior end to the posterior end; carapace length (CL) for all and shield length (SL) for paguroids are provided as an indicator of specimen size for the hosts. In my fresh collection, for the hermit crabs the shell were cracked using a vise and the crabs were removed for examination of parasites. In case of amphipods the whole host colony was collected in zip-lock plastic bags and brought back to the laboratory. The hosts were then dissected and commensal amphipods were removed from them or capturing amphipods individually in situ. Shrimps and Crabs were collected from the Karachi Fish Harbour and intertidal pools. All specimens were preserved in 2% seawater buffered formalin for morphological study.

In total 189 species belonging to 78 families are included in this compendium, at the species level, with full authorities. Species newly collected in Pakistan waters as new records or new species marked by an asterisk are illustrated and described, some still not specified. These discoveries ultimately pave for the creation of database collection of Pakistani species. The material housed in the Marine Reference Collection and Resource Centre (MRC), University of Karachi is incorporated. Material for the new study and specimens of the new species of marine species are deposited in the MRC.

Available collection obtained through the International Indian Ocean Expedition (IIOE) of galatheids was examined for parasitized galatheids and chirostylids collected by the IIOE (1960-65 cruises) yielded an additional three parasites species new to the Indian Ocean representing substantial range extensions.

SYMBIOTIC CRUSTACEAN SPECIES IN THE PAKISTANI REGION

CL. Maxillopoda Dahl, 1956: Barnacles, ostracods, copepods, and related parasitic groups – these are all examples of maxillopod crustaceans. They are a disparate lot; their classification is generally controversial, so here we give generally accepted one that is subject to change in which the Maxillopoda is no longer accepted (Oakley *et al*., 2013). Apart from some barnacles, most species are small or minute**.** Six sub classes: Thecostraca, Tantulocarida, Branchiura, Pentastomida, Mystacocarida, Copepoda are present, 3 occur here.

S.CL. Thecostraca Gruvel, 1905: Divided into three infra classes: Facetotecta, Ascothoracida, Cirripedia are present, the last occurs here.

I. CL. Cirripedia Burmeister, 1834: Three super orders**:** Ascothoracica, Rhizocephala, and Thoracica, the latter two occur here.The Ascothoracica are parasitic on zooanthids, antipatharians and echinoderms, although occur in the Indian Ocean but not yet collected from Pakistan.

SUP.O. Rhizocephala Müller, 1862: A rhizocephalan consists of a sac-shaped body, the *externa*, which is mainly involved in reproduction and is attached to the outside of the host's abdomen. Adult Rhizocephala are sessile, adult females have lost all obvious crustacean morphological traits and consist of a sac-like part attached to the host with outgrowths of rootlets extending cancer-like into the host's body. The males are reduced to dwarfs and live within the parasitic female. The rhizocephalan barnacles provide some of the most unusual examples of parasitism and adaptations of a host-parasite relationship. Rhizocephalans have little similarity with other cirripedes, or indeed other crustacean adults, as there are neither appendages nor segmentation (Høeg and Lützen, 1995, 1996).So lack of cirripede affinities in the recent mitochondrial genome study of rhizocephalans (Glenner and Høeg, 2002) resulted in to raise it as an independent phylum that acquired cirripede larvae by horizontal gene transfer.

The Rhizocephala comprise about 250 species parasites of other Crustacea, mostly they parasitize brachyuran and anomuran crabs, caridean shrimp, stomatopods, peracarids and even other barnacles. They extend into brackish waters, but only a few species occur on truly freshwater or semi terrestrial crustaceans, leading to marked changes in life history (Andersen *et al*., 1990). The rhizocephalans begin their lives as a free-swimming cyprid larva like any other barnacle, searching for a place to settle down and grow. Unlike other barnacles however, they attach within the body of a living host. Soon, the intruder reveals its presence to the outside world as a bulging sac- the *externa*, located where the host would normally carry a clump of eggs. Rhizocephalans are particularly fascinating because they induce marked behavioural changes in their hosts that can benefit host survival. They also have considerable economic importance causing mortality and castration, thus reducing the profitability of crustacean fisheries. Sometimes highly degenerate isopods are attached to the *externa* of a rhizocephalan, as hyperparasite. And just as the crab is castrated by its parasite, the parasite is rendered sterile by these hyperparasites.

Divided into 2 orders -Akentrogonida, Kentrogonida, both are found here.

O. Kentrogonida Delage, 1884: Three families- Lernaeodiscidae, Peltogastridae and Sacculinidae, all three are found here.

F. Sacculinidae Lilljeborg, 1860: Includes 7 genera and at least 53 species and subspecies. The Sacculinidae are parasitic barnacles that infect crabs (Høeg and Lützen, 1995, 1996; Walker, 2001). The cyprid larvae of Sacculinidae are dioecious, only the female cyprid infects the crab by settlement on the external cuticle or the gill filaments. The female cyprid then metamorphoses into a kentrogon which has a retracted hollow stylet (Glenner *et al*., 2000; Glenner, 2001), subsequently injected through the stylet into the haemolymph of the crab absorbs nutrients from the host's haemolymph (Bresciani and Høeg, 2001).

G. *Sacculina* Thompson, 1836: *Sacculina* are internal parasites (called the "interna"), cuticular tumors which grow inside their crustacean hosts. These tumors can develop a system of branching roots that ramify throughout their host crab' bodies and absorb its nutrients. The life cycle of *Sacculina*, therefore, comprises two stages: the endo- and ecto-parasitic stage (Boschma, 1955).

***Sacculina leptodiae* Guérin-Gavinet, 1911** (Figs. 5-6)

Alternate names, updated and Pakistani records.

Sacculina rotundata, Boschma, 1931
Sacculina leptodiae Guérin-Gavinet, 1911; Boschma, 1969; Moazzam and Moazzam, 2004
Sacculina sp. Siddiqui and Ahmed, 1993

Fig. 5. *Sacculina leptodiae* (Externae).

Fig. 6. host.

Pakistani host: *Leptodius exaratus* (crab)

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Hosts:** *Leptodius gracilis, Leptodius exaratus, Thalamita stimpsoni*, *Pseudozius caystrus* and possibly *Camposcia retusa* and *Carupa laeviuscula***.**

***Sacculina* sp.**

Alternate names, updated and Pakistani records

Sacculina Tirmizi and Ghani, 1996

Pakistani host: *Macromedaeus quinquedentatus* (crab)

G. *Heterosaccus* Smith, 1906

***Heterosaccus ruginosus* Boschma, 1931**

Alternate names, updated and Pakistani records

Heterosaccus ruginosus Boschma, 1931; Moazzam and Moazzam, 2004

Pakistani host: *Portunus sanguinolentus* (crab).

Found elsewhere and of their hosts there and elsewhere: India. **Hosts:** *Lissocarcinus pulshellus, Lissocarcinus orbicularis, Thalamita prymna* and *Th. crenata.*

F. *Peltogastridae Lilljeborg, 1859: They belong to the bizarre parasitic barnacles, comprise 14 genera, one occurs here which is yet to be confirmed.

G. **Peltogaster* Rathke, 1842

****? Peltogaster paguri* Rathke, 1842 (**Fig. 7)

Material: Two gravid female externae under abdomen, 4mm, 7-6-2008, Manora.

Alternate names, updated and Pakistani records.

Peltogaster pagur–Kazmi and Siddiqui, 2013 (abstract only)

The body is elongated, cylindrical, and 3 times longer than the width. The mantle aperture is an elevated terminal and often lobate structure. Stalk is narrow, about half way from the mantle opening. A prominent fusiform dark shield is present around the stalk on the body.

Fig. 7. *Peltogaster paguri* (Externae).

Pakistani host: Two females hermit crab *Areopaguristes perspicax* (SL2.5-3mm), there was a branchial pseudonine bopyrid genus *Parapagurion*, living in the right branchial chamber. Other diogenids in the same lot had either rhizocephalan or bopyrid. The peltogastrid is larger than the bopyrid in size, so this was the case of simultaneous sacculization and bopyrization.

Found elsewhere and of their hosts there and elsewhere: Red Sea, north Atlantic. **Hosts:** *Pagurus gracilipes, P. bernhardus, P. prideauxii, P. pubescens, P. cubanensis. Anapagurus chiroacanthus, A. laevis,* attached to the abdomen.

F. Lernaeodiscidae Boschma, 1928: one of the smallish families of Rhizocephala contains three genera , one is found here.

G. *Septodiscus* Van Baal, 1937

***Septodiscus flabellum* Van Baal, 1937**

Alternate names, updated and Pakistani records.

Septodiscus flabellum–Moazzam and Moazzam, 2004

Pakistani hosts: *Petrolisthes rufescens* and *Petrolisthes boscii* (false crabs)

Found elsewhere and of their hosts there and elsewhere: Red Sea, Pacific Ocean. **Hosts:** *Petrolisthes carinipes, P. lamarckii, P. hastatus, P. molukkensis and P. japonicas* (Van Bal, 1937).

F. ?*Parthenopeidae Rybakov and Høeg, 2013 (Fig. 8)

?Genus *Parthenopea*

Pakistani host: *Callichirus masoomi* (mud shrimp)

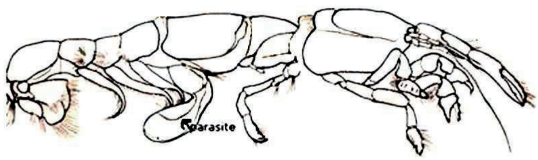


Fig. 8. Parasite with host, pointed by an arrow.

Note: The position of the parasite underneath one of the first three abdominal segments does suggest a rhizocephalan parasite. "The presence on *Callianassa* {now *Callichirus*} could suggest that it is a species of the rhizocephalan genus *Parthenopea,* which is presently monotypic: *Parthenopea subterranea*. This enigmatic rhizocephalan has been recorded both from Scandinavian waters and the Mediterranean, but never outside Europe" (Hoeg, pers. comm). The status of the parasite of *Callianassa* needs further corroboration.

O. *Akentrogonida Häfele, 1911

F. *?Clistosaccidae Boschma, 1928

G. *?*Clistosaccus* Lilljeborg, 1860 (Fig. 9)

***Clistosaccus* sp.**

Material: Two externae (1 spent, 1ov.) 6-2-2008, 7-6-2008, Manora

Pakistani host: *Areopaguristes perspicax* (hermit crab)

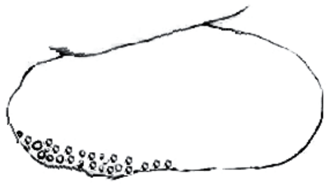


Fig. 9. *Clistosaccus* sp.

A broad, elongated, cylindrical sack, hanging off the abdomen of parasitized hermit crab, filled with reproductive tissues and eggs is enclosed in chitinous armour. The stalk is broad arising from the posterior end.

SUP. O. Thoracica Darwin, 1854: According to revised classification by Buckeridge and Newman (2006) 5 orders are included in the superorder Thoracica; they are Lepadiformes, Ibliformes, Cyprlilepadiformes, Scalpelliformes and Sessilia. They have unaccepted order Pedunculata. Here I am following ITIS classification where Order Pedunculata is under this superorder.

O. Pedunculata Lamarck, 1818. Pedunculata is now an invalid taxon whose members are now placed in Thoracica. The traditional classification includes four suborders in this order, one is included here.

S.O. Lepadomorpha Pillsbury, 1916: Three families are included, only one occurs here. Not only found growing on the hard surfaces of inanimate objects. They also grow on living mangrove trees; on mollusc shells and on the exoskeleton of crabs. They are also found on living creatures such as turtles, snakes and whales (Fig. 10).

Fig. 10. Barnacles on turtle and snake. *Platylepas ophiophila* on scales and *Conchoderma virgatum* on tail (Coutesy of Moazzam).

F. Lepadidae Darwin, 1852,

G. *Lepas* Linnaeus, 1758

***Lepas anserifera* Linnaeus, 1767** (Fig. 11)

Alternate names, updated and Pakistani records.

Lepas anserifera–Moazzam and Rizvi, 1978

Pakistani host: Floating subjects

Found elsewhere and of their hosts there and elsewhere: Indo-west Pacific. **Hosts:** Floating subjects including whales.

Fig. 11. *Lepas anserifera* on a wooden log, Bulleji.1995.

F. Poecilasmatidae Annandale, 1909: Eight genera are found, 3 are reported from here.

G. *Octolasmis* Gray, 1825: Species participate in interesting and sometimes deleterious epizoic associations with other marine non-barnacle animal species (Foster, 1987). Often a hundred or more are present and up to over 1000 specimens have been observed congesting the respiratory gill surfaces of a single crab *Scylla serrata*, thus reducing its available respiratory area (Voris *et al*., 2000) with the result that the host is debilitated and may die (Gannon and Wheatley, 1992).The inhalant aperture of the branchial chamber of host crab allows access for the cyprid to attach to the inner sides of the gills, where up to 90% of the individuals can reside. Species of *Octolasmis* can reinfest crabs quickly after ecdysis.

***Octolasmis grayi* (Darwin, 1851)** (Figs. 12 and 13)

Alternate names, updated and Pakistani records.

Octolasmis grayii var. *pernuda* Annandale, 1909; Moazzam and Rizvi, 1978, 1982.

Dichelaspis grayi Darwin, 1851
Dichelaspis lepadiformis Gruvel, 1900
Dichelaspis pellucida Darwin, 1851

Pakistani host: Sea snake

Found elsewhere and of their hosts there and elsewhere: Indo-west Pacific. **Hosts:** Eighteen species of snakes.

Fig. 12. *Octolasmis grayi.*

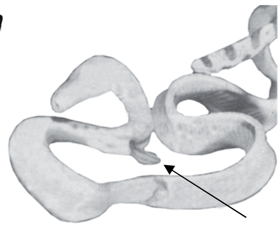


Fig. 13. Host with parasite marked by an Arrow.

***Octolasmis lowei* (Darwin, 1852) (**Fig. 14)

Alternate names, updated and Pakistani records.

Dichelaspis lowei Darwin, 1851
Octolasmis lowei–Moazzam and Rizvi, 1978*;* Kumaravel *et al*., 2009; Shahdadi *et al*., 2014.

2-3mm. It has a muscular peduncle without plates, a fleshy capitulum with 5 calcareous plates is embedded in the surface, which support it and protect vital organs such as the feeding apparatus enclosed by it. The calcareous plates include 2 scuta, 2 terga, and 1 carina, which are visible to the unaided eye but are more easily recognized with magnification.

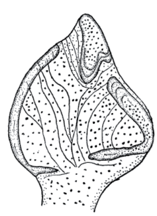


Fig. 14. *Octolasmis lowei*.

Pakistani host: Lobster

Found elsewhere and of their hosts there and elsewhere: This is the most cosmopolitan species of the genus :Malay Archipelago, Chennai, Singapore; Australia, Japan, Formosa, Atlantic Ocean, Gulf of Mexico Persian Gulf, Arabian Sea and Mediterranean. **Hosts:** Palinuridae and Scyllaridae, the brachyuran families: Calappidae; Glyphocrangonidae; Hepatidae; Leucosiidae; Menippidae; Portunidae; Mithracidae; Parthenopidae; Pisidae; Raninidae and Xanthidae (Jeffries and Voris, 2005).

Octolasmis geryonophila **Pilsbry, 1907** (Fig. 15)

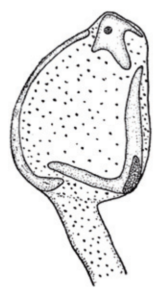


Fig. 15. *Octolasmis geryonophila*.

Alternate names, updated and Pakistani records.

Octolasmis aymonini geryonophila Newman, 1961 (see for complete synonyms); Moazzam and Rizvi, 1978.

Pakistani host: Lobster

Found elsewhere and of their hosts there and elsewhere: Western Atlantic Ocean. Indo-west pacific. **Hosts:** Deep sea variety of crustaceans (isopods, brachyurans) gills.

Octolasmis cor **(Aurivillius, 1892)** (Figs. 16-17)

Fig. 16. *Octolasmis cor*.

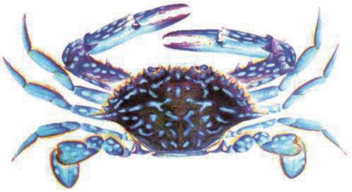


Fig. 17. host.

Alternate names, updated and Pakistani records.

*Dichelaspis co*r Aurivillius, 1892
Dichelaspis coutierei Gruvel, 1902
Dichelaspis maindroni Gruvel, 1902
Lepas sp. Hashmi and Zaidi, 1965
Octolasmis cor Moazzam and Rizvi, 1978; Mushtaq and Mustaquim, 2009; Rezaie-Atagholipour *et al*., 2013; Shahdadi *et al*., 2014.

Pakistani hosts: *Scylla serrata, Thalamita crenata*, *Portunus segnis* (= *P. pelagicus* Tirmizi and Kazmi, 1983; Lai *et al*., 2010). Moazzam and Rizvi (1978) mentioned that the identification of stalked barnacle as *Lepas* by Hashmi and Zaidi (1965) was not correct and the species should be referred to *Octolasmis cor*, which is the most common species along the Karachi coast.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific, Persian Gulf. **Hosts:** Attached to the gills of decapod crustaceans, *Scylla tranquberica.*

***Octolasmis bullata* (Aurivillius, 1894)** (Figs. 18-19)

Alternate names, updated and Pakistani records.

Octolasmis angulata forma *bullata*–Moazzam and Rizvi, 1978

Octolasmis bullata–Liu and Ren, 2007; Li *et al*., 2014

Pakistani hosts: *Panulirus polyphagus* (lobster) and *Portunus sanguinolentus* (crab)

1-3 mm. Labrum has strong teeth, arranged in two rows. Palpus is bluntly conical with bristles at the top and along the inner margin. The outer margin carries some scales. The mandible has four teeth and a pointed inner angle which is bifid. The maxilla one has a straight front edge without a notch. The maxilla two is broad with a distinct front edge with rounded corners. Margins of antenna two have long spine like hairs. The species is rather variable.

Found elsewhere and of their hosts there and elsewhere: Arabian Sea, China. **Hosts:** *Panulirus polyphagus*, *Panulirus stimpsoni, Portunus sanguinolentus* .

Fig. 18. *Octolasmis bullata.*

Fig. 19. Host.

***Octolasmis warwickii* Gray, 1825** (Fig. 20)

Alternate names, updated and Pakistani records.

Dichelaspis equine Lanchester 1902

Octolasmis warwickii–Moazzam and Rizvi, 1978; Jeffries *et al*., 1982; Jones *et al*., 2000; Shahdadi *et al*., 2014

Pakistani host: Crab.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Hosts:** Antipatharians, Limlus, molluscs, fishes, sea snakes and attached externally on the carapace, antennae, and proximal segments of locomotory appendages of decapods, (Jones *et al*., 2000), on Portunidae (*Scylla tranquberica*), Dorippidae, Leucosiidae, Majidae, Menippidae, Panuliridae, Scyllaridae and Xanthidae.

Fig. 20. *Octolasmis warwickii*.

***Octolasmis angulata* (Aurivillius, 1894) (**Figs. 21-22)

Alternate names, updated and Pakistani records.

Dichelaspis angulata Aurivillius, 1894
Dichelaspis aperta Aurivillius, 1894
Dichelaspis cuneata Aurivillius, 1894
Dichelaspis transversa Annandale, 1906
Octolasmis angulata–Moazzam and Rizvi, 1978; Yan *et al*., 2004; Mushtaq and Mustaquim, 2009; Chan, 2012 (description); Rezaie-Atagholipour *et al*., 2013; Shahdadi *et al*., 2014; Ihwan *et al*., 2014

Pakistani hosts: *Thalamita crenata, Scylla tranquiberica* and *Panulirus polyphagus.*

Found elsewhere and of their hosts there and elsewhere: Tropical to subtropical oceans. Australia, Taiwan, Bay of Bengal, Arabian Sea, Oman, Iran, Malay Archipelago. **Hosts:** *Charybdis callianassa*, *Charybdis truncata, Charybdis helleri*, *Charybdis vadorum*, *Ch. feriata*, *Portunus pelagicus*, *Scylla olivacea, Scylla tranquebarica. Scylla paramamosain*, Calappidae, Palinuridae, Majidae, Menippidae and Xanthidae.

Fig. 22. *Octolasmis angulata.*

Fig. 21. Host.

G. *Poecilasma* Darwin, 1852

***Poecilasma kaempferi* Darwin, 1852 (**Fig. 23)

Alternate names, updated and Pakistani records

Poecilasma kaempferi kaempferi Jones *et al.*, 2000
Poecilasma aurantia Darwin, 1851
Poecilasma kaempferi? Gruvel, 1905; Annandale, 1909 (in part); Krüger, 1911; Nilsson-Cantell, 1921; Chan *et al.*, 2009
Poecilasma dubium Hoek, 1907
Poecilasma kaempferi novaeangliae Pilsbry, 1907
Poecilasma kaempferi var. *dubium* Krüger, 1911; Moazzam and Rizvi, 1978.
Trilasmis kaempferi–Shahdadi *et al.*, 2014

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan, tropical and subtropical oceans. **Hosts:** Attached to the body of deep sea decapods at 185-914 m. Epizoic on *Macrocheira kaempferi*, *Neolithodes*, *Geryon trispinosus*, echinoderms (Williams 1986; Chan *et al.*, 2009).

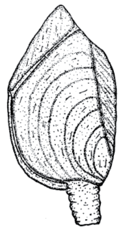


Fig. 23. *Poecilasma kaempferi*.

G. *Temnaspis* Fischer, 1884: *Fischeriella* nom. nov. was a replacement name for the genus *Temnaspis* Fischer, 1884 (Jones and Özdikmen, 2008).I have used the old name.

Temnaspis tridens **(Aurivillius, 1893)** (Fig. 24)

Alternate names, updated and Pakistani records.

Dichelaspis occlusa Lanchester, 1902
Poeeilasma iridens Aurivillius, 1894
Octolasmis tridens Nilsson-Cantell, 1934; Hashmi and Zaidi, 1965; Moazzam and Rizvi, 1978, 1982; Kumaravel *et al*., 2009
Dichelaspis (*Dichelaspis*) *tridens* Stubbings, 1936
Trilasmis (*Temnaspis*) *tridens* Stubbings, 1961
Temnaspis tridens–McLaughlin *et al*., 2005

Pakistani host: Lobster

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Hosts:** Mostly found attached to the mouthparts, along the inner carapace margin, on proximal leg segments, on the bases of epipodites, podobranchs and arthrobranchs, and lining the excurrent branchial passages of the decapod crustaceans mostly families Portunidae, Scyllaridae, and Menippidae (Jeffries *et al*., 1982).

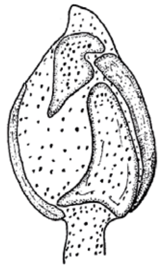


Fig. 24. *Temnaspis tridens.*

***Temnaspis minutum (*Gruvel, 1902) (**Fig. 25)

Alternate names, updated and Pakistani records.

Poecilasma minutum Gruvel, 1902
Trilasmis minuta–Moazzam and Rizvi, 1978; WoRMS, 2015

Pakistani hosts: Attached to the body of different decapods.

Found elsewhere and of their hosts there and elsewhere: Arabian Sea and Bay of Bengal. **Hosts:** Information not available

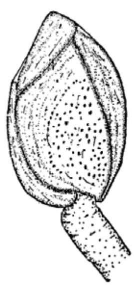


Fig. 25. *Temnaspis minutum*.

O. Sessilia Lamarck, 1818

S.O. Balanomorpha Pilsbry, 1916

SUP. F. Balanoidea Leach, 1817

F. Archaeobalanidae Newman and Ross, 1976-comprising on five sub families

G. *Conopea* Say, 1822: Currently, there are 21 described species of *Conopea.* There is very little data on host associations. All species of *Conopea* live in an obligate commensal symbiotic relationship with either a gorgonian or an antipatharian. The barnacle lives almost completely covered by host tissue, the basis of its shell clasps the axis of the host, with only the opercular opening exposed.

Alternate names, updated and Pakistani records.

***Conopea calceola* (Ellis, 1758)**
Balanus calceolus Ellis, 1758
Conopea calceola–Kazmi, 2001; Carrison-Stone *et al*., 2013; Shahdadi *et al*., 2014

Pakistani host: Commensal with gorgonids at 21-14m depth. 4-9mm

Note: Standing *et al*. (1983) have shown that gorgonians produce barnacle settlement inducers as well as inhibitors. Therefore locating a living gorgonian can be challenging for a small barnacle larva. When barnacle larvae locate and settle onto a gorgonian they may be recognizing the substratum, the presence of conspecifics, or both. It has been shown that barnacle larvae can determine where to settle by recognizing pheromone cues from their cohorts (Dreanno *et al*., 2007) or chemical cues from their host (Pasternak *et al*., 2004; Nogata and Matsumura, 2005).

Found elsewhere and of their hosts there and elsewhere: Indo-West Pacific, West Africa and Mediterranean. **Hosts:** Attached to horny coral.(Jones *et al*., 2000), *Eunicella singularis* (Gorgonia) (Peirano *et al*., 2013).

Fig. 26. *Conopea calceola*.

G. *Acasta* Leach, 1817

Acasta sp. (Figs. 27-28)

Alternate names, updated and Pakistani records.

Acasta sp. Tirmizi and Kazmi, 1995

Note: Commensal, embedded in sponge on hairs on the appendages of *Camposcia retusa*. Of barnacles, sponge-inhabiting taxa like *Acasta*, which are commensal or symbiotic with other marine organisms, may need to produce chemicals to prevent the host overgrowing them.

Pakistani host: *Camposcia retusa*

Fig. 27. *Acasta* sp.

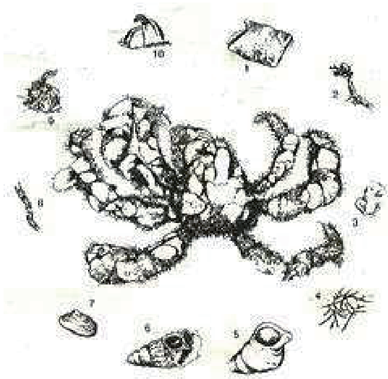


Fig. 28. Host and its associates. 1. calcareous tube; 2,4. seaweeds; 3. sponge; 5, 6. gastropod shells; 7. bivalve shell; 8. metallic chain; 9. *Acasta* sp; 10. Barnacle.

SUP. F. Coronuloidea Leach, 1817: They are specialized sessile crustaceans that live as obligate commensals of sea turtles, sirenians, whales, other crustaceans and sea snakes (Ross and Newman, 1967) (Fig. 29).

Fig. 29. Chelonibids on whale.

F. Chelonibiidae Pilsbry, 1916 divided into two subfamilies

S. F. Chelonibinae Pilsbry, 1916

G. *Chelonibia* Leach, 1817: *Chelonibia* is a genus in the monotypic family Chelonibiidae. Its members are epizoic and live attached to manatees, turtles, marine molluscs, sea snakes and crabs in all tropical and subtropical oceans. In a few instances, they have been found on alligators and inanimate substrates, but they are not found in the typical habitats of barnacles – on rocks, docks or boats.

***Chelonibia patula* (Ranzani, 1818)** (Fig. 30)

Alternate names, updated and Pakistani records.

Coronula patula Ranzani, 1818
Chelonobia patula–Javed and Mustaquim, 1994; Ozcan, 2012; Shahdadi *et al*., 2014

Pakistani hosts: *Charybdis helleri, Portunus segnis*

Note: It typically does not cause harm to its host. However, the weight of a heavy infestation may burden a crab; encrusted appendages can hamper its movement and the extra weight can increase vulnerability to predation (Overstreet, 1983). Infestations on crabs occasionally become so great that the barnacles weigh as much the crab. Over all the ectosymbiotism of *C. patula* affects the health, growth rate and economical value of the crabs.

Found elsewhere and of their hosts there and elsewhere : Occurs worldwide in warmer seas. **Hosts:** Lobsters,*Charybdis fruciata, Portunus segnis*, *Portunus sanguinolentes, Portunus validus, Arenaeus cribrarius, Callinectes bocourti, C. danae, C. amnicola, C. exasperatus, C. larvatus*, *C. sapidus*, *Hemigrapsus sanguineus, Libinia dubia* and *Scylla serrata*, *Hydrophis cyanocintus*, *Limulus polyphemus*, gastropod specifically *Busycon* spp, *Caretta caretta, Malaclemys terrapin macrospilota* and inanimate substrata.

Fig. 30. *Chelonibia patula* on host.

***Chelonibia testudinaria* (Linnaeus, 1758) (**Fig. 31)

Alternate names, updated and Pakistani records.

Lepas testudinaria Linnaeus, 1758
Chelonibia testudinaria–Mustaquim and Javed, 1993; Bugoni *et al*., 2001; Pereira *et al*., 2006; Shahdadi *et al*., 2014

Described material: Two males, 3 ov. females.

New material: 8-8-1995, Sand Spit, back of dead turtle.

25 mm. Shell is flattened, oval, white, and smooth, each side of plates is deticulated. Scutum is white and smooth, triangular; tergum is flattened, rectangular. Maxilla is globular; maxillule is without a notch, cutting edge is straight; mandible has 5 teeth, lower margin is short; mandibulatory palp is rectangular; labrum is clefted and is provided with numerous sharp teeth. Rami of cirrus I are sub-equal, armed with serrulate setae, intermediate segment of cirrus VI has 3 long serrulate setae.

Pakistani hosts: *Chelonia mydas, Caretta caretta* (Turtles)

Found elsewhere and of their hosts there and elsewhere: Worldwide. **Hosts***: Eretmochelys imbricata, Lepidochelys olivacea, Lepidochelys kempii, Natator depressus, Dermochelys coriacea, Chelonia mydas, Alligator mississippiensis*.

Fig. 31. *Chelonibia testudinaria* on host skin.

***Chelonibia caretta* (Spengler, 1790) (**Fig. 32)

Alternate names, updated and Pakistani records.

Chelonibia caretta–Rizvi and Moazzam, 2006; Kitsos *et al*., 2005; Badillo, 2007; Shahdadi *et al*., 2014

Pakistani host: *Eretmochelys imbricate* (Turtle), found attached to or embedded in the carapace.

Found elsewhere and of their hosts there and else where: Indo Pacific, Persian Gulf and Tropical Atlantic. **Hosts:** *Caretta caretta, Chelonia mydas*

Fig. 32.*Chelonibia caretta* on host skin.

F. Platylepadidae Newman and Ross, 1976- divided into four subfamilies

G. *Platylepas* Gray, 1825

***Platylepas ophiophila* Lanchester, 1902.**

Alternate names, updated and Pakistani records.

Platylepas ophiophilus Lanchester, 1902
Cryptolepas ophiophilus Kruger, 1912
Platylepas hexastyles Dong *et al*., 1980
Platylepas ophiophila–Utinomi, 1970
Platylepas krügeri Broch, 1931.
Platylepas ophiopholis Nilsson-Cantell, 1938; Chan, 2014
Platylepas ophiophia Ren, 1980; Liu and Ren, 2007.

Pakistani hosts: *Enhydrina schistosa*, *E. valakadyn, Hydrophis gracilis* and *Disteira major* (sea snakes). Found attached or embedded to the scales at the tail.

Found elsewhere and of their hosts there and elsewhere: Borneo; west Irian; Sea of Japan; Indonesia; northern Australia; western Australia; India; Malacca Strait; Manila; South China sea; Bay of Bengal, Arabian sea. **Hosts:** Sea snakes *Lapemis curtus, L. hardwickii, Aipysurus laevis, A. duboisii, A. eydouxii, Hydrophis elegans, Astrotia stokesii, Disteira kingie, D. Major,* Green turtle.

***Platylepas hexastylos* (Fabricius, 1798)**

Alternate names, updated and Pakistani records.

Platylepas hexastylos–Chan *et al*., 2009; Shahdadi *et al*., 2014

Pakistani host: Not exactly found in Pakistan but specimens were found attached to the front limb scales of the green turtle *Chelonia mydas* from Gwatr, Mekran Coast (25° 16'N, 60° 44'E) (Shahdadi *et al*., 2014),most likely to be occurring here also.

Shell with obvious external growth lines, median sulcus clear from ventral view, labrum with three teeth on each side. Largest specimen with basal diameter 8.0 mm.

Found elsewhere and of their hosts there and elsewhere: USA, Indo-Pacific. **Hosts:** Attached to sea turtles.

SUP.C. Oligostraca Zrzavy, Mihulka, Kepka, Bezdek and Tietz, 1998

C. Ichthyostraca Zrzavý, Mihulka, Kepka, Bezdek and Tietz, 1997

S. CL. Branchiura Thorell, 1864

O. Arguloida Yamaguti, 1963: The subclass Branchiura comprises about 175 species classified in six genera placed in a single order Arguloida and a single family Argulidae, ranging in length from a few millimeters to about 30 mm. All argulids are described as almost entirely as obligate ectoparasites of fish, but they are also frequently encountered swimming freely in the water column as they seek out new hosts, mates or when females detach from their hosts to deposit eggs, females deposit their eggs on stones and other objects. Many authors have commented on the lack of specificity of argulid parasites, sharing the opinion that individual species from this group can infect a wide range of host species (Kearn, 2004).However, some apparent host preferences have been demonstrated by Valtonen *et al*., (1997), Mikheev *et al*., (2000) and Pasternak *et al*., (2000). There are several reports of hundreds of *Argulus* species occurring on a single fish.

F. Argulidae Leach, 1819

G. *Argulus* Muller, 1785: The genus *Argulus* contains about 129 valid species and occurs in marine, estuarine, and freshwater habitats. Argulid females are generally larger than males, and the growth of the parasite may be influenced by the size of the host. Adults use suction discs for host attachment, whereas larvae utilize larval hooks (Pasternak *et al*., 2004; Oktener *et al*., 2007; Moller *et al.,* 2008). From Pakistan the genus

Argulus having 6 species is recorded. Two species from plankton are unnamed given here as sp 1 and sp 2.

* ***Argulus*** sp.1 (Fig. 33)

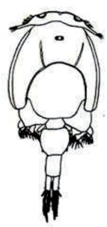


Fig. 33. *Argulus* sp. 1.

Pakistani host: Not known

****Argulus*** sp. 2 (Fig. 34)

Since the specimen was with ripe ovaries, it is presumed that it might have left the host for the purpose of egg laying and caught free in the plankton.

Pakistani host: Not known

Fig. 34. *Argulus* sp. 2.

Argulus sp.3 (Fig. 35-36)

Argulus sp Ghani and Ali, 2003

Pakistani host: *Pampus argenteus* (fish)

Note: There are probabilities that the undetermined species 3 is *Argulus quadristriatus* Ameer Hamsa, 1997 since it resembles *Argulus quadristriatus* found in neighboring waters of India.

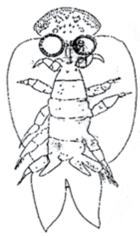


Fig. 35. *Argulus* sp. 3 (after Ghani and Ali, 2003).

Fig. 36. Host.

Argulus japonicus **Thiele, 1900** (Fig. 37)

Alternate names, updated and Pakistani records.

Argulus japonicus–Amin, 1981; Kazmi, 2003a; Yamaguchi and Shimizu, 2013

Not *Argulus japonicus* Jafri and Ahmed, 1991.

Material :from a household aquarium

Pakistani host: *Carassius* sp. (fish)

4-9 mm long and 3-6 mm wide. The tail is stumpy; suckers are ribbed, with rods exhibiting 5–9 imbricate plates, emerge from the maxillules; long mouth tube juts out ventrally from the head and can be fully retracted into the body; First antenna displays a knob at the anterior edge and the second antenna comprises two knobbed sections in the basal part and three sections in the distal part. Swimming legs are flagellated. There is a preoral spine on the ventral midline and post-antennal spines.

Found elsewhere and of their hosts there and elsewhere: originally described from China, but spread to Japan, Europe, Africa, Australia, and North America. **Hosts:** *Cyprinus carpio, Cyprinus rubrofuscus, Ctenopharyngodon idella, Labeo gonius, Labeo bata,Silurus asotus* and *Rhodeus ocellatus*.

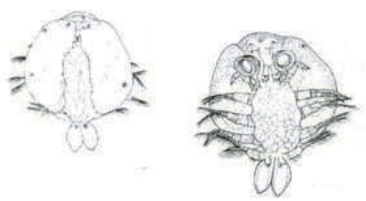


Fig. 37. *Argulus japonicus*.

Argulus sindhensis **Mahar and Jafri, 2011** (Figs. 38-39)

Alternate names, updated and Pakistani records.

Argulus sindhensis Mahar and Jafri, 2011

Pakistani host: *Labeo rohita* (fish)

The carapace is oval shaped, longer than wide, with different ratio in males and females; it does not cover the legs. On the dorsal side of carapace in the middle, there are two vertical, parallel ridges, starting from the level of eyes to the origin of first pair of legs. On the ventral side, along the margin of carapace, few rows of sharply pointed spines are present from sucker to the level of first pair of legs; the posterior lobes of carapace are rounded. The mesial sinus is broad in both the sexes. Anterior and posterior respiratory areas are sub-equal in length; both are long, narrow and slightly curved. Anterior end of outer area is club shaped and slightly touches the anterior end of the posterior respiratory area. Abdominal lobes in the female are short while in the male they are long and pointed. In female the abdominal lobes are 1.75 times longer than wide. Outer margin of lobes is curved; terminal portion is sub acute, with a short anal sinus, having small uropodes. Outer margin of lobes bear short, scattered setae. A pair of oval seminal receptacles is present. Body of male is narrower than that of female, carapace oval in shape and does not cover the last thoracopod. Both the respiratory areas are of almost equal width. Ventrally anterior half of the carapace bears many rows of small spines. Abdominal lobes are long and pointed, 2.4 times longer than wide .Outer margin is slightly curved. Anal sinus is much shorter as compared to that of female, having small uropods. Antennule is two segmented; terminal segment of the antennules has few very short spines in distal half and also some short terminal setae. Antenna is four segmented; terminal segment is provided with three spines. Two post antennal, long and blunt spines located in the medial position. Compound eyes are located at the base of post antennular spines. No median eye is present. A pair of suckers is present consisting of nineteen ribs. Each sclerite contains 5-6 imbricate plates. The maxilipedes are stout and five segmented .The first leg is similar to that of female. On the ventral margin of second segment of 2nd leg a row of small spines present. Second segment of 3rd leg bears a pair of rounded adhesive pads on the dorsal side and a long pad on ventral side. No notatory lobe is present in second segment of 4th leg as found in female (Adapted from Mahar and Jafri, 2011).

Found elsewhere and of their hosts there and elsewhere: Not outside Pakistan

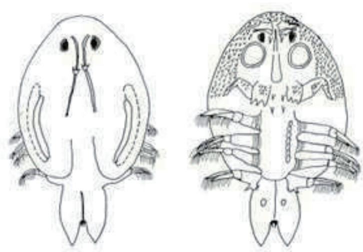


Fig. 38. *Argulus sindhensis* (after Mahar and Jafri, 2011).

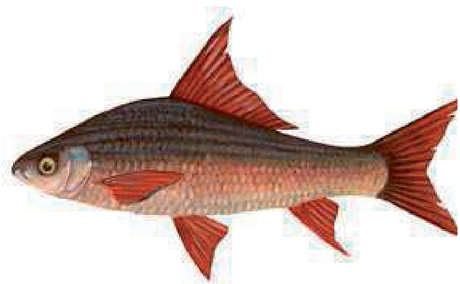


Fig. 39. Host.

***Argulus indicus* Weber, 1892** (Figs. 40-43)

Alternate names, updated and Pakistani records.

Argulus indicus Jafri and Ahmed, 1991; Lopez, 2001

Described material: Males 3.68-5.36 mm x 2. 76-4.35 mm; females 4.44-5.54 mm x 3. 77-4.15 mm

Pakistani hosts: *Labeo rohita, Gibelion catla* and *Cirrhinus mrigala* (fish)

Carapace is ovate, considerably narrows anteriorly with broad lateral lobes which fall slightly short of the abdomen, just reaching it or slightly overlapping it. Cephalic area is broadly triangular, distinctly separated from the rest of the carapace and projecting a little anteriorly. Anterior respiratory area is minute just anterior to the very large and oblong posterior one; second maxilla is slender, basal plate with three large teeth. The anterior surface of first antennae lacks knob or hook lacking. Basal plate of second maxillae is not lobed; tips of maxillary teeth are blunt, ribs of suction cup composed of three rods. Swimming lobe of fourth appendage is boot-shaped (After Lopez, 2001).

Found elsewhere and of their hosts there and elsewhere: India, Philippines. **Hosts:** *Oreochromis mossambicus*, *Carassius* sp., *Cyprinus carpio*, *Channa striata*, *Channa gachua*, and fresh water turtle *Lissemys punctata*.

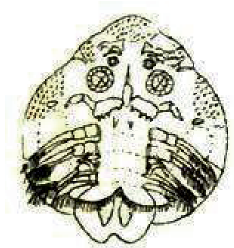


Fig. 40. *Argulus indicus* (after Jafri and Ahmed, 1991).

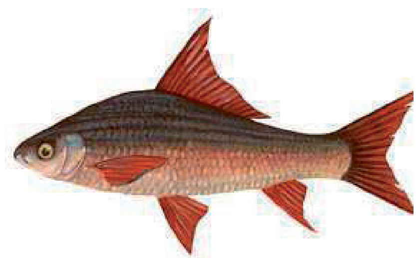


Fig. 41. Host 1.

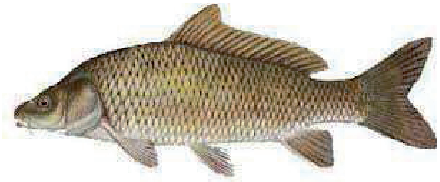


Fig.42. Host 2.

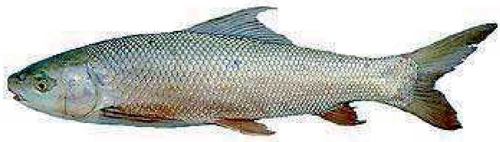


Fig. 43. Host 3.

Argulus bengalensis **Ramakrishna, 1951** (Figs. 44-45)

Alternate names, updated and Pakistani records.

Argulus bengalensis Jafri and Mahar, 2009

Pakistani host: *Cirrhinus reba* (fish)

Carapace sub ovate in female, oval in male, longer than wide; abdomen wider than long in female, in male abdomen longer than wide Respiratory areas banana shaped. Posterior respiratory area much smaller, located in the inner curve of anterior area; maxiliped stout with granulated surface, basal segment having three obtuse spines, last pair of thoracic leg in female bears notatory lobe, having a rounded portion and a pointed curved spine; 3rd pair of thoracic leg in males bears a large adhesive disc on ventral side, while the 4th pair has a small rounded adhesive disc on dorsal side. Anterior respiratory area minute, in the central mesial notch of the posterior one; ribs of suction cups with 5 to 6 imbricate plates of which the basal one is the longest; basal plate of second maxilla with three strongly pointed spines.

Found elsewhere and of their hosts there and elsewhere: India, Bangladesh. **Hosts:** *Cyprinus carpio*, *irrhinus mirgala* and *Eutroplichthys vacha*.

Male

Female

Fig. 44. *Argulus bengalensis* (after Jafri and Mahar, 2009).

Fig. 45 Host.

***Argulus foliaceus* (Linnaeus, 1758)** (Figs. 46-47)

Alternate names, updated and Pakistani records.

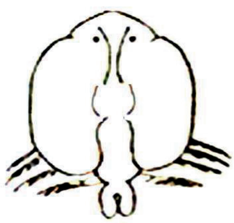
Argulus argulus Leach, 1814
Argulus armiger Müller, 1785
Argulus charon Müller, 1785
Argulus delphinus Müller, 1785
Argulus rothschildi Leigh-Sharpe, 1933
Argulus viridis Nettovich, 1900
Monoculus foliaceus Linnaeus, 1758
Monoculus gyrini Cuvier, 1798
Ozolus gasterostei Latreille, 1802
Argulus foliaceus–Jafri and Ahmad, 1991; Bhatti and Minhas, 2000; Chandra, 2006; Iqbal *et al*., 2013. Barzegar and Jalali, 2014

Pakistani hosts: *Cyprinus carpio* and *Carassius auratus* (fish)

3.7 mm; body is oval and flattened dorso-ventrally. Anterior end of cephalothorax forming broad protrusion is delimited laterally by shallow grooves. 2 complex faceted eyes are present. Cephalothorax is covered with a wide convex scutum and its posterior margin is indented. Anterior portion of cephalothorax forms a broad protrusion with shallow groove. Antennae I is modified. First maxillae are usually modified as powerful suctorial organs, which are clearly visible at ventral surface. The second maxilla is 5 segmented. There is dense ornamentation on it. Each thoracic segment bears a single pair of biramous swimming legs, the first 2 pairs of which in both sexes have a backwardly projecting process or flabellum. Urosome consisting of rounded lobes that are covered marginally with small spines. The posterior incisures of the urosome do not reach to the center.

Note: Since this is an obligate parasite of fish found in temperate region, its occurrence in south-east Asia was considered highly unlikely (Kabata, 1985). Now it is one of the most widespread crustacean ectoparasites of freshwater fish in the world in terms of both distribution and wide variety of fish it infests. This species has low host specificity, so it can infect a variety of fish within its habitat (Harrison *et al*., 2006; Pasternak *et al*., 2000; Taylor *et al*., 2006; Žiliukienė *et al*., 2012).

Found elsewhere and of their hosts there and elsewhere: Nearctic and palearctic region in advertently introduced to other continents along with its host throughout temperate regions of Europe, Central Asia, and North America, Philippines. **Hosts:** Cyprinidae, Salmonidae, Gobiidae, Gasterosteidae and Acipensenidae, parasitizes *Ballerus ballerus*, *Anguilla anguilla*, *Blicca bjoerkna*, *Carassius auratus, Lepomis gibbosu*n, *Leuciscus idus*, *Liza abu*, *Oncorhynchus mykiss*, *Perca fluviatilis*, *Rutilus rutilus*, *Salmo trutta*, *Scardinius erythrophthalmus*, *Silurus glanis*, *Sander lucioperca*, *Tinca tinca*, *Trachurus trachurus*, *Labeo calbasu, Gasterosteus aculeatus, Cyprinus carpio, Chalcalburnus chalcoides*, *Capoeta capoeta*, *Hypophthalmichthys molitrix, Mastacembelus mastacembelus*; Anura (frogs and toads), *Esox lucius, Abramis brama, Vimba vimba* and *Coregonus peled*.



(courtesy of Iqbal)

Fig. 46. *Argulus foliaceus* (after Jafri and Ahmad, 1991).

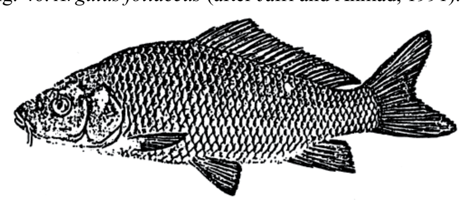


Fig. 47. Host.

S. CL. Copepoda H. Milne-Edwards, 1840: About 6000 valid species are known, which live in symbiotic associations. Most of these are probably parasitic but the precise nature of the relationship with the host has yet to be elucidated for the majority. Because of this uncertainty, such forms are typically referred to using the neutral term 'associates' in the literature. Six groups of typical parasitic life histories were recognized by Baer (1952): 1) all larval stages free swimming, only adults parasitic, 2) first larval stage and final adult stage free swimming, 3) one half of life cycle free swimming, 4) Nauplius and mature adults free swimming, all other stages parasitic, 5) part of larval development taking place within egg, third metanauplius and copepodid only free swimming, 6) first copepdid stage briefly swims freely then becomes parasitic.

It is evident that commensalism and parasitism have evolved independently several times in the subclass. It also has a range of associations from external and internal parasitism to varied forms of commensalism. Out of eleven copepod orders four of which are either wholly parasitic (order Monstrilloida), largely parasitic (orders Siphonostomatoida and Poesilostomoida) or contain some parasitic forms (order Harpacticoida). The body form of fish parasites varies from cyclopiform through to highly metamorphic .Copepods are known to be associated with all the major groups of marine vertebrates and invertebrates and aquatic plants. Their associations with cnidarians are among the best studied, although most of these copepods are symbiotic on benthic forms (i.e., Alcyonacea, Actiniaria, and Gorgonacea, among others) (Humes, 1985). There are only a few isolated records of copepods associated with epipelagic scyphomedusae, and all of these refer to strictly associated, non-planktonic forms (Boxshall and Halsey, 2004). Records of planktonic deep living copepods symbiotic on bathypelagic hydromedusae are also known (Gasca *et al.*, 2007). Species of limpets, opisthobranchs, shipworms, Bucciniids serve as hosts of copepods. There are 40 species of copepods belonging to 20 genera and nine families involved in association with decapods. These species have been found on four species of lobsters, 30 species of hermit-crabs and 23 species of brachyuran crabs.

In general, the symbiotic copepods of Pakistan are poorly known, particularly those occurring in association with marine invertebrates, certainly, those parasitic on marine fishes are better known than those parasitic or commensal on/in other hosts .There are at least 27 families which parasitize fishes .Parasitic families frequently inhabit relatively sheltered microhabitats on their hosts including the gill chambers, rectum and nostrils, although some species may occur on the outer body surface, on the fins or around the eyes. They usually attach using clawed antennae, but some also display modifications of the ventral body surface and limbs that allow them to generate suction onto the surface of the host. One group of copepods females develop into the huge, warty pustules. Somehow, the copepod causes the tissues of her host to grow a protective bag or gall around her body, lined with veins from which she somehow obtains blood. Somehow such actual feeding mechanism isn't fully understood. Joining the female in her anal skin-bag can be anywhere from one to several dozen tiny, arrow shaped males who spend their lives squished between the gall wall and their mate, competing with each other to fertilize her eggs.

In the marine intertidal zone many harpacticoids live in association with seaweeds, sea grass blades, marsh grass stems, macroalgal fronds, and floating algae (neuston) and are highly specialized for life on the surface of the fronds. Members of the Porcellidiidae, Peltidiidae, and Tegastidae are especially adapted to this environment. Phytal or epibenthic species display a host of body shapes including lateral and dorsal-ventral compression of the body, extremely rounded or broadened cephalosomes and larger overall size (Noodt, 1971). Harpacticoids are also found in burrows in wood inhabited by *Limnoria* spp., where the nature of the association is unclear (Hicks, 1988). Faunal community structure has been believed to be governed by plant diversity (Parker *et al*., 2001).

I. C. Neocopepoda Huys and Boxshall, 1991

SUP. O. Podoplea Giesbrecht, 1882

Key to orders of Podoplea containing associated species (after Gotto, 1993)

1. Buccal cone present, variously developed …. Siphonostomotoida

   Buccal cone absent ……………….………..………..………… 2

2. Mandible if present, basically of biting type ……………………… 3

   Mandible if present, basically falcate ..………. Poecilostomotoidea

3. Antenna one lacking an exopod ……………………..……. Cyclopoida

   Antenna one with prominent exopod ...…….……… Harpacticoida

O. Harpacticoida Sars, 1903: A few of them are planktonic others live in association with other organisms (invertebrates, vertebrates, weeds). There are 40 species, 20 genera and 9 families involved in association between harpacticoids and decapod crustaceans present in Indo-Pacific .Adult population with nauplii and copepodid stages associated with decapods indicates an early obligate association (Hendrickx and Fiers, 2010) but no such report is present here.

F. Tegastidae Sars G.O., 1904: Copepods of the family Tegastidae are characterized by a laterally compressed amphipod-like body, a modified male genital area, and nauplii possess a claw-like mandible (Lang, 1948, Ivanenko *et al*., 2008). All tegastid species have been found in shallow water habitats in association with algae, bryozoans and/or cnidarians, some listed as parasitic to corals. Currently 59 species belonging to 6 genera, namely *Tegastes, Smacigastes, Parategastes*, *Syngastes, Feregastes* and *Arawella* have been described world over. Only one genus is recorded from here.

G. *Parategastes* Sars G.O., 1904

***Parategastes* sp.** (Fig. 48)

Alternate names, updated and Pakistani records.

Parategastes sp Kazmi and Naushaba, 2001

Described material: One specimen (sex undetermined) collected during spatial diversity of meiofaunal study.

Head and last thoracic segment is large, produced ventrally, tapering to point; almost the whole surface is areolated. The seventh thoracic and first abdominal forms a genital complex produced ventrally into a large, elongated prominence; Maxilliped is 3-segmented, subchelate; syncoxa is elongated with 1 distal seta; basis has rows of spinules.

Pakistani associate: Unknown

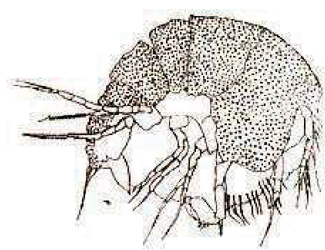


Fig. 48. *Parategastes* sp.

F. Thalestridae Sars, 1905

Note: Several thalestrid species have been reported to excavate galleries or form gall-like swellings within the macroalgal tissue.

G. *Paradactylopodia* Lang, 1944

***Paradactylopodia brevicornis* (Claus, 1866)** (Fig. 49)

Alternate names, updated and Pakistani records.

Dactylopus brevicornis Claus, 1866

Dactylopusia brevicornis Claus, 1866

Paradactylopodia brevicornis–Huys, 2001; Kazmi and Muniza, 2013 (Abstract).

Material: 18, all females, 20-11-1993 Jiwani,

Pakistani basibiont*:* *Sargassum*

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan; Bay of Bengal, European waters, Florida, Gulf of Mexico, Kenya, New Zealand, Japan. **Host:** Frond holdfast of *Laminaria ochroleuca*.

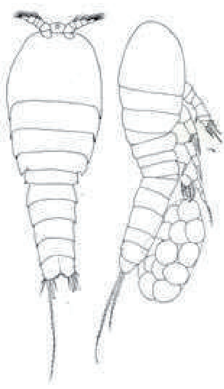


Fig. 49. *Paradactylopodia brevicornis*.

F. Peltidiidae Claus, 1860: The Peltidiidae are a world-wide distributed family of 100 pelagic, phytal and benthic species. Their often bright colours and typical dorso-ventrally depressed body shapes seem to characterize the Peltidiidae as an exclusively plant substrate-associated family.

G. *Eupelte* Claus, 1860

***Eupelte gracilis* Claus, 1860**

Alternate names, updated and Pakistani records.

Eupelte gracilis Kazmi and Muniza, 2013 (Abstract)

Material: One specimen, 20-11-1993, Jiwani

Pakistani basibiont: *Sargassum*

Found elsewhere and of their hosts there and elsewhere: North Atlantic. **Host:** Weeds.

F. Tisbidae Stebbing, 1910

G. *Sacodiscus* Wilson C.B., 1924

***Sacodiscus littoralis* (Sars G.O., 1904)** (Fig. 50)

Alternate names, updated and Pakistani records.

Aspidiscus littoralis–Sadiq, 1993
Sacodiscus littoralis Huys, 2001

Material: Abundant

Pakistani basibiont hosts: Algae *Sargassum swartzii, Padina pavonia, Endarchne binghamies, Stockeyia indica, Iyengaria stellata* and *Colpomenia sinousa*.

Found elsewhere and of their hosts there and elsewhere: North Atlantic Ocean. **Hosts:** *Ulva lactuca, Fucus serratus* (Hauspie and Polk, 1974).

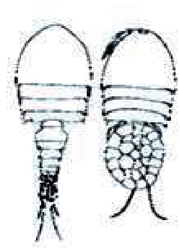
Fig.50. *Sacodiscus littoralis*.

***G. *Scutellidium* Claus, 1866**

****Scutellidium* sp. (Fi**g.51)

Material: Abundant**,** 20-6-1993, Jiwani, Baluchistan

Pakistani basibiont: *Sargassum*



Male Female

Fig. 51 *Scutellidium* sp.

F. Laophontidae Scott T., 1904

G. *Laophonte* Philippi, 1840

***Laophonte cornuta* Philippi, 1840** (Fig. 52)

Alternate names, updated and Pakistani records.

Laophonte cornuta cornuta Philippi, 1840
Laophonte cornuta dentioperculata Lang, 1936
Laophonte cornuta nigrocincta Nicholls, 1944
Laophonte forcipata Claus, 1866
Laophonte cornuta–Sadiq, 1993**;** Kazmi, 2004b

Pakistani basibiont: *Laurentia*

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan. Both Krishnaswamy (1957) and Murty (1983) collected adults and developmental stages from sponges and occasional specimens in algal washings. **Hosts:** *Halophila ovalis, Ulva fasciata, Caulerpa* *taxicola, Graclaria orticata, Amphiroa fragilissima*. Sub and eulittoral weed and reef (Por, 1964).

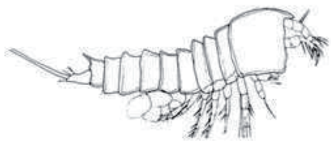


Fig. 52. *Laophonte cornuta*.

F. Porcellidiidae Boeck, 1865

G. *Porcellidium* Claus, 1860

Note: This genus and three other of the family are known to live in close association with Paguridae; one species is associated with sea urchin. The genus currently contains 64 species. With all but two generally regarded as marine algae and sea grass-dwellers.

***Porcellidium viride* (Philippi, 1840)** (Fig. 53)

Alternate names, updated and Pakistani records.

Porcellidium fimbriatum–Tirmizi and Sadiq, 1995
Porcellidium viride–Kazmi, 2004

Material: Abundant, females 0.6-0.8mm, males 0.45-0.5mm, 2004.

Pakistani basibionts: *Corallina, Sargassum, Caulerpa, Colpomenia* and *Ulva*

Note: There is a confusion between "viride" and "fimbriatum "(Harris, 2014). Lang (1948) lumped together *P. fimbriatum* and *P. lecanoides* under the one name *P. viride* Philippi. Other authors recognize *P. fimbriatum* as a valid species. Kazmi (2004) identified her *Porcellidium* as *P. viride*. The identification needs verification, but most probably this is *P. viride* since the body shape has ratio of L/W $\leq$ 1.5 while in *Porcellidium fimbriatum* this ratio is L/W > 1.7(Harris, 2014)

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan. **Hosts:** *Himanthalia elongata, Laminaria saccharina, Laminaria digitata, Ulva lactuca*

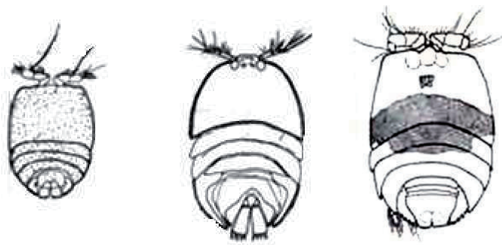


Fig. 53. *Porcellidium viride*.

F. Miraciidae Dana, 1846: The family Miraciidae consists of 426 species/subspecies which are classified into 50 valid genera most of which transferred from the former family Diosaccidae by Willen (2002).

G. *Metamphiascopsis* Thompson and Scott, 1903

***Metamphiascopsis hirsutus hirsutus* (Thompson and Scott, 1903)** (Fig. 54)

Alternate names, updated and Pakistani records**.**

Dactylopusia hirsutus Thompson and Scott, 1903

Metaphiascopsis hirsutus–Lang, 1948; Sadiq, 1996 (unpublished thesis data); Nurul Huda and Zaleha, 2009.

Pakistani basibionts: *Corallina* sp., *Hypnea maciformis*

Found elsewhere and of their hosts there and elsewhere: Bay of Bengal, Sri Lanka, Europe, and Algeria. **Host:** *Halimeda*

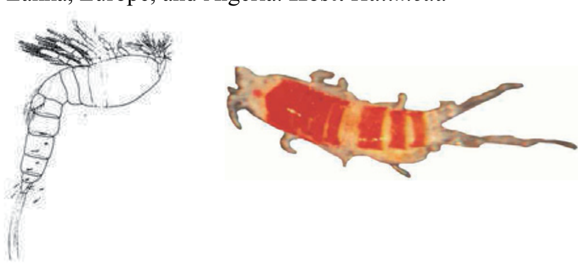


Fig. 54. *Metamphiascopsis hirsutus hirsutus.*

O. Poecilostomatoida Thorell, 1859 Mostly parasites and commensals of fishes and invertebrates.

F. Saphirinidae Thorell, 1860

G. *Sapphirina* Thompson, 183

Note: Sapphirinid Copepods are often associated with clams and salps in distribution (Hardy, 1936), spend part of their life as parasite and part of their life as predator i.e., they are parasitoid; 63 species are known worldwide, only one species is reported from here.

Sapphirina gemma Dana, 1849 (Fig. 55)

Alternate names, updated and Pakistani records.

Sapphirina Edwardsii Haeckel, 1864
Sapphirina gemma–Muniza, 1988 (unpublished thesis data); Kazmi, 2004; Vives and Shmeleva, 2010

Pakistani basibionts: Not specified as present specimen was collected from preserved plankton samples

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific, Red Sea, Atlantic, and Mediterranean. **Host:** Commensal in *SaIpa*

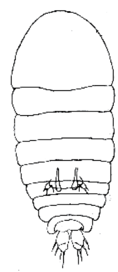


Fig. 55. *Sapphirina gemma*.

F. Clausidiidae Embleton, 1901

G. *Conchyliurus* Bocquet and Stock, 1957: Species of the genus *Conchyliurus* are exclusive associates of marine bivalves living in intertidal and shallow coastal waters. Eleven species are included in the genus.

Conchyliurus maximus **Reddiah, 1961** (Figs. 56-57)

Alternate names, updated and Pakistani records.

Conchyliurus maximus–Khan, 1977; Chad, 2014

Pakistani host: Adult parasitic in mantle cavity of *Sanguinolaria diphos.*

2.5 mm; Body form is somewhat elongate; first antenna is six segmented; second antenna is four segmented, with a claw on third segment; labrum has two globular expansions with denticulate margins; mandible has three terminal elements.

Found elsewhere and of their hosts there and elsewhere: India. **Host:** *Sanguinolaria diphos*.

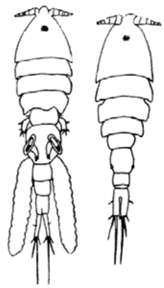


Fig. 56. *Conchyliurus maximus*.

Fig. 57. Host.

F. Chondracanthidae Milne Edwards, 1840: Chondracanthidae is one of the major families of Copepoda, comprising more than 150 species. Flat fish are the most preferred hosts of chondracanthids.

G. *Protochondracanthus* Kirtisinghe, 1950

***Protochondracanthus alatus* (Heller, 1865)** (Figs. 58-59)

Alternate names, updated and Pakistani records.

Chondracanthus alatus Heller, 1865

Chondracanthus angustatus Heller, 1865

Protochondracanthus psettodis Kirtisinghe, 1950, Ghani and Ali, 1996; Ostergaard, 2003

Protochondracanthus alatus–Yamaguti, 1963; Ho, 1970, Purivirojkul and Areechon, 2008; Abd El-Mohsen *et al*., 2013

Female: A pair of vermiform processes in oral region is found at bases of maxillae. First pediger is transformed into a short neck, bearing a pair of tripartite, lateral processes on both sides. Remaining pedigers are fused into a long cylindrical trunk, bearing a pair of long, lateral processes in front, another pair of short posterior processes at end, and a vermiform process at midposterior end. The abdomen is distinctly wider than long. Caudal ramus is in a form of spiniform process armed with three setae and a small tubercle. Egg sac is longer than body. The fleshy basal portion of antennule bear s a vermiform posteroventral process and a small knob-like setiferous terminal process; armed with 11 on basal portion and ten on terminal process. Antenna is two-segmented. Mandible is two-segmented; terminal blade with a row of 36 teeth on convex (inner) side. Maxillule is tipped with a lobe and two short setae. Maxilla is two-segmented. Maxilliped is slender and three-segmented; first segment largest but unarmed, second segment with spinules in terminal and subterminal regions, and third segment drawn out into a pointed process with two rows of spinules in basal region in addition to a single, subterminal spinule. Long, lateral process in anterior region of trunk tipped with four tubercles with each bearing a spinule at tip.

Male: the body has a swollen cephalosome. First two pedigers are separated, but remaining pedigers fused with genitor-abdominal somites. Caudal ramus is a short, spiniform process with six short setae in basal region and spinules in distal region. Antennule is filiform, armed. Antenna is two-segmented; terminal hook with a small outer knob in basal region. Mandible has a row of about 25 teeth on convex margin of terminal blade. Maxillule is tipped with a blunt knob and two setae. Maxilla as in female. Maxilliped is as in female only stubbier.

Pakistani host: *Psettodes erumei* (fish)

Found elsewhere and of their hosts there and elsewhere: Japan, Singapore, India, Mediterranean, Sri Lanka and Taiwan. **Hosts:** *Hippoglossus nolako, Epinephelus chlorostigma*, *Acanthopagrus berda, Acanthopagrus bifasciatus, Arius thalassinus, Cephalopholis hemistiktos, Cheimerius nufar, Epinephelus tauvina, Epinephelus chlorostigma, Halichoeres stigmaticus, Johinus maculates, Lethrinus nebulosus, Lutjanus ehrenbergi, Lutjanus malabaricus, Nematalosa nasus, Parastromateus niger, Plectorhinchus gaterinus, Plectorhinchus pictus, Pomadasys argenteus, Epinephelus chlorostigma, Scomberomorus commerson, Seriolinanigro fasciata, Siganus canaliculatus, Tylosurus crocodiles* and *Psettodes erumei.*

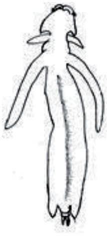


Fig. 58. *Protochondracanthus alatus*. (after Ghani and Ali, 1996).

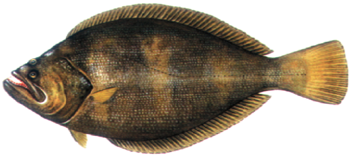


Fig. 59. Host.

F. Ergasilidae Burmeister, 1835: The copepod family Ergasilidae is one of the major families of the Cyclopoida (Ho *et al*., 1992, Boxshall and Montú, 1997) and is known to contain 26 genera and over 260 known species that are ectoparasites of teleosts mostly in freshwater, but also in brackish, and coastal marine waters (El-Rashidy and Boxshall, 1999). *Neoergasilus ferozepurensis* Kumari *et al*., 1988 on *Strongylura strongylura* is reported from Indian Punjab (River Sutlej, Ferozpur), is expected to occur here also.

G. *Ergasilus* Nordmann, 1832: *Ergasilus* has a direct life cycle using only the freshwater fish as a host. It can spend prolonged periods swimming free. It is not too host specific. Both sexes are free swimming, after mating male dies. Only female ergasilids enter the gill cavity of the fish, where they creep to the gills and attach using their large clasper-like claws which are second antennae trans formed into; the males free-living. The genus *Ergasilus* comprises more than 80 species, widespread in marine and freshwater habitats in many parts of the world (Kabata, 1985). They are sexually dimorphic. Though small-sized, *Ergasilus* spp. can become very harmful to the host, damaging the gills as a result of their attachment and feeding activities. In heavy infections, large areas of the gills may become eroded and respiration severely impaired (Kabata, 1970).

***Ergasilus pakistanicus* Jafri, 1995** (Fig. 60)

Alternate names, updated and Pakistani records.

Ergasilus pakistanicus Jafri, 1995

Pakistani host: *Mestacembalus armatus* (fish)

Cephalothorax is barrel shaped, longer than wide, depressed laterally at both ends, few small humps are present on the anterior margin. The thorax is made up of three free segments which gradually decrease posteriorly. Ovisac is elongated; last two abdominal segments are complete bifurcated (Adapted from Jafri, 1995).

Found elsewhere and of their hosts there and elsewhere: Not outside Pakistan.

Fig. 60. *Ergasilus pakistanicus* (after Jafri, 1995).

***Ergasilus* sp.**

Alternate names, updated and Pakistani records.

Ergasilus sp. Khan *et al*., 2003

Pakistani hosts: *Cyprinus carpio, Hypophthalmichthys molitrix*- Silver Carp

Note: *E. punjabensis* Battish on *Wallago attu* and *Ompok malabaricus* is reported from Indian side of Punjab (Ferozpur, River Sutlej). The present status of this species of *Ergasilus* in not known.

G. *Nipergasilus* Yamaguti, 1939

G. *Nipergasilus parabora* El-Rashidy and Boxshall, 2000 (Fig. 61)

Alternate names, updated and Pakistani records.

Nipergasilus parabora El-Rashidy and Boxshall, 2000

Material: Eight females

Pakistani host: *Valamugil cunnesius*

Found elsewhere and of their hosts there and elsewhere: India. **Host:** *Valamugil cunnesius*

Fig. 61. *Nipergasilus parabora* (after El-Rashidy and Boxshall, 2000).

F. Bomolochidae Sumpf, 1871

G. *Nothobomolochus* Vervoort, 1962: Flattened antennules and first swimming legs function as part of the sucker rim that forms the seal against the mucous-covered skin of the host. Primary attachment is by claws, the suckers provide a secondary attachment mechanism.

***Nothobomolochus triceros* (Basset-Smith, 1898)** (Fig. 62)

Alternate names, updated and Pakistani records.

Bomolochus triceros Bassett-Smith, 1898; Pillai, 1965a, 1969.
Bomolochus managatuwo Yamaguti, 1939
Nothobomolochus triceros–Vervoort, 1962; Pillai, 1965b; Ghani and Ali, 2003; Chinglong and Ho, 2004, Khosheghbal and Pazooki, 2015.

Described material: 10 Females TL 2-3.5mm

Pakistani host: *Pampus argenteus* (fish)

N. triceros can be easily distinguished by the nature of its antennule. The three basal segments are partially fused, with a stout chitinous plate carrying three long slender chitinised processes. The outer processes are apically drawn out whereas the median is apically blunt and shorter than the former. In addition to these the antennule carries on its basal part twelve stout strongly hirsute setae and three modified setae; the one nearest the chitinous plate is long. The cephalothorax is much broader than long. The second thoracic segment is transversely rectangular and the third transversely oblong. The fourth segment is partially overlapped by the third. Abdomen is four-segmented and its first segment is slightly broader than the fifth thoracic segment.

Found elsewhere and of their hosts there and elsewhere: India, Persian Gulf, North Pacific Ocean: Taiwan, and Japan. **Hosts:** *Lobotes surinamensis* gill cavity, *Pampus argenteus,* high host specificity towards *Pampus argenteus* (El-Rashidy and Boxshall, 2014)

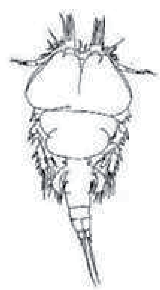


Fig. 62. *Nothobomolochus triceros* (after Ghani and Ali, 2993).

G. *Hermilius* Heller, 1865: This genus is exclusively parasitic on the gill filaments of marine fish of Ariidae known to occur in the tropical and subtropical of the world ocean, seven of the eight species occur on the Indian Ocean cat fish.

***Hermilius longicornis* Basselt- Smith, 1898** (Fig. 63)

Alternate names, updated and Pakistani records.

Harmilius longicornis–Niazi and Ahmed, 1973; Ho and Kim, 2000

Pakistani host: *Arius* sp. on gill filaments

Found elsewhere and of their hosts there and elsewhere: India, Sri Lanka, and Persian Gulf. **Hosts:** *Plicofollis dussumieri, Arius thalassinus, Arius acutirostris*.

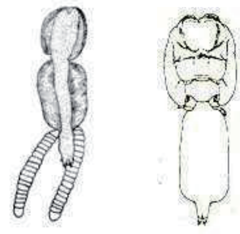


Fig. 63. *Hermilius longicornis* (after Niazi and Ahmed, 1973; Ho and Kim, 2000).

F. Shiinoidae Cressey, 1975- a monogeneric family.

***G. Shiinoa* Kabata, 1968**

Shiinoa occlusa Kabata, 1968

Alternate names, updated and Pakistani records.

Shiinoa occlusa–Cressey and Cressey 1981, Walter and Boxshall, 2015

Pakistani host: *Scomberomorus commerson*

Found elsewhere and of their hosts there and elsewhere: Pacific and Eastern Atlantic. **Hosts:** *Acanthocybium solandri*, *Grammatorcynus bicarinatus*, *Gymnosarda unicolor*, *Scomberomorus commerson, Scomberomorus guttatus, Scomberomorus niphonius, Scomberomorus queenslandicus, Scomberomorus tritor*

O. Cyclopoida Burmeister, 1834: There are 18 families in the order mostly parasites and commensals of fishes and invertebrates.

F. Lernaeidae Cobbold, 1879.

Note: The disease Lernaeosis caused by these parasites is reported to cause severe economic losses in fisheries sector of Pakistan (ABDA/NACA, 1991)

G. *Lernaea* Linnaeus, 1758: They are parasitic on fresh water teleosts. Only the worm-like females, which have horn-like processes or anchors on the cephalothorax, are parasitic. The encephalic horns enable the parasite to fix itself into the host muscle tissues, attaching on the outside surface of host body by boring into the underlying muscle tissues, although the greater part of the parasite body remains outside the host. Heavy infestation by *Lernaea* is fatal to the host.

***Lernaea multilobosa* Jafri and Mahar, 2003** (Figs. 64-65)

Alternate names, updated and Pakistani records.

Lernaea multilobosa Jafri and Mahar, 2003

The cephalic horns bear a considerable number of finger-like lobes, the 5th leg is distinctive, 6th leg is vestigial, anal laminae and setae on the abdomen are absent.

Pakistani host: *Salmostoma bacaila* (fish)

Found elsewhere and of their hosts there and elsewhere: Not reported outside Pakistan.

Fig. 64. *Lernaea multilobosa* (after Jafri and Mahar, 2003).

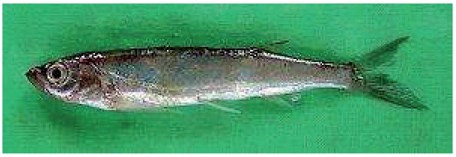


Fig. 65. Host.

***Lernaea polymorpha* Yü, 1938** (Figs. 66-67)

Alternate names, updated and Pakistani records.

Lernaea polymorpha–Shariff,1981; Tasawar *et al.*, 1999, 2007; Iqbal *et al.*, 2012; Kanwal *et al.*, 2012.

Pakistani hosts: *Labeo rohita*, *Ctenopharyngodon idella, Gibelion catla, Cirrhinus mrigala*

Found elsewhere and of their hosts there and elsewhere: Thailand; Malaysia; China. **Hosts:** *Cyprinus carpio, Puntius gonionotus, Hypophthalmichthys nobilis* and *Hypophthalmichthys molitrix.*

Fig. 66. *Lernaea polymorpha.*

Fig. 67. Host.

***Lernaea lophiara* Harding, 1950** (Fig. 68)

Alternate names, updated and Pakistani records.

Lernaea lophiara–Tasawar *et al*., 1999; Kanwal *et al*., 2012; Lopez, 2001

Pakistani hosts: *Labeo rohita, C. idella, C.mrigla, Hypophthalmichthys molitrix, Gibelion catla*

Found elsewhere and of their hosts there and elsewhere: Thailand. **Hosts:** *Puntius gonionotus, Lethrinops lthrinus, L. praeorbitalis, Haplochromis prostoma, H. breviceps, Rhamphochromis lucius, Pseudotropheus tropheops, Diplotaxodon argenteus, Tilapia melanopleura, Labeo cylindricus, Variorhinus nyasensis, Anabas testudineus, Glossogobius giurus, G. biocellatus, Aristichthys nobilis, Lebistes reticulatus, Ophiocephalus striatus, Oxyeleotris marmorata, Oreochromis mossambicus, Therapon plumbeus* and *Chanos chanos*.

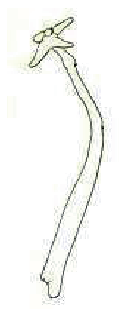


Fig. 68. *Lernaea lophiara* (after Yamaguti, 1985).

***Lernaea oryzophila* Monod, 1932**

Alternate names, updated and Pakistani records.

Lernaea oryzophila–Tasawar *et al*., 2007, 2011; Kanwal *et al*., 2012

Pakistani hosts: *Labeo rohita*, *Ctenopharyngodon idella*, *Cirrhinus mrigala, Gibelion catla, Hypophthalmichthys molitrix*.

Found elsewhere and of their hosts there and elsewhere: Cochin, China, and Thailand. **Hosts:** *Philypnus marmoratus, Hampala macrolepidota, Puntius gonionotus, Cyprinus carpio, Gobius* sp., *Hypophthalmichthys molitrix, Gibelion catla.*

***Lernaea arcuata* Soejanto, 1965**

Alternate names, updated and Pakistani records.

Lernaea arcuata–Tasawar *et al*., 2000, 2007

Pakistani hosts: *Hypophthalmichthys molitrix*, *Gibelion catla*

Found elsewhere and of their hosts there and elsewhere: Indonesia, Thailand. **Host:** *Puntius gonionotus*

***Lernaea cyprinacea* Linnaeus, 1758** (Figs. 69-71)

Alternate names, updated and Pakistani records.

Lernaea cyprinacea–Tasawar *et al.*, 1999, 2000, 2007; Minhas *et al.*, 2001; Khan *et al.*, 2003; Chandra, 2006; Iqbal *et al.*, 2012; Kanwal *et al.*, 2012

Pakistani hosts: *Labeo rohita, Gibelion catla; Ctenopharyngodon idella; Hypophthalmichthys molitrix, Cirrhinus mrigala, Aristichthys nobilis*.

Note: This species is one of the more common and well described species. Epizoic algae on this parasite from *Gibelion catla* was reported by Mahar *et al*., 2008.

Found elsewhere and of their hosts there and elsewhere: Europe, Scandinavia, France, Italy, and Germany, America, Japan, throughout Central Asia as well as in the southern regions of West Siberia,Iran,Philippines. **Hosts:** In more than 100 fish species belonging to 25 different families (Kabata, 1988); *Carissus auratus, Carassius carassius ,Anguilla japonica, Gobio gobio, Cyprinus carpio*, *Puntius partipentazona, Anabas testidineusm, Channa striata, Chanos chanos, Glossogobiub biocellatus, Glossogobius giurus, Terapon plumbeus*, *Capoeta aculeata, Capoeta damascina, Alburnus alburnus*, *Hemibarbus labeo, Zacco temminkii, Silurus asotus, Oreochromis niloticus*, *Mugil cephalus, Tilapia zillii, Aphanius vladykovi*, *Aristichthys nobilis, Ctenopharyngodon idella*, *Chalcalburnus mossulensis*, *Chondrostoma regium*, Hypophthalmichthys *molitrix*, *Leuciscus persidis*, *Mastacembelus mastacembelus*, *Pseudorasbora parva*, *Schizothorax* sp. and Amphibian *Rana boylii.*

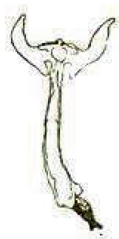


Fig. 69. *Lernaea cyprinacea*.

Fig. 70. On host 1 (courtesy of Z. Iqbal).

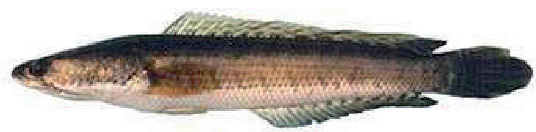


Fig. 71. Host 2.

***Lernaea ctenopharyngodonis* Yin, 1961**

Alternate names, updated and Pakistani records.

Lernaea cyprinacea Sharif and Sommerville, 1989
Lernaea quadrinucifera Poddubnaja, 1973
Lernaea ctenopharyngodonis–Tasawar *et al.*, 1999, 2000, 2007; Iqbal *et al.*, 2012, Raissy *et al.*, 2013.

Pakistani hosts: *Gibelion catla, Ctenopharyngodon idella, Hypophthalmichthys molitrix* (fish).

Found elsewhere and of their hosts there and elsewhere: China. **Host:** Adult parasitic on *Ctenopharyngodon*

G. *Catlaphila* Tripathi, 1960

***Catlaphilla elongata*Tripathi, 1960**

Alternate names, updated and Pakistani records.

Catlaphilla elongata-Ho *et al.,* 2009

Pakistani host: *Gibelion catla* (fish)

The maxilla is modified and armed with a robust hook for attaching to the host; the antenna is non prehensile; first and second pedigers are fused to form a narrow neck; the third and fourth pedigers are fused to form a large trunk; abdomen is long, 3-segmented; leg 1 with 2-segmented rami and legs 2-4 with 2- or 3-segmented, reduced rami (From Ho *et al.*, 2009).

Found elsewhere and of their hosts there and elsewhere: India. **Host:** *Gibelion catla*.

G. *Lamproglena* Nordmann, 1832: The species complex currently comprises 43 nominated species of the genus is very confusing; all of them are gill parasites of fresh water fish. Two species are reported from Sindh waters and six species by Kumari *et al*., (1989) on *Labeo bata* from Indian Punjab (Ludhiana).

Lamproglena chinensis **Yu, 1937** (Fig. 72)

Alternate names, updated and Pakistani records.

Lamproglena chinensis–Jafri and Mahar, 2009; Raissy *et al*., 2009
Lamproglena ophiocephali Yamaguti, 1939

Pakistani host: *Channa striata* (fish)

In adult female, cephalothorax is longer than wide and includes the first thoracic leg. Cephalothorax separated from trunk by deep constriction. Another constriction separates the anterior and posterior portion of cephalothorax. Trunk unsegmented externally, oval in shape, twice longer than wide. Trunk length 1/3 of total length. Four pairs of thoracic legs located on trunk. First pair of legs is located at the junction of cephalothorax and trunk. 5th leg is present on a separate small segment of the trunk. Genital segment, slightly wider than long and bears a pair of oblong shaped seminal receptacles. A pair of long ovisacs attached in gravid females. These contain oblong shaped, uniseriate eggs. Length of ovisac varies according to the number of eggs present. 18–30 eggs ovisacs of various females. Abdomen three segmented, length about half of total body length, length about seven times of width. First two segments together are less than the length of last segment, last segment narrower than the first two, last abdominal segment slightly bilobed and bears a pairs of caudal ramii. Tips of rami slightly tapering. Each ramus has a small conical spine and seta. First antenna, uniramous and unsegmented, bears a few setae on outer margin. Second antenna poorly developed. Mouth parts cyclopoid type. First maxilliped, one segmented stout, with a prehensile claw, second maxilliped, strong, two segmented and prehensile, terminal segment bears four claw like spines which are sub equal in size outer spine is the largest, 2nd, 3rd and 4th spines are gradually smaller in size. All spines are slightly curved. Four pairs of biramous legs present, 5th legs uniramous. Exopod and endopod of legs 1–4, two segmented, exopod with small terminal spines and few short setae, while endopod bears a row of short spines on inner margin. 5th leg has a slightly bilobed basipod. Outer lobe bears a long seta, while the inner lobe has two short setae. A small spine is also present on the basipod (Adapted from Jafri and Mahar, 2009).

Found elsewhere and of their hosts there and elsewhere: China, Japan, Thailand, Vietnam, and Iran. **Hosts:** *Anabus testudineus, Capoeta aculeata, Capoeta damascina* and *Capoeta capoeta, Ophiocephalus argus, Barillus hardmandi*, *Channa striata*.

Fig. 72. *Lamproglena chinensis* (after Jafri and Mahar, 2009).

***Lamproglena notopterai* Jafri and Mahar, 2006** (Figs. 73-74)

Alternate names, updated and Pakistani records.

Lamproglena notopterai Jafri and Mahar, 2006

Described material: One male, sex not confirmed, TL 3.6mm

Pakistani host: *Notopterus notopterus* (fish)

The cephalothorax is much longer than wide, head region is separated by a distinct notch, external segmentation is absent, and notches are present in anterior and posterior parts. Genital segment is wider than long, somewhat spherical in shape. The abdomen is quite long, unsegmented, consisting of anterior barrel shaped part and posterior cylindrical narrow part; the posterior end of abdomen is bilobed, with a pair of small lobe -like caudal rami. The fist antennae are three segmented; first maxilliped is prehensile, two -segmented; second maxilliped is much reduced. Two pairs of vestigial unequal thoracic legs are present in the anterior half (Adapted from Jafri and Mahar, 2006).

Found elsewhere and of their hosts there and elsewhere: No where outside type locality.

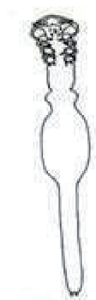


Fig. 73. *Lamproglena notopterai* (after Jafri and Mahar, 2006).

Fig. 74. Host.

O. Siphonostomatoida Thorell, 1859: Mostly parasites and commensals of fishes and invertebrates.

F. Caligidae Burmeister, 1834

G. *Caligus* Muller, 1785: Two hundred and thirty nine species are members of *Caligus* (Ho, 2000a) which can cause severe economic losses to fin-fish aquaculture, particularly of salmonids (Boxshall and Defaye, 1993, Pike and Wadsworth, 1999). Caligids typically attach to the host using a combination of claws and suction. Despite bodily modifications most caligid adults are freely motile over the surface of their hosts and adults of several species are routinely taken in plankton samples (Manora Channel 18-5-1994 -30-5-1995).

***Caligus punctatus* Shiino, 1955** (Fig. 75)

Alternate names, updated and Pakistani records.

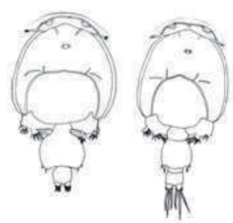
Caligus punctatus–Tirmizi and Sadiq, 1996; Maran *et al.*, 2009

Material: Four females 2.5-2.7mm, 2males TL 2.6-2.9mm, Manora Channel, 18-5-1994

Pakistani hosts: Not known. The present specimens were collected in the plankton

Note: Pale yellow pigmentation all over the body

Found elsewhere and of their hosts there and elsewhere: Japan. Malaysia, Taiwan, Korea. **Hosts:** *Lateolabrax japonicus, Epinephelus malabaricus, Chanos chanos, Acanthopagrus latus*, *Oreochromis aureus, Acanthopagrus schlegelii schlegelii, Lates calcarifer, Liza macrolepis, Mugil cephalus, Oreochromis mossambicus, Rhabdosargus sarba, Terapon jarbua, Trachinotus blochii*.



Female Male

Fig. 75 . *Caligus punctatus.*

Caligus diaphanus Nordman, 1832 (Fig. 76)

Alternate names, updated and Pakistani records.

Caligus isonyx Scott, 1894

Caligus diaphanus Nordman, 1832; Yamaguti, 1986; Niazi and Ahmed, 1973

Pakistani host: *Pampus argenteus*, gill cavity.

Found elsewhere and of their hosts there and elsewhere: Mauritania, British Isles, Atlantic coast from Spain to Norway, western Mediterranean, Adriatic Sea; India, Sri Lanka; Panama, Ghana. **Hosts:** *Chelidonichthys uculus, Terapon puta, Chelidonichthys capensis, Chelidonichthys lucerna, Eutrigla gurnardus, Gadus morhua, Lates calcarifer, Lepidotrigla cavillone, Lithognathus mormyrus, Pagellus acarne, Pagellus bogaraveo, Pagellus erythrinus, Platichthys, lesus, Pollachius virens, Scomberomorus tritor, Trachinotus botla, Trachurus trachurus, Trigla lyra* and *Trigloporus lastoviza*.

Fig. 76. *Caligus diaphanus* (After Niazi and Ahmed, 1973).

***Caligus robustus* Basset-Smith, 1898** (Figs. 77-78)

Alternate names, updated and Pakistani records.

Caligus robustus–Niazi and Ahmed, 1973; Ho and Lin, 2007; Pilla *et al.*, 2012

Caligus mercatoris Capart, 1941- Hayes *et al.*, 2012

Caligus oligoplitisi Carvalho, 1956- Hayes *et al.*, 2012

Caligus validus Pearse, 1952

Pakistani hosts: *Argyrops spinifer* and *Caranxs* sp. gill cavity.

4-5 mm. Second antenna is two segmented, basal segment is with one adhesion pad. First leg basipod is large with one short plumose seta in the inner proximal region and vestigial endopod is oblong with two spines.

Found elsewhere and of their hosts there and elsewhere: Indian Ocean, European waters, Jamaica, Brazil, Florida, Bermuda Texas and Mauritania, Taiwan. **Hosts:** *Carangoides bartholomaei*, *Caranx crysos*, *C. hippos*, *C. melampygus*, *C. ignobilis*, *C. sexfasciatus*, *C. sansun, C. leptolepis, Lutjanus analis*, *Chorinemus tala, Mugil, Oligoplites palometa*, *Oligoplites saliens*, *Oligoplites saurus* and *Selene setapinnis*

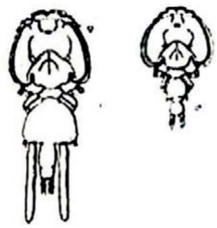


Fig. 77. *Caligus robustus* (after Morris and Cressey, 1986).

Fig. 78. Host.

Caligus platytarsis **Basset-Smith, 1898** (Figs. 79-80)

Alternate names, updated and Pakistani records.

Caligus platytarsis Bassett-Smith, 1898; Pillai, 1965; 1969
Caligus bombayensis Rangnekar, 1955; Niazi and Ahmed, 1973

6mm*;* abdomen is long, apparently one-segmented, setae are found on the fourth legs. Furca has two terminal knobs.

Pakistani hosts: *Mugil cephalus* and *M. speigliri* (Fish)

Found elsewhere and of their hosts there and elsewhere: India. Muscat. **Host:** *Mugil cephalus*

Fig. 79. *Caligus platytarsis* (after Niazi and Ahmed, 1973).

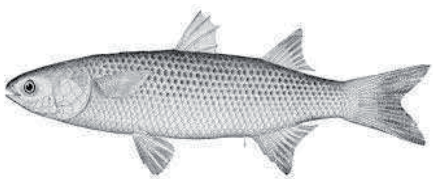


Fig. 80. Host.

***Caligus longicaudus* Basset-Smith, 1898** (Figs. 81 and 82)

Alternate names, updated and Pakistani records.

Caligus longicaudus Basset-Smith, 1898; Niazi and Ahmed, 1973; Dojiri and Ho, 2013

Pakistani hosts: *Megalaspis cordyla*, *Rastralliger kanagurta* and *Chirocentrus dorab*

Fig. 81. *Caligus longicaudus* (after Niazi and Ahmed, 1973).

Fig. 82. Host.

Found elsewhere and of their hosts there and elsewhere: India, Sri Lanka. **Hosts:** *Trichurus haumelia, Chirocentrus dorab*.

***Caligus dakari* Van Beneden, 1892** (Fig. 83)

Alternate names, updated and Pakistani records**.**

Caligus mauritanicus Brian, 1924
Caligus dakari–Niazi and Ahmed, 1973; Boxshall and El-Rashidy, 2009

Pakistani hosts: *Arius malabaricus*

Found elsewhere and of their hosts there and elsewhere: India, Sri Lanka and Africa, Europe. **Hosts:** *Argyrosomus regius, Plicofollis dussumieri, Ariopsis felis, Caranx rhonchus, Pseudotolithus moorii, Pseudotolithus elongatus, Dentex dentex, Dentex gibbosus, Plectorhinchus mediterraneus* and *Lichia amia*.

Fig. 83. *Caligus dakari* (after Niazi and Ahmed, 1973).

***Caligus cunicephalus* Gnanamuthu, 1950** (Figs. 84-85)

Alternate names, updated and Pakistani records.

Caligus cunicephalus–Niazi and Ahmed, 1973; not Pillai, 1963

Pakistani host: *Lepturacanthus savala*

Found elsewhere and of their hosts there and elsewhere: India. **Host:** *Trichiurus lepturus*.

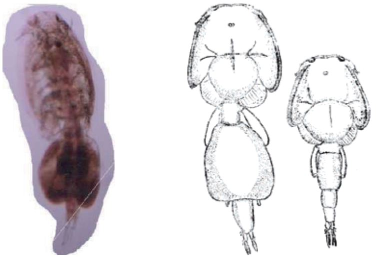


Fig. 84. *Caligus cunicephalus* (after Niazi and Ahmed, 1973).

Fig. 85. Host.

Caligus cordyla **Pillai, 1963** (Fig. 86-87)

Alternate names, updated and Pakistani records.

Caligus cordyla–Niazi and Ahmed, 1973; Boxshall and Huys, 2007

Pakistani host: *Magalaspis cordyla,* gill cavity

Found elsewhere and of their hosts there and elsewhere: India, New Caledonia, Papua, Taiwan. **Host:** *Megalaspis cordyla*

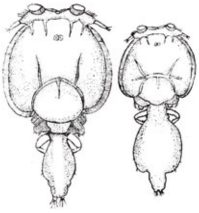


Fig. 86. *Caligus cordyla* (after Niazi and Ahmed, 1973).

Fig. 87. Host.

G. *Parapetalus* Steenstrup and Lutken, 1861

***Parapetalus hirsutus* (Basset-Smith, 1898)** (Fig. 88-89)

Alternate names, updated and Pakistani records.

Tripartia hirsutus Bassett-Smith, 1898
Caligus hirsutus Yamaguti, 1985
Parapetalus hirsutus–Kirtisinghe, 1950; Niazi and Ahmed, 1973; Leong, 1985; Lin and Ho, 2000

Pakistani host: *Eleutheronema tetradactylum*, gill cavity

Found elsewhere and of their hosts there and elsewhere: Sri Lanka, India, Java, Taiwan, and China. **Hosts:** *Polydactylus plebeius* and *Eleutheronema tetradactylum*

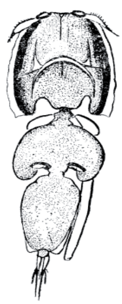


Fig. 88. *Parapetalus hirsutus* (after Niazi and Ahmed, 1973).

Fig. 89. Host.

G. *Sinocaligus* Shen, 1957

***Sinocaligus formicoides* (Redkar, Rangnekar and Murti, 1949)** (Figs. 90-91)

Alternate names, updated and Pakistani records.

Caligus formicoides Redkar, Rangnekar and Murti, 1949
Parapetalus formicoides Rangnekar and Murti, 1950
Pseudopetalus formicoides Niazi and Ahmed, 1973
Sinocaligus denticulatus Shen, 1957
Sinocaligus formicoides–Dojiri and Ho, 2012

Pakistani host: *Sardinella longiceps,* gill cavity.

Found elsewhere and of their hosts there and elsewhere: India. **Hosts:** Adult ectoparasitic on *Dussumieria acuta* and *Sardinella fimbriata*.

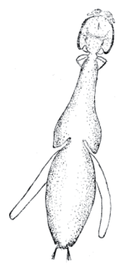


Fig. 90. *Sinocaligus formicoides* (after Niazi and Ahmed, 1973).

Fig. 91. Host.

G. *Synestius* Streenstrup and Lutken, 1861

***Synestius caliginus* Steenstrup and Lutken, 1861** (Fig. 92)

Alternate names, updated and Pakistani records.

Synestius caliginus–Niazi and Ahmed, 1973; Leong, 1985; Lin C -L and Ho, 2000; Purivirojkul and Areechon, 2008; Dojiri and Ho, 2012

Pakistani hosts: *Parasromateus niger* and *Pampus argenteus,* gill filaments.

Found elsewhere and of their hosts there and elsewhere: Batavia, Java, Malaysia, India, Sri Lanka, Persian Gulf, China, Taiwan, and Thailand. **Hosts:** *Lutjanus sebae*, *Parastromateus niger*.

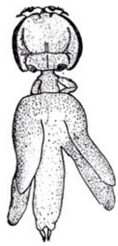


Fig. 92. *Synestius caliginus* (after Niazi and Ahmed, 1973).

G. *Caligodes* Heller, 1868

***Caligodes laciniatus* (Kroyer, 1863)** (Fig. 93)

Alternate names, updated and Pakistani records.

Caligus laciniatus Krøye, 1863
Sciaenophilus laciniatus Krøyer, 1863
Caligodes laciniatus–Niazi and Ahmed, 1973; Boxshall, 2001; Aneesh *et al*., 2013, 2014

Pakistani hosts: *Tylosurus strongylurus* and *T.leiurus*

Found elsewhere and of their hosts there and elsewhere: Europe, Florida; Mississippi; Caribbean Sea; northern Brazil; West Africa; west coast of Mexico; Peru; Hawaii; Japan; Maldives Island; India; Philippines; Haiti; Virgin Island; Red Sea; Trinidad; Venezuela; Gulf of Aden; Zanzibar; Madagascar; Arabian Gulf; Sri Lanka; Gulf of Thailand; Samoa; Panama; Cocoas Island and Taiwan. **Hosts:** *Platybelone argalus argalus, Tylosurus crocodilus crocodiles, Strongylura leiura,* *Strongylura strongylura, Tylosurus acus acus, Tylosurus acus imperialis, Tylosurus choram*.

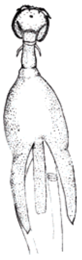


Fig. 93 *Caligodes laciniatus* (after Niazi and Ahmed, 1973).

G. *Lepeophtheirus* Nordman, 1832

***Lepeophtheirus plotosi* Barnard, 1948** (Figs. 94-95)

Alternate names, updated and Pakistani records.

Lepeophtheirus plotsoi–Niazi and Ahmed, 1973

Pakistani host: *Plotosus lineatus*

Found elsewhere and of their hosts there and elsewhere: South Africa. **Host:** *Plotosus lineatus*

Fig. 94. *Lepeophtheirus plotosi* (after Niazi and Ahmed, 1973).

Fig. 95. Host.

G. *Paralebion* Wilson, 1911: Four species are found in the genus.

***Paralebion elongatus* Wilson, 1911** (Fig. 96)

Alternate names, updated and Pakistani records.

Paralebion elongatus–Benz *et al.*, 1992; Ali, 1995; Dojiri and Ho, 2013

Fourth pairs of legs are uniramous and 4-segmented; other legs are biramous; maxillary hook and furca are present, the latter is double

Pakistani host: Unspecified marine fish.

Found elsewhere and of their hosts there and elsewhere: Chesapeake Bay, Galapagos Is. and Gulf of Mexico. **Host:** Sharks*, Carcharias obscures, C. commersoni, C. limbatus, Rhizoprionodon terraenovae, Negaprion brevirostris, Carcharinus leucas, Triaenodon obesus*.

Fig. 96. *Paralebion elongatus*.

***Paralebion aliuncus* (Rangnekar, 1955)** (Fig. 97)

Alternate names, updated and Pakistani records.

Diphyllogaster aliuncus Rangekar, 1955; Niazi and Ahmed, 1973; Ghani and Ali, 2003; Boxshall and Chad, 2014

Paralebion aliuncus Pillai and Padmanabhan, 1963

Pakistani hosts: *Pampus argenteus, Parastromateus niger*

5-7mm .The body is, elongated, cyclopoid. Antenna one is with an outwardly curved spines on the base which is projecting beyond the broad rostrum,the basal segment is with four strong outwardly directedspines,the remaining segments bear plumose setae and spines.

The second antenna is with a pectinate portion and claw like setae. First maxilla is with three strong setae; the second maxilla terminates into three setal processes. The thoracic legs are with well-developed thee segmented exo and endopodites. The fifth thoracic leg is uniramous and two -segmented. The telson is biramous,each ramus bears one very large and strong seta and two small setae on the lateral sides; in the middle of each ramus there is single outward seta.

In females the genital segments are enlarged. These segments have long posterior variable processes extening up to the telson. The first maxilliped is with two strong claws,the firt leg bears a rudimentary exopodite; fourth legs are uniramous.

Found elsewhere and of their hosts there and elsewhere: India. **Host:** *Pampus argenteus*.

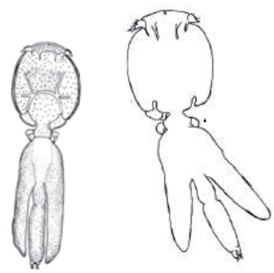


Fig. 97. ***Paralebion aliuncus*** (after Niazi and Ahmed, 1973; Ghani and Ali, 2003).

G. *Gloiopotes* Steenstrup and Lutken, 1861

***Gloiopotes ornatus* Wilson, 1905** (Figs. 98-99)

Alternate names, updated and Pakistani records.

Gloiopotes ornatus Wilson, 1905; Siddiqui and Bilqees, 1995

Pakistani host: *Thunnus albacares*

10mm. First and fourth legs are uniramous; hook and furca present on maxilla; both compound in females; genital segment with a pair of serrate syliform appendages.

Found elsewhere and of their hosts there and elsewhere: India, Atlantic. **Hosts:** Specific on swordfish and spearfish: *Tetrapturus amplus, Makaira mituskurii, M. nigricans, Carcharhinus plumbeus, Istiophorus albicans, Kajikia albida*.

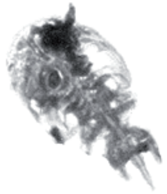


Fig. 98. *Gloiopotes ornatus* (after Siddiqui and Bilqees, 1995).

Fig. 99. Host.

Gloiopotes americanus **Cressey, 1967** (Fig. 100)

Alternate names and Pakistani record.

Gloiopotes americanus Cressey, 1976; Siddiqui and Bilqees, 1995; Dojiri and Ho, 2013

Pakistani host: *Thunnus albacores (*fish)

Found elsewhere and of their hosts there and elsewhere: Atlantic. **Host:** Sailfish *Istiophorus americanus*.

Fig. 100. *Gloiopotes americanus* (after Siddiqui and Bilqees, 1995).

G. *Tuxophorus* Wilson, 1908 – Six species are included in the genus, one is reported from Pakistan.

***Tuxophorus cervicornis* Heegard, 1962**

Alternate names, updated and Pakistani records.

Tuxophorus cervicornis–Australian Museum Marine Invertebrate Collection, 1950; Heegard, 1962;Cressey and Cressey, 1980

Pakistani host: *Scomberomorus commerson*

Found elsewhere and of their hosts there and elsewhere: Australia **Host**: *Scomberomorus commerson*.

F. Pennellidae Burmeister, 1834

G. *Lernaeenicus* Le Sueur, 1824: Thirty two species are included in the genus, two are found here. The third is a new record from here, will be published separately.

***Lernaeenicus hemirhamphi* Kirtisinghe, 1933** (Figs. 101-102)

Alternate names, updated and Pakistani records.

Lernaeenicus hemirhamphi–Niazi and Ahmed, 1973; Ghani and Ali, 1996; Gopala Krishnan *et al.*, 2010; Vijayakumar *et al.*, 2013

New material: 5-3-2003, 2013

Pakistani hosts: *Hyporhamphus xanthopterus, Thryssa, Polydactylus sexfilis*

Found elsewhere and of their hosts there and elsewhere: India, Sri Lanka, Hawaii, South Australia. **Hosts:** *Hemirhamphus intermedius*, *Hemiramphus far, Hemiramphus lutkei, Hyporhamphus xanthopterus.*

Fig. 101. *Lernaeenicus hemirhamphi*.

Fig. 102. On host tail.

Lernaeenicus* sp**. near ***seeri Kirtisinghe, 1934 (Figs. 103-104)

Material: Three females

Pakistani hosts: *Scomberomarus guttatus*

Fig. 103. *Lernaeenicus* sp. near *seeri.*

Fig..104. *Lernaeenicus* sp on host. (Courtesy of M. Moazzam).

***Lernaeenicus longiventris* Willson, 1917**

Alternate names, updated and Pakistani records.

Lernaeenicus longiventris–Masood *et al*., 2015

Pakistani host: *Mugil cephalus*

Found elsewhere and of their hosts there and elsewhere: Mauritania, Atlantic. **Host:** Mullets.

F. Pseudocycniidae Wilson, 1922

G. *Pseudocycnus* Heller, 1865

***Pseudocycnus appendiculatus* Heller, 1865**

Alternate names, updated and Pakistani records.

Pseudocycnus spinosus Pearse, 1952
Pseudocycnus thunnus Brandes, 1955
Pseudocycnus appendiculatus Ceressey and Ceressey, 1980

Pakistani host: *Thunnus albacares* ,*Thunnus tonggol*

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan.. Thailand; Peru, Seychelles Island, Somalia, Australia (Queensland), Philippines, Caroline Is.Florida, **Hosts**: 12 species of scombrids *Thunnus thynnus*, *T. alalunga*, *T. albacares*, *T. obesus*, *T. Tonggol, Euthynnus alletteratus*, *E. affinis*, *Coryphaena* sp, *Katsuwonus pelamis*, *Sarda sarda*, *S. chiliensis, Coryphaena hippunus*

G. *Cybicola* Bassett-Smith, 1899

***Cybicola armata* (Bassett-Smith 1899)**

Alternate names, updated and Pakistani records.

Helleria armata Bassett-Smith, 1898
Paracycnus lobosus Heegaard, 1962
Pseudocycnoides armatus (Bassett-Smith, 1898)
Pseudocycnoides lobosus (Heegaard, 1962)
Pseudocycnoides rugosa Kensley and Grindley, 1973
Pseudocycnus armatus (Bassett-Smith, 1898)
Pseudocycnus lobosus (Heegaard, 1962)
Pseudocycnus rugosus (Kensley and Grindley, 1973)
Cybicola armata–Cressey and Cressey, 2014

Pakistani host: *Scomberomorus commerson*

Found elsewhere and of their hosts there and elsewhere: Red Sea, India, Sri Lanka, Gulf and Thailand, Australia, Honkong, S. Africa.

Host: *Scomberomorus commerson*, *S. guttatus, S. koreanus, S. concolor, S. lineolatus, S. multiradiatus, S. plurilineatus, S. queenlandicus, S. semifasciatus*.

G. *Pseudocycnoides* Yamaguti, 1963

***Pseudocycnoides armatus* (Bassett-Smith, 1898**

Alternate names, updated and Pakistani records.

Paracycnus lobosus Heegaard, 1962

Pseudocycnoides armatus (Bassett-Smith, 1898) (superceded combination), Cressey and Cressey, 1980

Pseudocycnoides lobosus (Heegaard, 1962)

Pseudocycnoides rugosa Kensley and Grindley, 1973

Pseudocycnus armatus (Bassett-Smith, 1898)

Pseudocycnus lobosus (Heegaard, 1962)

Pseudocycnus rugosus (Kensley and Grindley, 1973)

Pakistani Host: *Scomberomorus commerson*.

Found elsewhere and of their hosts there and elsewhere: Red Sea (Suez), Malagasy Republic, India , Sri Lanka, Natal ,Gulf of Thailand, Australia (NSW and Queensland), Philippines, Borneo, New Guinea, Hong Kong, Sumatra, China. **Hosts:** *Scomberomorus guttatus*; *S. semifasciatus*; *S. lineotatus*; *S. koreanus*, *S. queenslandicus*; *S. plurilineatus*.

O. Monstrilloida Sars, 1901: The order Monstrilloida represents one of the most intriguing taxa among the Copepoda. They are endoparasites of marine invertebrates (pyramidellid and vermetid gastropod and polychaetes) during their postnaupliar and juvenile stages but also have three free-living phases, an infective naupliar stage, a final copepodite stage that leaves the host but soon moults, and non-feeding adults lacking mouthparts. Some species were observed as nodules on the mantle of molluscs or swellings of the body surface of polychaetes. Recently (Suárez-Morales, 2010), a species of *Monstrilla* was recorded infecting the mantle of the commercially valuable bivalve, the brown mussel *Perna perna* in Brazil. It was found with a high prevalence in this cultured population and a recent episode of mortality of this mussel (almost 20%) was partially attributed to this *Monstrilla*. If correct, this would be the first report of a monstrilloid's negative effect on a population of commercially valuable invertebrates. In general, they are rare; a reduced number of specimens can be obtained occasionally during plankton samplings from shallow coastal environments, particularly at night. There are, however, reports of relatively high local concentrations of monstrilloids in reef-related areas, where they can be highly diverse (Suárez-Morales, 2011).

F. Monstrillidae Giesbrecht, 1892

Note: One hundred and twenty species of seven valid genera are currently recognized, but some species have been synonymized or are deemed as invalid so the number of valid species is somewhat smaller. Because of their relative rarity in plankton samples and the taxonomic complexity of the group, there are large geographic areas in which the monstrilloid copepod fauna remains practically unknown (Suárez-Morales, 2011).

In the plankton samples it is difficult to link males and females of a species as they are mixed with those of other species in the water column.

G. *Monstrillopsis* Sars, 1921. Twelve species belong to *Monstrillopsis*.

***Monstrillopsis dubia* (Scott, 1904)** Fig. 105

Alternate names, updated and Pakistani records.

Monstrilla dubia–Zubairi and Khan, 1973
Monstrillopsis dubia–Suárez-Morales and Ivanenko, 2004.

Pakistani host: Not known

Note: It is considered that *M. dubia* and related forms represent a species complex with subtle morphological differences and a wide distribution.

The once purportedly cosmopolitan *M. dubia* is now known to contain at least three different species (Suárez-Morales and Ivanenko, 2004).

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan

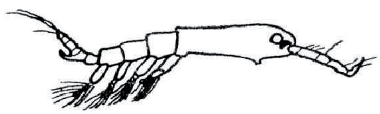


Fig. 105. *Monstrillopsis dubia* (after Zubairi and Khan, 1973).

G. *Cymbasoma* Thompson, 1888: Comprises 41 species, about one-third of all recorded monstrilloid species.

***Cymbasoma rigidum* Thompson, 1888** (Fig. 106)

Alternate names, updated and Pakistani records.

Thaumaleus rigidus Thompson, 1888; Dias, 1996
Monstrilla rigida Bourne, 1890
Monstrilla ostroumowi Karavaev, 1894
Cymbasoma rigidum–Khan *et al.*, 1975 Threlkeld, 1977; Grygier, 1995; Suarez-Morales, 2001, 2011; Bernier *et al.*, 2002; Vives and Shmeleva, 2010.

Pakistani host: Endoparasitic naupliar on polychaetes and gastropods and planktonic adult.

1-7mm. Cephalosome: Female cephalic segment is as long as rest of body, dilated in the middle. Male cephalic segment is without indentation near anterior end. An innermost fifth leg seta is almost as long as the other two, long elements on the second antennular segment present, two knob-like processes are present on the posterior margin of the genital somite. Legs 5in female is narrow. The genital segment of female is shorter than rest of abdomen, ovigerous spines are about half body length. Anal segment has a suture in dorsal view. The caudal rami have 3 strong setae, outer seta is attached to prominent projection; male has 4 furcal setae.

Note: The uncertainty of the identity of the original specimen and the geographic amplitude of the records of *C. rigidum* suggest that the nominal species represents a taxonomic complex with several undescribed taxa (Suárez-Morales, 2006).

Found elsewhere and of their hosts there and elsewhere: Atlantic, Pacific and Indian Oceans; absent from the eastern Pacific, central south Atlantic and Polar seas. **Hosts:** The serpulid polychaete *Salmacina dysteri* and the spionid polychaete *Polydora giardi*.

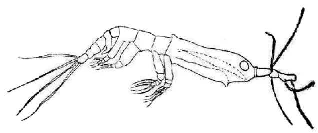


Fig. 106. *Cymbasoma rigidum* (after Khan *et al*., 1975).

Cymbasoma williamsoni **Khan, 1975** (Fig. 107)

Alternate names, updated and Pakistani records.

Cymbasoma williamsoni Khan, 1975a

Note: Endoparasitic naupliar and planktonic adults.

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Not outside type locality.

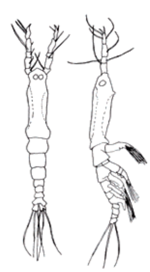


Fig. 107. *Cymbasoma williamsoni* (after Khan, 1975).

***Cymbasoma tirmiziae* Khan and Kamran, 1975.** (Fig. 108)

Alternate names, updated and Pakistani records.

Cymbasoma tirmiziae Khan and Kamran, 1975; Grygier, 1995

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Northern Arabian Sea.

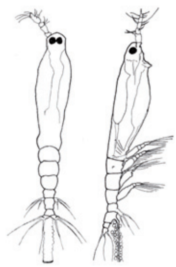


Fig. 108. *Cymbasoma tirmiziae* (after Khan and Kamran, 1975).

CL. Ostracoda Latreille, 1802: The phytal species are included here. The abundance of ostracodes differ significantly among algal types, with structurally complex algae bearing many more ostracodes per gram of algae than simple forms. Although most ostracode species are recovered from multiple kinds of algae, different algae harbour distinct assemblages ostracode samples, turf-forming algae are more species rich than samples from other kinds of macroalgae.Since turf-forming algae are easily damaged by human trampling, this component of ostracode biodiversity may be particularly vulnerable to anthropogenic impacts on the intertidal habitat (Frame *et al*., 2007).

O. Myodocopida Sars, 1866

F. Cylindroleberididae Mueller, 1906: Currently there are 219 described species in 32 genera.

G. *Cylindroleberis* Brady, 1867: There are currently 14 species in the genus.

***Cylindroleberis bacescui* Kornicker and Caraion, 1975** (Fig. 109)

Alternate names, updated and Pakistani records.

Cylindroleberis bacescui–Sadiq, 1993

Material: A large series, all females

Pakistani hosts: On all local algae

Found elsewhere and of their hosts there and elsewhere: Mauritania, Italy. **Host:** Not known.

Fig. 109. *Cylindroleberis bacescui.*

F. Sarsiellidae Brady and Norman, 189

G. *Ancohenia* Kornicker, 1976: *Ancohenia* could be collapsed in future into *Chelicopia* (Churchill *et al*., 2014)

Ancohenia robusta (Brady, 1890) (Fig. 110)

Alternate names, updated and Pakistani records.

Pleoschisma robusta Brady, 1890 [probably only part].
Sarstella robusta Brady, 1897
Eusarsiella robusta Poulsen, 1965
Ancohenia robusta–Kornicker, 1981; Sadiq, 1993

Material: A large series of both sexes

Pakistani hosts: Algae- *Colpomenia sinousa, Sargassum virgatus, Ulva fasiata, Caulerpa taxifolia, Iyengaria stellata* and *Padina pavonia*.

Found elsewhere and of their hosts there and elsewhere: North Pacific Ocean. **Host:** Not known

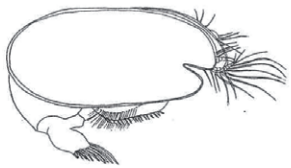


Fig. 110. *Ancohenia robusta*.

CL. Malacostraca Latreille, 1802

SUP. O. Peracarida Calman, 1904

O. Amphipoda Latreille, 1816: In Amphipoda the associations are of at least three types. 1). Amphipods living among the epifauna of crab carapaces, 2). Egg predators, and 3). Direct associates on the surface of the host, probably mainly commensals. Perhaps no Amphipoda except the cymid amphipods are the true parasites living on whales and are the only parasitic crustaceans which cannot swim during any part of their life cycle. (Fig. 111)

Fig. 111. Cymid amphipod.

The gammarids amphilochids and stenothoids and caprellids live with decapods and medusa, the medusae are either Hydromedusae or Rhizostomeae. The amphipods seem to feed on secretions from their hosts (Vader, 1983). Some amphipods-the hyperiids live inside host organisms such as salp tunicates, sponges, and sea anemones and are considered commensally symbionts using the salp test as a protective house, the host gains little or no advantage. Such an association may be epifaunal or endofaunal. In the latter instance the amphipod can be a parasite or commensal (Vader and Krapp-Schickel, 1996), not harming their hosts (Vader and Beehler, 1983). Some species are parasites or predators of heteropod molluscs and jellyfish in the plankton (Laval, 1980). The relationship is nearly always detrimental to the host, although Vader (1983) categorized the different types of hyperiid relations as ectocommensalism, endocommensalism, protection, and micropredation, while hyperiids also obtain buoyancy and transportation.

Caprellid amphipods are exclusively marine, most prefer low intertidal zones and subtidal waters among eelgrass, sponges, foliose invertebrates like hydroids and bryozoans, and this suggests that these amphipods use their hosts more as a substratum than as a partner in some interdependent association. They are typically seen attached to substrate by their grasping pereopods. Patton (1968) described the caprellid, *Caprella grahami* as a commensal on the starfish *Asterias*. Some amphipods are found almost exclusively on algae, but the nature of the relationships between amphipods and the algae is uncertain. Many species are found on more than one species of alga. From Pakistan Ahmad (1976) gave 12 species mentioning of specimens clinging to the fronds of algae, gave no more details. Members of some families build tubes, nests, or columns from strands of material secreted from glands in their anterior legs, variously incorporating mud, sand, shell, bryozoans fragments, and other particles from their habitats. One corophioid amphipod occurs only on the hermit crab, where up to 50 at a time live among the dense setae on the host's chelipeds, walking legs, and carapace (Moore, 1983).One gammarid was collected (26 March, 1994) from *Thais* shell harbouring *Diogenes planimanus*.

Amphipoda includes, currently, about 7,000 species grouped into four suborders: Senticaudata, Gammaridea, Hyperiidea and Ingolfiellidea, according to Lowry and Myers (2013).

S.O. Senticaudata Lowry and Myers, 2013: The suborder Senticaudata was split off from the formerly suborder Gammaridea by Lowry and Myers in 2013. It encompasses the previously recognized Caprellidea and Corophiidea.It includes almost all freshwater species as well as a number of marine benthic taxa.

I. O. Corophiida Leach, 1814 (sensu Lowry and Myers, 2013)

P. O. Corophiidira Lowry and Myers, 2013: Earlier Myers and Lowry (2003) proposed a phylogeny and classification for the suborder Corophiidea divided into two infraorders, the Corophiida and the Caprellida. In their new classification, the superfamily Caprelloidea contains five families: Caprellidae, Caprogammaridae, Cyamidae, Dulichiidae and Podoceridae. The family Cyamidae is a compact family, associate with whales; they are cosmopolitan found in all major zoogeographic zones. Despite its name, whale lice they are not true lice. Whale lice are found in skin lesions, genital folds, nostrils and eyes of the order Cetacea. Though cosmopolitan but not reported from Pakistan, however samples were collected from Cape Monze from a stranded whale (Moazzam, pers. corresp). The harmless parasites ride the whales their entire lives; their evolution reflects the evolution of the whales (Seger and Rowntree, 2012).

SUP. F. Corophioidea Leach, 1814

F. Ampithoidae Boeck, 1871: The amphipods from the family Ampithoidae are among the most abundant associated to the phytal substrates (Nelson, 1979; Edgar, 1983; Duffy, 1990). The taxon contains 13 genera and two subgenera which are divided between two subfamilies – the Ampithoinae and the Exampithoinae (Myers and Lowry, 2003).The Amphithoinae contains 12 genera, only one is present here.

G. *Cymadusa* Savigny, 1816: The genus is composed by 36 species. *Cymadusa filosa*, recorded from Pakistan, is in fact a species complex, and this situation has confused the generic concept (Peart, 2004). According to Peart (2007a), species of *Cymadusa* tend to be bigger, brighter and more colorful than other amphipods.

***Cymadusa filosa* Savigny, 1816** (Fig. 112)

Alternate names, updated and Pakistani records.

A*mpithoe filosa* Savigny, 1816

Cymadusa australis Barnard, 1940

Cymadusa coei Kunkel, 1910

Cymadusa hirsute Chevreux, 1900

Grubia filosa Savigny, 1816; Ahmad, 1976

Cymadusa filosa–Javed, 1983; Sadiq, 1993; Peart, 2004; Bano and Kazmi, 2012

Pakistani hosts: All local algae, common on *Iyengaria stellata*, *Padina pavonia, Colpomenia sinousa, Stockeyia indica, Sargassum virgatum.*

Note: *Cymadusa filosa* has long been considered a polymorphic, pantropical species complex (Ledoyer, 1984; Barnard and Karaman, 1991; Peart, 2004).

Found elsewhere and of their hosts there and elsewhere: Circumtropical (Griffiths, 1973). **Hosts:** *Sargassum binderi* and *Ulva lactuca*, weaving nest (tubes) out of algal fronds.

Fig. 112. *Cymadusa filosa*.

F. Corophiidae Leach, 1814

G. *Monocorophium* Bousfield and Hoover, 1997

***Monocorophium acherusicum* (Costa, 1853).**

Alternate names, updated and Pakistani records.

Corophium acherusicum–Ahmad, 1976; Horton *et al*., 2013

Monocorophium acherus Bousfield and Hoover, 1997.

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan. **Hosts:** Among alga *Zostera marina*, tunicates, polyzoa.

***Monocorophium insidiosum* (Crawford, 1937)** (Fig. 113)

Alternate names, updated and Pakistani records.

Corophium insidiosum Crawford, 1937
Monocorophium insidiosum–Bano and Kazmi, 2012; Bakir, 2012

Pakistani Associates: in mud tubes on algae.

Found elsewhere and of their hosts there and elsewhere: Atlantic Ocean, Pacific Ocean, Mediterranean Sea, and Northern Arabian Sea. **Hosts:** *Phyllochaetopterus socialis,* weeds, hydroids.

Fig. 113. *Monocorophium insidiosum*.

I. O. Talitrida Rafinesque, 1815.

Includes one pavorder, 4 superfamilies and 15 families

P.O. Talitridira Rafinesque, 1815

SUP. F. Talitroidea Rafinesque, 1815

F. Hyalidae Bulycheva, 1957 - divided into two subfamilies

G. *Protohyale* Bousfield and Hendrycks, 2002: The genus is subdivided into four subgenera, dominates the phytal communities of the rocky intertidal zone in abundance.

***Protohyale rubra* (Thomson, 1879)** (Fig. 114)

Alternate names, updated and Pakistani records.

Nicea rubra Thompson, 1879
Protohyale rubra Bousfield and Hendrycks, 2002

Hyale rubra–Sadiq, 1973; Barnard *et al*., 1993

Material: A large series, males only

Pakistani hosts: *Padina pavonia, Colpomenia sinousa, Stockeyia indica, Sargassum virgatum, Ulva fasiata*

Found elsewhere and of their hosts there and elsewhere: California, Chile, South Africa, Korea, Australia, and New Zealand. **Hosts:** *Ulva rigida, Enteromorpha intestinalis, Gigartina chamissoi, Pterocladia* capillacea, *Glossophora kunthii* also occurs in sea grass meadows (*Heterozostera tasmanica) (*Gonzalez, 1990)

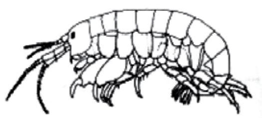


Fig. 114. *Protohyale rubra*.

***G. Apohyale* Bousfield and Hendrycks, 2002**

***Apohyale ayeli* (J.L. Barnard, 1955)** (Fig. 115)

Alternate names, updated and Pakistani records.

Hyale ayeli Barnard and Karaman, 1970; Sadiq, 1993
Apohyale ayeli–Bousfield and Hendrycks, 2002

Material: Large series, both sexes

Pakistani hosts: On all local algae, more occasionally on *Stockeyia indica***.**

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Host:** Thirty seven algal species given but not given specifically for *A.ayeli* (Coles *et al*., 1998)

Fig. 115. *Apohyale ayeli*.

I. O. Hadziida Karaman, 1932: Comprises of one pavorder, two superfamilies and 12 families.

P.O. Hadziidira Karaman, 1932

SUP. F. Hadzioidea Karaman, 1943 (Bousfield, 1983)

F. Maeridae Krapp-Schickel, 2008

G. *Elasmopus* Costa**, 1853:** It contains 95 species in the world and 50 species in the Indo Pacific; it is one of the most diverse maerid genera in the Indopacific tropics**.**

***Elasmopus pectenicrus* (Bate, 1862)** (Fig. 116)

Alternate names, updated and Pakistani records.

Moera pectenicrus Bate, 1862.
Elasmopus serrula Walker, 1904.
? Elasmopus brasiliensis Oliveira, 1951
Elasmopus pectenicrus–Barnard, 191*;* Ahmad, 1976; Sadiq, 1993; Krapp-Schickel and Ruffo, 1990; Appadoo and Steele, 1998; Appadoo and Myers, 2003; Lowry and. Hughes, 2009; Bano and Kazmi, 2012

Material: Numerous specimens of both sexes

Pakistani hosts: *Padina pavonia, Caulerpa racemosa, Stockeyia indica, Ulva fasiata*

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan in tropical and temperate seas. **Hosts:** Hydroids and crinoids, epibenthic, occasionally found on the carapace of the loggerhead sea turtle, *Caretta caretta* (LeCroy, 2000).

Fig. 116. *Elasmopus pectenicrus*.

S.O. Gammaridea Latreille, 1802

F. Cyproideidae J.L. Barnard, 1974: The Cyproideidae is a well-defined family of 18 genera and 43 species living mainly in the Indo-West Pacific have been described as of 2008. They are small, brightly coloured amphipods, often associated with other invertebrates such as hydroids, sea fans, bryozoans, sponges, soft corals and crinoids (Potts, 1915; Moore, 1992; Ortiz and Sanchez-Diaz, 2000), but some also naturally found in association with marine algae, intertidal rocks, or coral debris (Barnard, 1972; Moore, 1981; Lowry and Stoddart, 2003).

G. *Cyproidea* Haswell, 1879: Of the eleven cyproideid genera known from the Indo-West Pacific, the *Cyproidea* is the most widely distributed genus. So far, only six species of *Cyproidea* have been described, only one from Pakistan.

***Cyproidea ornata* Haswell, 1879** (Fig. 117)

Alternate names, updated and Pakistani records.

Cyproidea crinita Spandl, 1924
Cyproidea ornata–Sadiq, 1993; Lowry and Stoddart, 2003; Bano and Kazmi, 2012

Material: Few males only

Pakistani hosts: **S***tockeyia indica, Iyengaria stellata, Sargassum virgatum, S. swartzii*

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific, extending to South West Africa. **Host:** Dictyotalean alga.

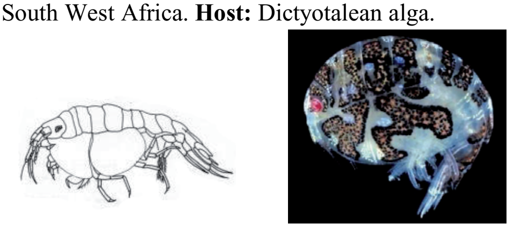


Fig. 117. *Cyproidea ornata*.

F. Leucothoidae Dana, 1852: It contains 163 species in five genera and can be found inhabiting sessile invertebrate hosts worldwide as endocommensal associates of sponges, ascidians, and bivalve molluscs, where they utilize the feeding current produced by their hosts to feed (White, 2011; White and Reimer, 2012).

G. *Leucothoe* Leach, 1814: *Leucothoe* is a cosmopolitan genus, currently comprised of 125 species that have been reported from wide variety of hosts, including sponges, bivalves and ascidians (Crowe and Thomas, 2002; Horton *et al*., 2013), where they find a stable microhabitat that provides feeding shelter from predation. Most authors have suggested that these amphipods are obligate symbionts of these hosts; they may also be found in fine sand or mud, or in association with algae, corals, or coral rubble. Two species of the genus *Leucothoe* are reported from Pakistan.

***Leucothoe furina* (Savigny, 1816)** (Figs. 118-119)

Alternate names, updated and Pakistani records.

Lycesta furina Savigny, 1816
Leucothoe hornelli Walker, 1904
Leucothoe furina–Kazmi, 1993,1995; Azman and Othman, 2013

Pakistani hosts: Tunicate and among the eggs of *Dorripoides* crab

Up to 12-18 mm. First coxal plate is prolonged anteriorly, rounded; first four plates have rounded distal margin. Posterodistal angle of third epimeral plate is quadrate or with minute blunt tooth. Eyes are large, irregularly rounded, bright red in colour. Palp of the mandible is stout. Antenna 1 is about one-third of body length, articles 1-2 of peduncle are of sub equal length, distal angle of article I acute, flagellum of about 15 - articules. Antenna 2 is little shorter than 1, peduncle article 4 is longer than 5, its flagellum of about 7-articles, accessory flagellum is minute. The carpal process of gnathopod I is smooth, and curved distally, inner margin of the propodus is minutely toothed, the dactylus is shorter than propodus. Carpus of gnathopod 2 is broad, densely setose, margin is lobed and crenulate, propodus is extremely large and robust; anterodistal angle is acute, palm is irregularly toothed, dactylus is long and curved; propodus is larger in male than female and margin is more strongly sculptured. The pereopods are slender. The telson is about three times as long as wide, with acute apex. Uropod 1 is spinose.

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan -Sri Lanka, Maldives, Red Sea, Suez, South Arabian coast, Thailand, Gamier Archipelago, East Indies and Australia. **Hosts:** Branchial sacs of tunicates, *Rhabdocynthia*, *Phallusia nigra*, atrial siphon of *Polycarpa aurita,* branchial sac of *Cnemidocarpa irma, Phallusia depressiuscula* (Nayar, 1966), *Ecteinascidia thurstoni*, sea anemones (Ortiz, 1975), sponges (Connes, 1967), bivalve molluscs (Ortiz, 1975), brachiopods (Vader, 1970), Actinaria *Bolocera luediae* (Vader, 1980), live corals (*Porites* sp., *Montipora* sp., *Acropora* sp.). *Leucothoe furina* shows a high tendency toward inquilinism, but with very low host specificity with a preference for *Polycarpa* sp.

Fig. 118. *Leucothoe furina*.

Fig. 119. Host.

***Leucothoe spinicarpa* (Abildgaard, 1789)** (Fig. 120)

Alternate names, updated and Pakistani records.

Gammarus spinicarpus Abildgaard, 1789

Cancer (*Gammarus*) *articulosus* Montagu, 1804

Leucothoe articulosa Bate, 1862

Leucothoe antarctica Pfeiffer, 1888

Leucothoe spinicarpa–Ahmed, 1976; Crowe, 2006; Chavanich *et al.*, 2007.

Pakistani host: Not recorded

10 mm. The coxal plate 1 is prolonged anteriorly, rounded; distal margin of plates 1-4 rounded. Posterodistal angle of epimeral plate 3 is quadrate. Eyes are large, irregularly rounded, bright red in colour. Antenna 1 is about one-third of body length, articles 1-2 of peduncle are subequal in length, article I has an acute distal angle, flagellum is made of 15 -articles. Antenna 2 is little shorter than 1; flagellum has nearly 7 articles. Gnathopod I carpal process is spiniform, smooth, curved distally, propodus inner margin is minutely toothed, and dactylus is shorter than the propodus. Carpus of gnathopod 2 has a broad, densely setose, posterior lobe, propodus is extremely large and robust; its anterodistal angle is acute, palm is irregularly toothed; dactylus is long and curved; propodus is larger in male than female and margin more strongly sculptured. The pereopods are slender. Telson is about three times as long as wide, the apex is acute.

Note: Crowe (2006) made no attempt to resolve the many records of *L. spinicarpa* from around the world. It is widely regarded to be part of a species complex with cosmopolitan distribution. Now this concept is vanishing and the Southern Ocean records of Leucothoe *spinicarpa* were analyzed to belong to several southern species (Krapp-Schickel and De Broyer, 2014).

Found elsewhere and of their hosts there and elsewhere: Introduced cosmopolitan. **Host:** Ascidian *Phallusia nigra*- the amphipod spends its entire life cycle inside the host (Thiel, 2000); this interaction provides not only food, but refuge for the juvenile amphipods, that can grow nearby the adults of the same species. Furthermore, within this microhabitat, parental care may occur in amphipods both in embryonic and post embryonic stages (Cantor *et al.*, 2009).Other ascidians are *Microcosmos exasperates, Styela plicata, Ascidia nigra, Clavelina oblonga* and stolonal ascidians. This species shows a high tendency toward inquilinism, but with very low host specificity. *L. spinicarpa* usually lives in sponges (Connes, 1967) or tunicates, but it has also been found in bivalve molluscs (Ortiz, 1975), brachiopods (Vader, 1970) and algae.

Fig. 120. *Leucotho spinicarpa* (Goole image).

SUP. F. Dexaminoidea Leach, 1814

F. Dexaminidae Leach, 1814

G. *Polycheria* Haswell, 1879: Members of genus *Polycheria* have a muddled taxonomy, they are cosmopolitan associates of tunicates and sponges, individuals live in tunicate domiciles excavated by them. There is no evidence that amphipod consumes its host ascidian tissues but this burrowing association with tunicate may provide an important structural or chemical refuge from prospective fish predators.

Polycheria atolli Walker, 1904 (Figs. 121-122)

Alternate names, updated and Pakistani records.

Tritaeta antarctica Walker, 1904
Polycheria atolli–Foster, 2008

The antennal seta is short, there is no apical seta on the inner plate of maxilla 1; dorsal keel on urosomite 1 is weakly developed; apical article of the maxillipedal palp is short and subtriangular. Urosomal segments have dorsal carinae, segments 2 and 3 are fused; pereopods are chelate; uropods 1 and 3 are subequal, 2 is much shorter with outer ramus half the inner; telson is cleft up to base.

Pakistani host: unknown ascidian, the amphipods were observed harbouring in the excavations made on host, leaving some appendages and red eyes exposed.

Found elsewhere and of their hosts there and elsewhere: Antarctic and southern Oceans, tropical Indian Ocean. **Hosts:** Compound ascidians and sponges (Griffiths, 1976).

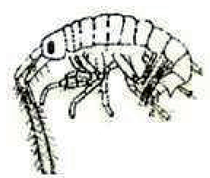


Fig. 121. *Polycheria atolli*.

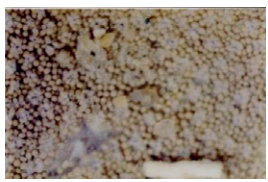


Fig. 122. Host.

P.O. Caprellidira Leach, 1814 (sensu Lowry and Myers, 2013) divided into seven superfamilies

SUP. F. Photoidea Boeck, 1871

F. Ischyroceridae Stebbing, 1899

G. *Ericthonius* Milne-Edwards, 1830

***Ericthonius brasiliensis* (Dana, 1852)** (Fig. 123)

Alternate names, updated and Pakistani records.

Erichthonius brasiliensis Dana, 1852; Duffy, 1990; Kazmi, 1995
Podoceros brasiliensis–Ahmad, 1976

Pakistani host: Associated with caprellids in algae

Found elsewhere and of their hosts there and elsewhere: Cosmopolitan in tropical and temperate seas. **Hosts:** Calcareous green algae *Penicillus capitatus*, or tubes of *Erichthonius* are attached to hydroids or ephemeral and filamentous algae. Host of ectoparasitic *Sphaeronella danica* Hansen, 1897

Fig. 123. *Ericthonius brasiliensis.*

SUP. F. Caprelloidea Leach, 1814, consisting of five families

F. Podoceridae Leach, 1814

G. *Laetmatophilus* Bruzelius, 1859: The genus contains 15 species worldwide.

***Laetmatophilus paradurbanensis* Bano and Kazmi, 2004** (Figs. 124-125)

Alternate names, updated and Pakistani records.

Laetmatophilus paradurbanensis Bano and Kazmi, 2004

The pereon is depressed, with 5-7 segments; urosome is made of 2 segments. Accessory flagellum is absent; epistome is produced; inner plate of maxilla 1 is greatly reduced, non-setose, outer plate is with 9 spines; maxilla 2 is without facial setae; maxilliped palp 4 is blunt; gnathopod 2 of female is nearly as large as that of the male; brood plates are preset on pereopods 2-4; uropod 2 is without rami, the uropod 3 is absent.

Pakistani hosts: *Camposcia retusa* (crab), *Muricella* (gorgonid).

Found elsewhere and of their hosts there and elsewhere: Not outside type locality.


Fig. 124. *Laetmatophilus paradurbanensis*.

Fig. 125. Host.

F. Caprellidae Leach, 1814: The caprellids inhabit mainly coral rubble, sediments and hydroids, rather than algae (Guerra-García, 2006)

G. *Pseudocaprellina* Sundara Raj, 1927

***Pseudocaprellina pambanensis* Sundara Raj, 1927** (Fig. 126)

Alternate names, updated and Pakistani records.

Pseudocaprellina pambanensis–Sadiq, 1993; Guerra-Garcia 2002, 2004; Zeina *et al.*, 2013.

The body is elongate stick-like and the abdominal appendages are reduced. Head is generally fused with pereonite 1; gnathopods 2 being the largest used in defense, feeding and substrate attachment. Gills on pereonites 3 + 4, rarely on pereonite 2. Pereopods 5-7 much smaller than 1 + 2, used for clinging to the substratum. In females, öostegites develop on pereonites 3 + 4.

Pakistani host: All local algae

Found elsewhere and of their hosts there and elsewhere: Indo Pacific, Red Sea associated with brown, red and green macro-algae macroalgae

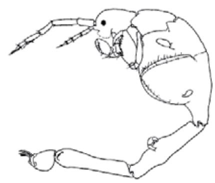


Fig. 126. *Pseudocaprellina pambanensis.*

G. *Hemiaegina* Mayer, 1890

***Hemiaegina minuta* Mayer, 1890** (Fig. 127)

Alternate names, updated and Pakistani records.

Hemiaegina minuta Mayer, 1890; Sadiq, 1993; Guerra-García, 2003, 2004, 2006; Bano and Kazmi, 2012; Zeina *et al.*, 2013.
Hemiaegina quadripunctata Sundara Raj, 1927
Hemiaegina costai Quitete, 1972

Pakistani host: Cnidarian colony

Found elsewhere and of their hosts there and elsewhere: Worldwide. Associates: brown algae *Coulpomenia peregrine* and *Hormophysa cunieformis* (Müller, 1990).

Fig. 127. *Hemiaegina minuta*.

SUB.O. Hyperiidea Milne Edwards, 1830: Hyperiids have developed a benthic-like existence on the pelagic substratum provided by gelatinous zooplankton (Laval, 1980). They are known to be associated, parasites and commensals, of marine gelatinous macro zooplankton. The hosts include siphonophores, medusae, salps and ctenophores, which the hyperiids use for transportation and protection (Gasca *et al*., 2007). The relationship between host and amphipod seems uncertain, but the consistent pairings of some species found only on the jellyfish indicate commensalism. Species of the family Phronimidae apparently eat the viscera of pelagic tunicates, siphonophores, and heteropods and use the prey's transparent covers as a refuge against predators and for rearing their eggs. Two families are included in this study.

I.O.Physocephalata Bowman and Gruner, 1973, divided into five superfamilies

F. Phronimidae Rafinesque, 1815,a small family of two genera

G. *Phronima* Latreille, 1802: The Phronimidae live in transparent "barrels, "open at both ends, made by remodeling pyrosomes or siphonophores. Females of the genus *Phronima* attack salp *Abyla* or *Abylopsis*, using their mouth and claws to eat the animal and hollow out its gelatinous shell. The nectophore of the siphonophore is fashioned into a barrel. By holding the abdomen outside of one of the barrel entrances and beating the pleopods, the *Phronima* can propel the barrel through the water as the larvae develop, providing them with fresh food and water . The genus *Phronima* contains 6 species, one is reported from here.

***Phronima bowmani* Shih, 1991 (Fig. 128)**

Alternate names, updated and Pakistani records.

Phronima colletti Bovallius 1887; Bano and Kazmi, 2005, 2012
Phronima gasti Dudich, 1926
Phronima bowmani Shih, 1991
Phronima dunbari Shih, 1991

Pakistani host: Not noted

Length to 18 mm (females), to 9 mm (males). The body is delicate and thin, particularly in females. The antennae in males are well developed. Antennae I have a five to six-segmented flagellum; antennae II are approximately 1.5 times longer and the flagellum 11 to 17-segmented. The head is generally bent ventrally. Pereopods III-IV are thin and approximately 1/3 longer than pereopods V. The 2nd segment of pereopods V is at least ¼ shorter than that of pereopods III and considerably shorter than the 2nd segment of pereopods IV. The length and breadth of the 4th segment of pereopods V are equal in females, while in males the width is greater than the length due to the strongly bulged posterior margin, with the result that the maximum width of the segment is seen in its proximal third; the width of the 5^{th} segment is more than its length in males while in females the segment is almost rectangular and generally narrower than in males, the posterior proximal angle of the 5th segment projects roundly along the posterior margin of the 4th segment; the anterior distal tooth is somewhat higher than the medial protuberance; the medial protuberance of the distal margins is not high with three-four close-set denticles on the posterior side, the medial denticle is developed in both sexes; the 6th segment does not project beyond the anterior margin of the 5th segment. The first pair of gills is greatly reduced and approximately half the second pair in size. The exopodite of uropod II is equal in length to the endopodite or slightly longer. The basipodites of all uropods have parallel margins.

Found elsewhere and of their hosts there and elsewhere: Atlantic, Mediterranean, Pacific, and Indian Ocean. **Hosts:** *Salpa aspera, Diphyes, Chelophyes appendiculata*.

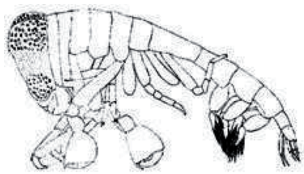


Fig. 128. *Phronima bowmani*.

F. Oxycephalidae Bate, 1861

G. *Oxycephalus* H. Milne-Edwards, 1830

***Oxycephalus clausi* Bovallius, 1890** (Fig. 129)

Alternate names, updated and Pakistani records.

Oxycephalus clausi–Barnard, 1937; Nayeem *et al.*, 1993;Nair, 1995
Oxycephalus tuberculatus Bate, 1862
Oxycephalus piscator Claus, 1879
Oxycephalus erythraeus Cecchini, 1929
Oxycephalus mancinni Cecchini, 1929

Pakistani host: Sampling disturbs natural associations so host is not defined.

Found elsewhere and of their hosts there and elsewhere: Mediterranean Sea, Red Sea, north and south Atlantic, Tropical and south Pacific and Indian Ocean. **Hosts:** Ctenophores, heteropods, salps and tunicates *Eurhamphaea vexilligera, Mnemiopsis mccradyi, Bolinopsis vitrea, Ocyropsis crystallina crystalline, Pterotrachea hippocampus, Pegea socia* and *Salpa cylindrica* (Madin and Harbison, 1977).

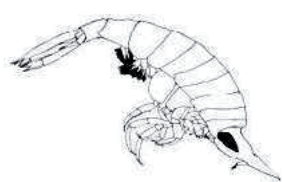


Fig. 129. *Oxycephalus clausi*.

O. Tanaidacea Dana, 1849: A minor order having about 1200 species in four suborders. Some Tanaidacea occur on hydroids, bryozoans, coralline algae, barnacles or other epibenthic organisms, others occur on mud. Most live either in tunnels or in tubes cemented together from particles of detritus. Shell inhabiting tanaidaceans are found in the family Pagurapseudidae also recorded from here.

S.O. Apseudomorpha Sieg, 1980

SUP. F. Apseudoidea Leach, 1813

F. Pagurapseudidae Lang, 1970: Divided into three subfamilies

G. *Pagurapseudes* Whitelegge, 1901 .Members of this genus, *Pagurapseudes*, live coiled inside tiny gastropod shells with their claws protruding like minute hermit crab.

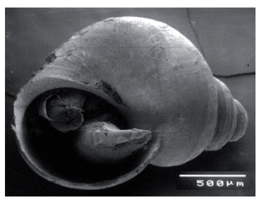


Fig. 130. Tanaid in gastropod shell.

***Pagurapseudes setulosa* Kazmi and Siddiqui, 2001** (Fig. 131)

Alternate names, updated and Pakistani records.

Pagurapseudes setulosa Kazmi and Siddiqui, 2001

Pakistani host: Small gastropod shells, shell species not noted.

Found elsewhere and of their hosts there and elsewhere: Not outside type locality.

Fig. 131. *Pagurapseudes setulosa.*

O. Isopoda Latreille, 1817: Isopods are the most diverse in form and the most species-rich crustaceans of the superorder Peracarida. Isopods are common inhabitants of nearly all environments –terrestrial,marine and fresh water; include more than 10,000 described species, in 10 suborders. A number of isopod groups have evolved a parasitic lifestyle. The suborder Cymothoida is exclusively parasitic, while the sub order Flabellifera is partly parasitic. In marine farms and reef aquaria, parasitic isopods can become a pest. many isopods are commensal, many species show strong preference for living upon algae.

S.O. Asellota Latreille, 1802: The Asellota are known to associate with other isopods; they have radiated widely from deep sea. The present family Joeropsididae is one of the shallow water marine families.

SUP. F. Janiroidea Sars, 1897

F. Joeropsididae Nordenstam, 1933

G. *Joeropsis* Koehler, 1885

***Joeropsis karachiensis* Kazmi and Yousuf, 2003** (Figs. 132-133)

Alternate names, updated and Pakistani records.

Joeropsis karachiensis Kazmi and Yousuf, 2003

Pakistani host: Serpulid reef wrongly given as sabellid reef for holotype (correction courtesy of J.Mustaquim)

3.0mm. Body is parallel-sided, Antero-lateral angles of cephalon are not very acute; cephalon wider than long, with pigmented dorso-lateral eyes. Rostrum is dome shaped, with transparent scales sub apically and fringe of hair apically. Lateral margin of the pereonites are smooth, few setae are present in the sub marginal area, and lateral margin of pleotelson with has 4-5 denticles. Antenna 1 is made up of 2 peduncular and 4 flagellar segments, its surface has few granules, the basal peduncular segment is the longest, its margins is produced into transparent fringe of shallowly rounded teeth and few setae; this membrane extends to other joints; penultimate flagellar joint is provided with 2 strongly developed asthetascs, ultimate joint is small, with 7 small and large setae. Antenna 2 consists of 6 segments; basal segment is the longest. All pereopods are similar without any armature except for few setae on all the segments, the dactylus terminates into three ungui. The laterodistal lobes of pleopod 1 are triangular, blunt; mesiodistal lobes triangular, with 12-13 marginal setae. The medio distal angle of uropod is acute, inner ramus bears 6 setae, outer ramus is shorter with 9 long and short setae.

Found elsewhere and of their hosts there and elsewhere: Not outside type locality.

Fig. 132. *Joeropsis karachiensis*.

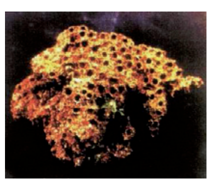


Fig. 133. Host.

***Joeropsis curvicornis* (Nicolet, 1894)**

Alternate names, updated and Pakistani records.

Joeropsis patagoniensis Richardson, 1909
Jaera curvicornis Nicolet, 1849
Joeropsis curvicornis–Ghani, 2003

Pakistani hosts: *Gellidum pusilum, Laurencia obtusa*

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific, Chile, Sri Lanka,New Zealand,Antartica. **Host:** No information

F. Santiidae Wilson, 1987: The Santiidae is a small family of the Asellota with 28 species in five genera.

G. *Halacarsantia* Wolff, 1989: Species of *Halacarsantia* are tiny (0.62–0.85 mm) and include seven marine species (Shimomura and Bruce, 2012). The genus is known from tropical and coral-reef habitats (Wolff, 1989).

Halacarsantia sp. (Fig. 134)

Alternate names, updated and Pakistani records.

Halacarsantia sp. Kazmi, 2001

Material: One female 4.5mmTL

Body is depressed, the pereonite 3 is the broadest of all pereonites, setae on body moderately long; head has large, broadly rounded frontal lobe with eleven setae, the eye lobes are clear, pleonite is dorsally invisible, article 2 of antenna 1 has a lateral projection, article 3 of antenna 2 having lateral projection with single seta, pereopods are robust short, pereopod 1 having one claw, and uropods are uniramous.

Pakistani host: Sea weeds.

Note: The present material is near to *Halacarsantia ovata* Shimomura and Ariyama, 2004 from Japan, *H. justi* Nolff,1989 and *H. colombiensis* Wolff and Brandt, 2000 from Columbia. The Pakistani specimen differs from described species (Wolff, pers comm.)

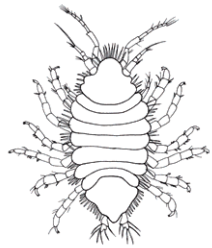


Fig. 134. *Halacarsantia* sp.

S.O. SphaeromatideaWägele, 1989, divided into two superfamilies

SUP.F.Sphaeromatoidea Latreille, 1825

F. Sphaeromatidae Latreille, 1825: This is a large family**.** Some species of spheromatoids are associated with limpets, chitons and some with wood as borers. Boring sphaeromatid isopods may destroy expanded polystyrene foam floats under docks. This boring damage was observed in multiple sites in Asia, Australia, Panama and the USA. An adult isopod expels thousands of microplastic particles when creating a burrow.

G. *Sphaeroma* Latreille, 1802: The genus *Sphaeroma* is cosmopolitan and contains several wood-borers of economic importance, about 25 present of valid species have been reported from the Indian Ocean. Mangrove boring *Sphaeroma terebrans, S. triste* and algal *S.walkeri* are reported from here.

Sphaeroma terebrans **Bate, 1866** (Figs. 135-136)

Alternate names, updated and Pakistani records.

Sphaeroma terebrans–Barkati and Tirmizi, 1990, 1991; Hossain and Bamber, 2013

Pakistani host: Live *Avecinnia* branches.

Note: The burrowing activities of *Sphaeroma terebrans* hinder the growth of mangroves, and its wood boring activities limits mangroves to the upper limits of the intertidal zone.

Fig. 135. *Sphaeroma terebrans*.

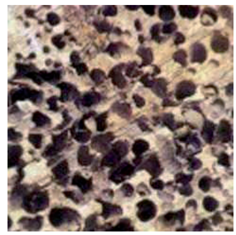


Fig. 136. Host wood damaged.

***Sphaeroma triste*–Heller, 1868**

Alternate names, updated and Pakistani records.

Sphaeroma triste Nooruddin, 1960; Singh and Sasekumar, 1994; Poore, 2002

Found elsewhere and of their hosts there and elsewhere: Nicobar, Malaysia, **commensal** *Iais singaporensis* Menzies and Barnard in corals

***Sphaeroma walkeri* Stebbing, 1905** (Fig. 137)

Alternate names, updated and Pakistani records.

Sphaeroma walkeri–Nooruddin, 1960; Ghani and Ali, 2001; Khalaji-Pirbalouty and Wägele, 2010

Material: No new material.one male TL33mm ,27-10-1989, Paradise Point; one male TL 16mm ,10-12-1989, Bulleji; one male TL 9mm ,29-9-1989, Bulleji

Pakistani hosts: Red algae

Found elsewhere and of their hosts there and elsewhere: Indigenous to the Indian Ocean, introduced to old world and new world ports. **Hosts:**

In sand tubes of sabellid worms, in the calcareous tubes of Serpulid worms, dense vegetation (*Grcilaria verrucosa, Cystoseira barbata*).

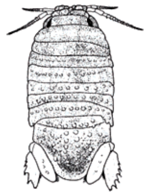


Fig. 137. *Sphaeroma walkeri*.

G. *Paracilicaea* Stebbing 1910: The genus *Paracilicaea* includes 20 Indo-Pacific species of infratidal or subtidal habitat. These are often recorded in association with corals, sponges or sea plants.

***Paracilicaea keijii* Javed, 1990** (Fig. 138)

Alternate names, updated and Pakistani records.

Paracilicaea keijii Javed, 1990; Benvenuti and Messana, 2000

Pakistani hosts: All local algae

Found elsewhere and of their hosts there and elsewhere: Somalia. **Host:** *Pocillopora* coral.

Fig. 138. *Paracilicaea keijii*.

G. *Paraimene* Javed and Ahmed, 1988: The genus is found from coral rubble encrusted with coralline algae.

Paraimene tuberculata Javed and Ahmed, 1988 (Fig. 139)

Alternate names, updated and Pakistani records.

Paraimene tuberculata Javed and Ahmed, 1988; Sadiq, 1993; Ortiz *et al.*, 2012

Pakistani hosts: *Ulva fasiata, U. indica, Stockeyia indica, Sargassum swartzii, Padina pavonia, Codium iyengarii, C, latum,Colpomenia sinousa; Sarconema furcatum* and *Cystoseira indica*.

Found elsewhere and of their hosts there and elsewhere: Not outside Pakistan

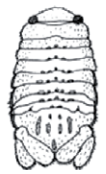


Fig. 139. *Paraimene tuberculata.*

G. *Paracerceis* Hansen, 1905

***Paracerceis sculpta* (Holmes, 1904)**

Alternate names, updated and Pakistani records

Paracerceis sculpta–Yasmeen and Javed, 2001; Ariyama and Otani, 2004

Pakistani host: Algae attached to poles of the wharf

Found elsewhere and of their hosts there and elsewhere: Mediterrnean, Europe, Northeast Pacific from Southern California to Mexico, but has since been introduced to many other countries **Host:** Algae and sponges

F. Limnoriidae White, 1850 The family Limnoriidae are mostly pale white and small crustaceans, 6 mm in length have various species which bore into marine plants as tunnels into wood, seagrasses or macroalgae as well as submerged intact wood or timber. There are three known genera, *Paralimnoria, Limnoria*, and *Lynseia* in 56 species. Little is known which species is actually involved in Pakistan.

G. *Limnoria* Leach, 1813

Approximately 20 species constitute the genus. Two species, *L. bombayensis* and *Limnoria lignorum* are reported from Pakistan. However identification of *L. lignorum* is unlikely from Pakistan as most wood boring limnoriids were called *L. lignorum*. *L. lignorum*, is a cold-water, high-latitude species.

Some authors argue that *L. lignorum* has worldwide distribution. However, this is unclear as reports from different locations may be based on specimens of other species (Holthuis, 1949). Furthermore, Cookson and Cragg (1991) did not give it in the Indo-Pacific list of species of *Limnoria*.

***Limnoria lignorum* (Rathke, 1799**) (Figs. 140-141)

Alternate names, updated and Pakistani records.

Cymothoa lignora Rathke, 1799
?*Limnoria lignorum*–Anwarullah, 1971

In favourable conditions can be present in large numbers, with densities of as many as four hundred individuals per 1 in^3 (16.4 cm^3) of wood.

Pakistani hosts: Not specified

Found elsewhere and of their hosts there and elsewhere:

A world-wide distribution. but the history of its introduction and spread have been significantly complicated by centuries of cross oceanic travel in the hulls of wooden ships. **Host:** marine plants as well as submerged intact wood or timber wood borer.

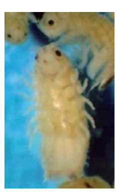


Fig. 140. *Limnoria lignorum*.

Fig. 141. Marine piling damaged.

***Limnoria bombayensis* Pillai, 1961**

Alternate names, updated and Pakistani records.

Limnoria bombayensis–Anwarullah, 1971

Found elsewhere and of their hosts there and elsewhere: Western Indo-Pacific. **Host:**mangrove forest wood

S.O. Cymothoida Wägele, 1989

SUP. F. Anthuroidea Leach, 1914

F. Paranthuridae Menzies and Glynn, 1968

G. *Paranthura* Bate and Westwood, 1866

***Paranthura latipes* Barnard, 1955** (Fig. 142)

Paranthura latipes -Javed and Yasmeen, 1992; Sadiq, 1993; Kazmi and Yousuf, 2012

Pakistani hosts: *Halimeda tuna, Stockeyia indica, Caulerpa taxifolia, Chaetomorpha antenna, Bryopsis plumose*

Found elsewhere and of their hosts there and elsewhere: Mozambique. **Host:** Not known.

Fig. 142. *Paranthura latipes*.

I. O. Epicaridea Latreille, 1831: Infraordinal status of Epicaridea is provisional pending further analyses of relationships with other cymothooids. Epicaridea is a former suborder of Isopoda, now treated as part of the suborder Cymothoida. About 704 species have been recorded. They represent a diverse group of highly derived taxa in two super families and 10 families. Epicaridean isopods are ecto parasitic on other crustaceans namely ostracods, copepods, barnacles and malacostracans.

Host specificity is highly variable. The epicarideans bring change in the host by the energy burden they impart on hosts, which can sometimes be compounded by multiple isopod infestations on a single host. In addition to these major potential impacts on host reproduction, parasitic isopods may also affect the morphology and perhaps also the behaviour of hosts. Of the 95 known families of Isopoda only a few are holoparasitic ectoparasites namely, Bopyridae, Cryptoniscidae, Cymothoidae, Dajidae, Entoniscidae, Gnathiidae and Tridentellidae. Three taxa Bopyroidea, Cryptoniscoidea and Cymothooidea, including Gnathiidae are composed of parasites that attach either permanently or during larval stages to their hosts, some cymothooids such as Aegidae are temporary ectoparasites or micropredators of fish. A lack of sampling is suggested to reflect fewer parasitic species records from here rather than a true representation of the number of associates. New material is being described at coarse taxonomic levels for the time being.

Unidentified epicaridean sp.

Microniscus stage (Figs. 143-144)

Alternate names, updated and Pakistani records.

Microniscus larva Kazmi and Muniza, 1995

Material: Manora Channel, 12-4-1995

Note: Bopyrid Isopoda have complex life cycles with three distinct larval stages, females brood epicaridean larvae that locate, transform, and feed on copepods as microniscus larvae, and transform yet again into cryptoniscus larvae that seek out the definite host where the final metamorphosis occurs to the adult form. It is the larval stage of a cymothoiidean; at this point it is not possible to match the present species even to family, and it may not all even be Bopyroidea.

Pakistani host: Intermediate host calanoid copepod *Eucalanus pileatus.*

Fig. 143. Microniscus stage of unidentified epicaridean sp.

144. Same with host.

Unidentified cymothoiidean sp. (Fig. 145)

Alternate names, updated and Pakistani records.

Juvenile gnathid Kazmi and Naushaba, 2001

Note: Reviewing the photograph it may be referred to either as a male of family Hemioniscidae (Cryptoniscoidea) or could belong to a cryptoniscus larval stage of *Cabirops* (Family Cabiropidae), but it could as easily belong to almost any others species of Pakistani bopyrids.

Fig. 145. Unidentified cymothoiidean sp. (larva).

SUP. F. Bopyroidea Rafinesque, 1815: The members of Bopyridae that branchially infest decapods cause large swellings of their branchiostegites. Cryptoniscoids can also cause swellings in certain hosts such as pedunculate barnacles. Morphological impacts extend to changes in secondary sexual characteristics, including feminization of male hosts. Unlike most other isopods, which have direct development, all epicaridean bopyrids have three to four larval stages (epicaridium, cryptoniscium, microniscus and bopyridium, if the latter is considered a separate larval stage) and a life cycle involving two hosts (Fig. 146), approximately 600 species of Decapoda are infested by Bopyroidea.

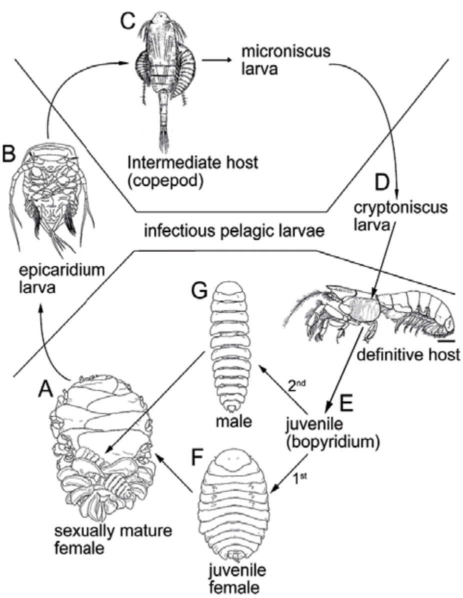


Fig. 146. Life cycle of a bopyrid (after Williams and Boyko, 2013).

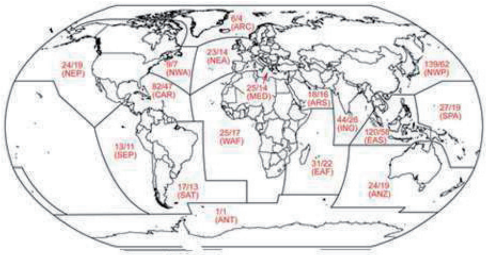


Fig. 147. Zoogeographic distribution of parasitic bopyrid isopods associated with crustacean hosts: numbers of species/genera shown within marine ecoregions: Ecoregional abbreviations, shown in parentheses in part A (ANT, Antarctic; ANZ, Australia/New Zealand; ARC, Arctic; ARS, Arabian Sea; CAR, Wider Caribbean; EAF, East Africa; EAS, East Asian Sea; INO, Central Indian Ocean; MED, Mediterranean; NEA, North East Atlantic; NEP, North East Pacific; NWA, North West Atlantic; NWP, North West Pacific; SAT, South Atlantic; SEP, South East Pacific; SPA, South Pacific; WAF, West Africa (after Williams and Boyko, 2012).

Of the three families of the superfamily the Bopyridae is by far the largest family, currently divided into eight subfamilies and comprising 605 described species (Williams and Boyko, 2012;Boyko et al,2013).

Key to families and subfamilies of Bopyroidea based on female characters (modified from Markham, 1985 and Boyko *et al.*, 2013.)

1a. Vermiform, pereopods and antennae lacking (endoparasitic). ……..
……………………………………………………….*Entoniscidae

1b. Not vermiform; modified isopod body with pereopods and antennae present (ectoparasitic) ……………………………………….……… 2

2a. Uropods with lateral plates; numerous filamentous rami extending from lateral plates ……………………………………….... *Ionidae

2b. Uropods without lateral plates …….. Bopyridae ....…………….. 3

3a. Pleomeres with extended, digitate or tuberculate lateral plates, usually directed anterolaterally from pleon …………………….. Keponinae

3b. Pleomeres with short, simple, non-digitate or tuberculate lateral plates, usually directed laterally, or lateral plates lacking ………… 4

4a. Marsupium not much enlarged beyond margins of pereon, composed of five pairs of loosely fitting subequal oostegites; pleopods, when present, not pedunculate ...…………………………………….… 5

4b. Marsupium enlarged beyond at least one side of pereon, formed of close-fitting oostegites, usually fewer than five pairs of oostegites, unequal in size; pleopods and lateral plates, when present, pedunculate 8

5a. Coxal plates and frontal lamina of cephalon greatly enlarged, giving anterior portion of body a semicircular aspect ……...….. Orbioninae

5b. Coxal plates and frontal lamina not greatly enlarged, body more linear in appearance ………………………………………………. 6

6a. Marsupium completely closed by oostegites.………….. Pseudioninae

6b. Marsupium with variably sized median exposed space between oostegites ………………………………………………………….. 7

7a. Head oval or fusiform, never fused with pereon; lateral plates pedunculate; pleopods knob-like, uniramous …………….. Argeiinae

7b. Head subrectangular or subtriangular, often fully or partially fused with pereon; lateral plates, if present, not pedunculate; pleopods flap-like, usually biramous ……………………………………. Bopyrinae

8a. Body symmetrical to slightly asymmetrical; brood pouch symmetrical to slightly asymmetrical (if asymmetrical then expanded on one side at posterior margin), formed by oostegites from both sides of body...9

8b. Body highly asymmetrical; brood pouch greatly expanded and formed by oostegites from one side of body ……….. Hemiarthrinae

9a. Body symmetrical, lateral margins of cephalon not overlapped by forward curved lateral portions of posterior pereomeres; lateral plates and pleopods falcate ………………………………... *Phyllodurinae

9b. Body asymmetrical, lateral margins of cephalon overlapped by forward curved lateral portions of posterior pereomeres; lateral plates

and pleopods variably foliose (thin elongate to very broad) ……
……………………………………………………….Athelginae

(* not found in Pakistan)

F. Bopyridae Rafinesque, 1815: The family currently contains over 500 described parasitic specis on decapod hosts they are mainly found in marine Decapoda, but occur also in decapods from brackish and freshwater, and on land. Almost all known species except very few infest their hosts externally. The larval parasite generally infests a young decapod and metamorphoses to an adult female, which soon completely fills out the branchial cavity and stays there for the rest of its life, which may be several years, the carapace bulges in the branchial region to accommodate the parasite. A second intruder metamorphoses to a male [protandrous hermaphrodite] and attaches to the female. After moulting, when the carapace is still soft. Adult males are much smaller than the females and are usually found attached between her pleopods. The male has apparently has no contact with the host. Whether males are hyperparasites on the female, or do not feed at all, is not known. Females feed on host haemolymph by piercing a blood sinus usually on the inside wall of the gill cover or 'branchiostegite' and harms it to a variable degree in different species, including, in some cases, parasitic castration, but generally, the harm seems small and the host survives to reach normal size for the species (Rasmussen *et al.*, 2008). The female Bopyridae attaches with head towards the posterior end of its host and ventral side towards the branchiostegite, to which it attaches by its pereopods. The body is dorsoventrally flattened and asymmetric according to the form of the left or right branchial cavity. They are true parasites, living as bloodsuckers. In those bopyrids that do not survive as long as the host, signs of the branchial enlargement frequently remain. Most bopyrids are restricted to a single, or a few species of decapods as their hosts, but bopyrids of different species, genus or, even family may occur as a parasite in same species of decapods. A determination of the parasite genus cannot be based on the species of host. One aspect in bopyrids is interesting that it is common in them for one genus of host to harbour parasites in several genera in different subfamilies. Bopyrids are not known to cross over infraordinal host division.

Most of the bopyrids live in the branchial cavity of Caridea, in Anomura and in Brachyura, only approximately 15% of described species occur on Brachyuran hosts, among which the Ioninae and Pseudioninae are known to infest the branchial chambers of brachyuran crabs; carideans are mostly infested by Bopyrinae and Argeniinae, those found on deep-water species are often Pseudoninae. Markham (1986) reported all the ratios of bopyrid parasitic species to host decapod species to be about 10%, except within the Brachyura whose ratio is 52%, and he suggested this reflects the principle those parasites do not range as far as their host species. Three subfamilies of bopyrid isopods are known to infect hermit crabs. Members of the subfamily Pseudioninae infect the branchial cavities of hermit crabs while the subfamily Althelginae is dorsoabdominal parasites of hermit crabs. The subfamily Bopyrophryxinae is represented by one species described from Indonesia which inhabits the branchial cavity and extends onto the abdomen of infected hermit crabs. Markham (2003) has provided a worldwide list of hermit crabs and their allied groups reported as hosts of isopod Bopyridae.

In the penaeid shrimps the swelling caused by the bopyrids is a problem in commercial shrimp fisheries where mechanical sorters select small parasitized shrimps with much larger unparasitised shrimps, and as a consequence staff has to be employed to remove the parasitized shrimps from the premium grades (Owens, 1993). Bopyrids may cause a slight decrease in host growth (Somers and Kirkwood, 1991), or in the case of male shrimp, a slight increase, and may cause small changes in the host's secondary sexual characters but the most dramatic changes are in the host's reproductive capability. Males are less affected. When the parasites are removed, females recover, sometimes partially and often totally.

The double branchial infestation seen in the decapod host is not unusual for bopyrids (Bonnier, 1900; Bourdon, 1968; Roccatagliata and Lovrich, 1999; Kazmi and Boyko, 2005; Vinuesa and Balzi, 2010), but single infestations are the norm. Codreanu (1961) has stressed close similarities in bopyrid fauna of Europe and Indo-West Pacific region.

S. F. Argeininae Markham, 1947

G. *Argeiopsis* Kensley, 1974

***Argeiopsis kensleyi* Boyko and Kazmi, 2005** (Fig. 148-149)

Alternate names, updated and Pakistani records.

Bopyrid Kazmi, 1996
Argeiopsis kensleyi Boyko and Kazmi, 2005; Schram and Klein, 2010

Described material: One ov. female TL 5mm and one male 1.0mm, Pacha, 20-1-1996 MRC ISOPOD-12

Pakistani host: *Microprosthema? validum* female CL 5mm, left chamber. Pakistani workers have identified the host as the only stenopoid occurring here as *Microprosthema validum* but their specimens are not *M. validum,* they represent an undescribed species of *Microprosthema* (Ref. Goy and Martin, 2013)

Found elsewhere and of their hosts there and elsewhere: Not outside type locality.

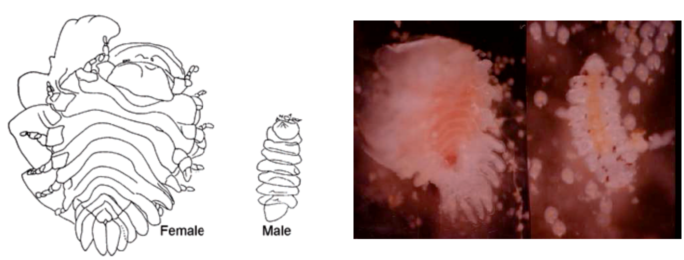


Fig. 148. *Argeiopsis kensleyi*.

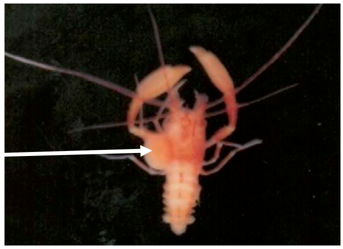


Fig. 149. Host carrying parasite (Marked by an arrow).

S. F. Athelginae Codreanu and Codreanu, 1956: Members of the bopyrid isopod subfamily Athelginae are ectoparasites found on the abdomen of hosts, nearly all being hermit crabs (one species is known from another anomuran host, a lithodid crab). Males of the Athelginae are diagnostic for that subfamily, but difficult to distinguish by genus. There are eight athelgine genera with a total of 41 currently recognized described species (Boyko and Williams, 2009; Markham, 2010). Three genera are reported from Pakistan.

***G.? *Pseudostegias* Shiino, 1933:** The genus *Pseudostegias* contains eight described species, some authors (Shiino, 1933; Lemos de Castro, 1965) have incorrectly described species of *Pseudostegias* as lacking 5th pleomere lateral plates, although all species in this genus possess such plates in the form of either a pair of globose processes or a pair of discs, these structures are modified lateral plates (Page, 1985). The shape of this plate is considered to be diagnostic in species of *Pseudostegias*, since it has been shown to be constant within species juveniles and adults (Markham, 1985). The two larger digitiform lateral projections under the fifth oostegites in *Pseudostegias setoensis* have not been recorded before and their function is unknown. These could be of taxonomic importance in *Pseudostegias* and should be considered in future studies. (An *et al*., 2011).Pakistani material is only tentatively placed in the genus *Pseudostegias* as I could not see 5th pleomere lateral plates in any form. This is the first record of the *Pseuostegias* Shiino from the hermit crab genus *Areopaguristes* and from Pakistan. Examination of these specimens showed that they may belong to the athelgine genus *Pseudostegias*, but cannot be placed into any described seven species. Therefore a new name is given to the Pakistani material.

***Pseudostegias ashooae* n .sp** (Fig. 150)

Material: Holotype 1 ov.female, TL 7mm, MW4.5mm; allotype 1 male, 6-2-2008, Manora

Pakistani host: *Areopaguristes perspicax* (hermit crab), SL 2.5mm, also infested with rhizocephalan, det.of host F.A.Siddiqui

Female holotype: The pleon is deflected to the left. The body outline is narrow and elongated. The pereon is tapering posteriorly. Pleon 1-4 pleomeres have extended lanceolate, biramous pleopods; pleotelson has a pair of large lanceolate, distally rounded, uniramous uropods.

Male allotype: Head is sub rectangular, incompletely fused with 1st segment of pereon, truncate anteriorly, broadest near posterior edge though slightly narrower than front of first pereomere nearly completely fused with it, anterior corners rounded. Dark circular eyes are present near poster lateral corners. Pereon is nearly parallel sided, all pereomeres are sharply separated; pereomeres 2-6 are broadest, tapering anteriorly and posteriorly. Pleotelson is produced medially, slightly widest immediately behind anterior edge, tapering smoothly posteriorly, it is overall shaped as broadly rounded triangle. All indications of appendages are completely absent. Antennae are prominent, tending well beyond sides of head, distal article of each tipped by thick tuft of long setae, some setae also on penultimate article of each antenna. Pereopods slightly larger posteriorly, all of similar structure and proportions, with all articles distinct; dactyli being somewhat smaller posteriorly, each reflexing into receptacle on surface of propodus surrounded by row of overlapping corneous plates.

Notes: I describe this as new species *Pseudostegias ashooae* and compare to its congeners *P.dulcilacuum* Markham, *P.hapalogasteri*

Shiino and *P. setoensis* Shiino. The new species resembles females of *P. hapalogasteri* in having uropods shorter than pleopods and *P. dulcilacuum* Markham, 1982. It is believed that *Pseudostegias dulcilacuum* is a junior synonym of *Pseudostegias setoensis* but further research is required to determine the extent of variation in the species (An *et al*., 2011)

Etymology: The species name is after the nickname Ashoo of my elder daughter Aysha.

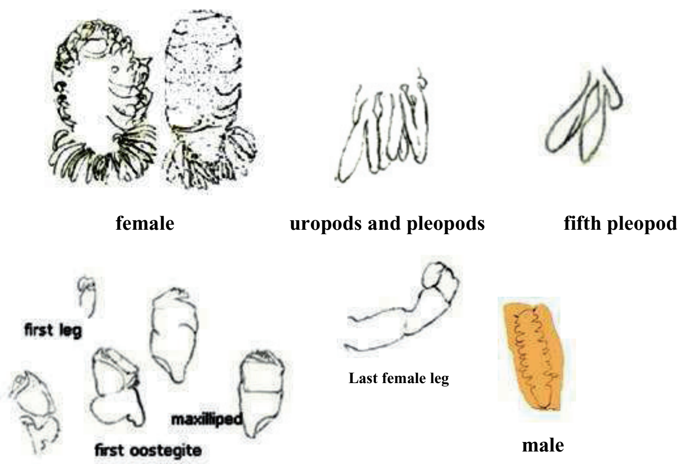


Fig. 150. *Pseudostegias ashooae*.

G. *Allathelges* Kazmi and Markham, 1999

***Allathelges pakistanensis* Kazmi and Markham, 1999** (Fig. 151)

Alternate names, updated and Pakistani records.

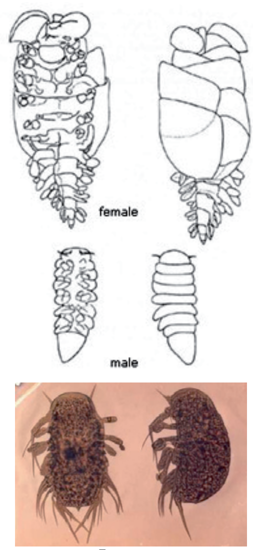
"An abdominal parasite" Kazmi and Tirmizi, 1996

Allathelges pakistanensis Kazmi and Markham, 1999; Kazmi and Yousuf, 2013

Material: No new material, 1 female TL 7mm holotype, 1 male TL 2mm allotype, larvae 10-2-1994, Manora Island (MRCC ISOP-4)

Pakistani host: *Areopaguristes perspicax* (Hermit crab) det.of host F.A.Siddiqui

Found elsewhere and of their hosts there and elsewhere: Not reported outside Pakistan.



Larva

Fig. 151. *Allathelges pakistanensis* (after Kazmi and Markham, 1999).

G. *Parathelges* Bonnier, 1900

***Parathelges neotenuicaudis* (Shyamasundari, Hanumantha Rao, Ra Jalajakumari and Mary, 1993)** (Fig. 152)

Alternate names, updated and Pakistani records.

Athelges neotenuicaudis Shyamasundari *et al.*, 1993

Parathelges neotenuicaudis–Kazmi and Markham, 1999; Markham, 2003; Kazmi and Yousuf, 2013

Described material: One female, TL 10mm, MW 5mm, 1 male, TL3mm, 23-12- 1996, New Pacha(MRC ISOP-5); one female, one male, 22-4-2000, New Pacha

Pakistani hosts: *Pagurus kulkarnii* and *Clibanarius virescence* (Hermit crabs). Det.of hosts F.A. Siddiqui.

Found elsewhere and of their hosts there and elsewhere: India. **Host:** *Pagurus kulkarnii*

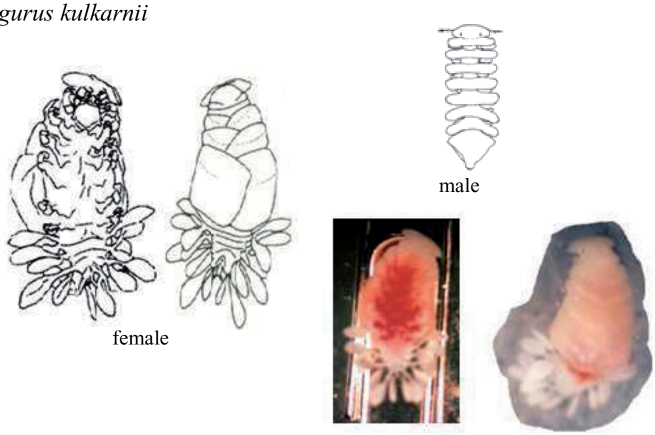


Fig. 152. *Parathelges neotenuicaudis*.

S. F. Bopyrinae Rafinesque, 1815: Thirty three genera and more than 100 species mainly infesting the carideans.

***G. *Bopyrina* Kossmann, 1881:** It contains 7 species, all of which infest hippolytid shrimps (Markham, 1985).

* ***Bopyrina ocellata* (Czerniavsky, 1868)** (Figs. 153-154)

Alternate names, updated and Pakistani records.

Bopyrus ocellatus Czerniavsky, 1868
Bopyrus virbii Walz, 1881
Bopyrina ocellata forma *pontica* Czerniavsky, 1881
Bopyrina ocellata forma *mediterranea* Czerniavsky, 1881

Bopyrina virbii Giard and Bonnier, 1890
Bopyrina ocellata–Bourdon and Bruce, 1983a; Shimomura *et al*., 2006
Bopyrina giardi Bonnier, 1900

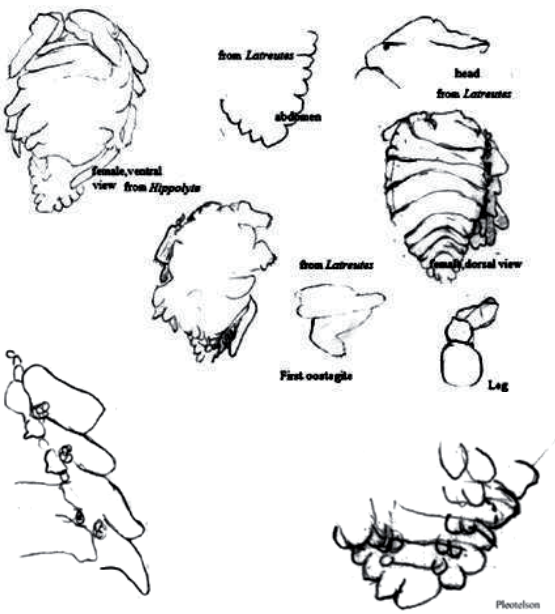
Material: 1 ov. female TL 2.5mm, dextral, 20-3-2006, Gharo, Sindh;1female, data not noted.

Pakistani hosts: *Latruetes cf. anoplonyx* left gill chamber and *Hippolyte ventricosa*.

Female: Body is oval, asymmetrical, body distorted, one side is swollen. Thoracic segments are distinct dorsally, lateral margins of segments on longer side of the body are separate and expanded, lateral margins on reduced side are curled dorsally, exposing pereopods to dorsal view; coxal plates are absent. Maxilliped has a palp. Pereopods are smaller on reduced side. The oostegites are small, they do not completely enclose the brood chamber, only fringe the brood chamber; first oostegite is enlarged on reduced side, distal margin is fringed with setules. Pleone is made up of 6 segments, fused dorsally and well defined laterally by incisions .The female has only 3 or 4 pairs of uniramous pleopods, the most posterior of which may be represented only as small swellings .Uropods are absent.

Note: It is with reservations that I identify these specimens with *B. ocellata* (Czerniavsky) and place them provisionally in *Bopyrina* because the females show distinct analogies with that of *B. ocellata* (Czerniavsky). The females are in unsatisfactory condition, considerably damaged and unaccompanied by males. Since it is the only record of the genus from Pakistan Sea it was worth including. Although there is some doubt that this form represents a new species, its generic position will remain uncertain until a male has been found .The females show diminution in the number of pleopods. However, Chopra (1923), Shiino (1934) and Bourdon (1968) have indicated that this character is subject to variation since there are differences in Japanese, European, Indian and American forms (Shino, 1933). This is its first report from the hippolytid genus *Latreutes.*This hippolytid genus is infested with *Probopyrus latreuticola*(Gissler) in Florida.

Found elsewhere and of their hosts there and elsewhere: A wide known range, from Britain thorough the Mediterranean and Black Sea, to India, Japan and Australia. **Hosts:** *Hippolyte longirostris, H. inermis, H. varians, H ventricosa, H. leptocerus, H.cf.commensalis, H.armoricana* and *Heptacarpus geniculatus*.



Right pereomeres (from *Latreutes*)

Fig. 153. *Bopyrina ocellata*.

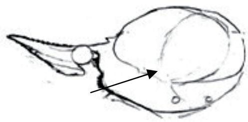


Fig. 154. Host *Hippolyte* carapace showing buldge due to parasite (marked by an arrow)

G. *Parabopyrella* Markham, 1985: This is a large genus(28spp). An *et al.,* (2013) divided the genus fmalesinto 3 groups.It is documented that no *Parabopyrella* species significantly affects the host female sexual system but does not cause castration which involves associated phenomena i.e., gonads of a female host do not mature and parasitized males are feminized. Almost all the species of *Parabopyrella* are known from alpheid hosts with only four species known from hippolytids.

Parabopyrella indica (Chopra, 1923) (Figs. 155-156)

Alternate names, updated and Pakistani records.

Bopyrella deformans indica Chopra, 1923; Monod, 1933: Qazi, 1959

Parabopyrella indica–Markham, 1980; Kazmi *et al*., 2002; Kazmi and Yousuf, 2013

Material: 1 female, 1 male 29-5-1995, Sand Spit; 1 female, 1 male, 20-1-1996, Pacha; 1 female, 1male, Manora 10-5-1997.

Pakistani hosts: *Alpheus inopinatus* (right chamber)r, *Synalpheus tumidomanus* (left chamber)

Found elsewhere and of their hosts there and elsewhere: India. **Hosts:** *Synalpheus huluensis = Synalpheus tumidomanus, S.niladensis*

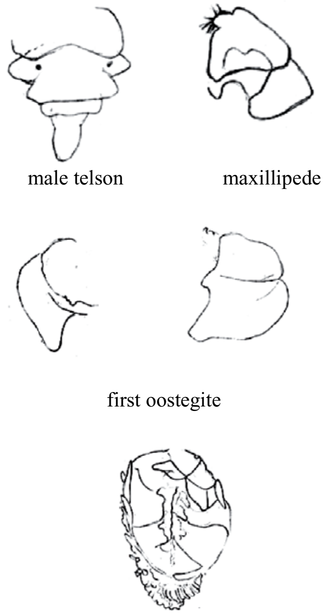


Fig. 155. *Parabopyrella indica*.

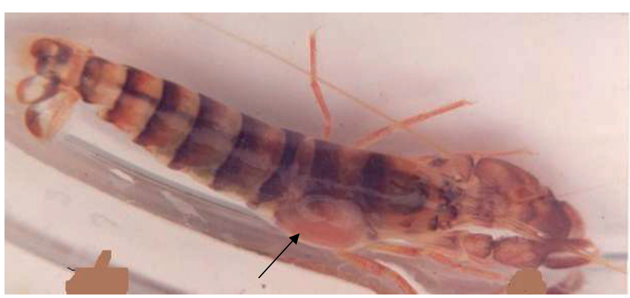


Fig. 156. Host carrying parasite (marked by an arrow).

Parabopyrella nierstraszi **(Chopra, 1930)** (Figs. 157-158)

Alternate names, updated and Pakistani records.

Bopyrella nierstraszi Chopra, 1930
Not *Bopyrella mortenseni* [sic} Qazi, 1959
Parabopyrella nierstraszi–Kazmi *et al.*, 2002; Kazmi and Yousuf, 2013

Material: It has been collected several times, but not recently, 1 female, 1 male, 14 -3-1995, Somar Goth; 1 female, TL 5.8mm, MW 4.5mm, 29-5-1995, Sand Spit (illustrated); 1 female with 25000 larvae, 1 male, 18-1-1996, Manora; 1 female, 1 male, 4-7-1996, Bulleji; 2 males, 2 females, 8-7-1997; 2 females, 1 ov. TL 8-10mm, MW 6-8mm, 2 males 1.5-2.5mm MW0. 6-1.0mm ?-9-1997 (illustrated).

Pakistani hosts: *Alpheus* (multiple species), *Synalpheus tumidomonas,* right or left chamber.

Note: The differences probably reflect individual variations rather than taxonomic differences. Qazi (1959) s' work was suffering from misidentification. His synonymy and extended host and geographical range for *Bopyrella mortenseni* (now =*Parabopyrella mortenseni*) was not accepted by Markham (1985), same is followed here.

Found elsewhere and of their hosts there and elsewhere: India. Bay of Bengal. **Host:** *Lysmata vittata*

Parabopyrella saronae **(Bourdon and Bruce, 1979)** (Figs. 159-160)

Alternate names, updated and Pakistani records.

Bopyrella saronae Bourdon and Bruce, 1979; Ghani and Tirmizi, 1993; Kazmi, 1996

Parabopyrella saronae -Markham, 1985; Kazmi and Yousuf, 2013

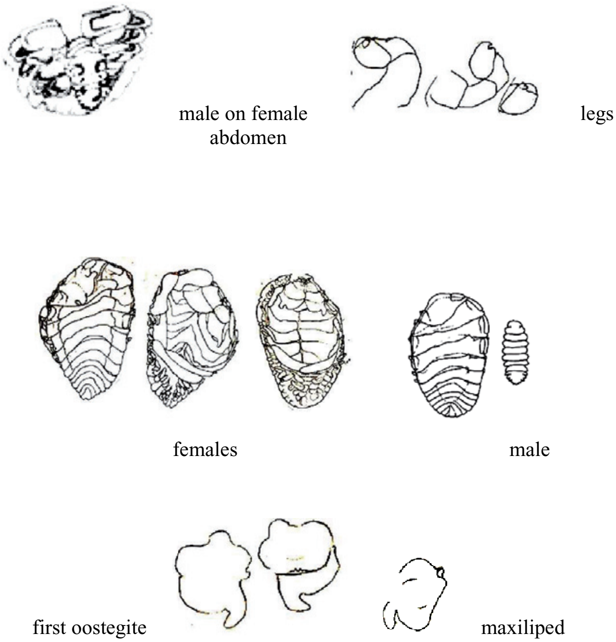


Fig. 157. *Parabopyrella nierstraszi*.

Fig. 158. Host carrying parasite (marked by an arrow).

Material: It has been collected several times. No new material, 1 female, 10-4-1977; 2 females 12mm, 2 males 2.8-3mm, 19-12-1989, Sonari (MRC-ISOP-1); 3 females, 8mm, 1 male 2.8mm Paradise Point (MRC-

ISOP-2);1 female, 1 male, 22-11-1995; 1 female 12 x 8mm, 1 male, 15-1-1996, Bulleji, left chamber; 1 female, 1 male, 15-2-1996.

Pakistani host: *Saron marmoratus*, parasite noticed in 1977 but left unidentified till reported in 1993 (Ghani and Tirmizi, 1993)

Notes: All infested *Saron* specimens were incidentally males; some had parasite in left branchial chamber and some on the right side. In the parasitized males the extraordinary bushy setae on their third maxillipeds, shorter first legs and reduced appendix masculinae were noticed (Kazmi, 1996). The host specimens discussed by Kazmi (1996) show some deviations from *Saron marmoratus* of Chace (1997) resembling *S. neglectus*; as the parasite is said to be host specific it needs further study (Bourdon, pers comm. QBK).Here it can be added that distinct colour variants of *Saron* were observed resembling to *Saron* sp. 8 of Debelius (2001:140). It needs a scientific explanation.

Found elsewhere and of their hosts there and elsewhere: Kenya, Persian Gulf. **Host:** *Saron marmoratus*.

Fig. 159. *Parabopyrella saronae* male and female.

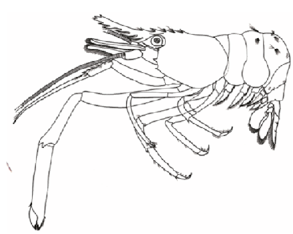


Fig. 160. Host.

*** G. *Bopyrella* Bonnier, 1900**

****Bopyrella tanytelso*n Markham, 1985** Fig 161

Alternate names, updated and Pakistani records

*Bopyrella tanytelso*n Markham, 1985; Huang, 2001

Material: One female, one male, 22-4-2000, New Pacha; one female, one male, 3-12-2005, Bulleji (illustrated).

Pakistani host: *Alpheus* right chamber. Because of loss of appendages, the host was not identifiable to species, but as a parasite of many species of *Alpheus*, *Bopyrella* is to be expected on this host.

Female: The eyes are not visible. The maxillipede has a non-articulating setose palp. There are five pairs of oval pleopods, overlapping each other, not covering the whole pleonal surface.

Male: Head is semi-circular anteriorly, markedly narrower than pereomere 1 and partly set; the eyes are as scattered pigment spots near posterolateral corners. Pereomeres all are well separated, first four of nearly same width, fifth is slightly broader, and last two are slightly narrower. The pleon is made up of 5 pleomeres distinct laterally but incompletely separated dorsally and ventrally except the first one. First pleomere is broader than pereomeres, last 4 pleomeres are shorter than pereomeres; they become progressively narrower posteriorly, giving pleon triangular outline. The terminal pleomere is extended but posteriorly indented, uropods are absent.

Note: Initially the material was identified as belonging to the genus *Probopyria* Markham, 1985 but later on was thought to be a possible species of *Bopyrella.* The specimens are close to *Bopyrella tanytelson* described by Markham (1985) on *Alpheus*, however, there are differences between Pakistani and Thai material. The present record extends its range northeast to the Arabian Sea.

Found elsewhere and of their hosts there and elsewhere: China, Thailand. **Host:** *Alpheus*.

female male maxilliped

Fig 161.*Bopyrella tanytelson.*

G. *Probopyrus* Giard and Bonnier, 1888: It is one of the most confused genera of the family Bopyridae. Its hosts are all in the family Palaemonidae except that reported by Shireen (1997) from Pakistan on a marine Penaeidae.

***Probopyrus prashadi* (Chopra, 1923)**

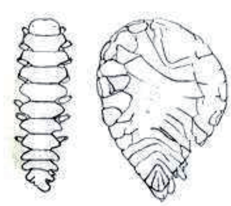
Alternate names, updated and Pakistani records.

Palaegyge prashadi Chopra, 1923; Shireen, 1997 (unpublished data thesis); Kazmi and Yousuf, 2013

Material: No new material, two females TL11-13mm, two males TL 4-5mm, 16-11-1991; two females TL11-13 mm, two males TL5mm, 12-3-1992, Karachi.

Pakistani host: *Parapeneaopsis stylifera*

Found elsewhere and of their hosts there and elsewhere: India, Bangladesh. **Hosts:** *Macrobrachium lamarrei; Palaemon* spp.



male female

Fig. 161. *Probopyrus prashadi.*

***Probopyrus pica* (Chopra, 1923)** (Fig. 162)

Alternate names, updated and Pakistani records.

Palaegyge pica Chopra, 1923-Qazi, 1959
Probopyrus pica–Nierstrasz and Brandis, 1929; Kazmi and Yousuf, 2013

Material: No new material

Pakistani host: *Palaemon* sp. (Shrimp).

Found elsewhere and of their hosts there and elsewhere: India. **Hosts:** *Leptocarpus potamiscus*, *Palaemon*.

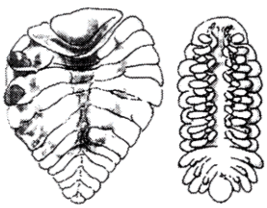


Fig. 162. *Probopyrus pica* (after Chopra, 1923).

****Probopyrus alcocki* (Chopra, 1923**) (Fig. 163)

Alternate names, updated and Pakistani records.

Palaegyge alcocki Chopra, 1923
Probopyrus alcocki–Nierstrasz and Brandis, 1929

Bopyrid - Yaqoob, 2006

Material: One female, 1 male, no data

Pakistani host: *Macrobrachium malcomsonii*

Note: Yaqoob (2006) mentioned of an unnamed bopyrid from *Macrobrachium malcomsonii* from Pakistan. This report of parasite is assumed to be for *Probopyrus alcocki*.

Found elsewhere and of their hosts there and elsewhere: India, Bangladesh **Host:** *Macrobrachium malcomsonii*. The host is also reported to have cymothoid infestation as exceptional (Marriappan *et al*., 2003)

male female

Fig. 163. *Probopyrus alcocki.*

S. F. Keponinae Boyko, Moss, Williams and Shields, 2013

G. *Hypocepon* Nierstrasz and Brender a Brandis, 1930

***Hypocepon enoeensis* Nierstrasz and Brender à Brandis, 1930**

Alternate names, updated and Pakistani records.

Hypocepon enoeensis–Siddiqui, 2012

Pakistani hosts: *Nepinnotheres villosulus* in *Meretix casta* var *ovum, Protapes cor, Amianlis umbonella, Gastrana multantgula, Marcia marmorata*, *Tellinimectra angulata, Anadara antiquata*

Note: The bopyrid parasite of pinnotherid host specimen of my collection was lost during this study.

Found elsewhere and of their hosts there and elsewhere: Indonesia. **Host:** *Nepinnotheres villosulus* in *Pinna* and *Meleagrna*.

*** G. *Cancricepon* Giard and Bonnier, 1887:** There are eight species in this genus.The Pakistani species is a new one.

****Cancricepon pilumnopeusiae* sp nov.** (Figs. 164-165)

Material: 1 ov. female holotype TL 3.5mm (without uropods), cream, male allotype TL 2mm, off-white with black dots, Kaka Village, Sandspit 5 October, 2006

Pakistani host: *Pilumnopeus convexus* (crab), subadult female CL6mm

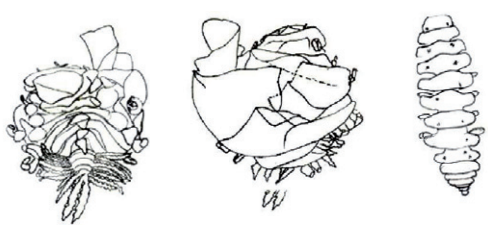
Female holotype: The body is asymmetrical. The pereomeres 3–5 are with prominent mid-dorsal projections.

Male allotype: The head is suboval, distinctly separated from the first pereomere. The eyes are small. The pereomeres 3–5 are almost equally wide, having truncate margins. All pereopods are relatively similar in size and structure. The pleon is made up of 6 pleomeres; last pleomere has an anal cone on median portion; the uropods are absent.

Notes: This is the first record of this genus and the first record of this host bearing parasitic isopod from Pakistan. *Cancricepon* were recorded infesting hosts from six families of brachyurans (Xanthidae, Goneplacidae, Pilumnidae, Dacryopilumnidae, Ocypodidae and Eriphiidae). A new taxon, *Cancricepon pilumnopeusiae* n. sp., is described based on specimens parasitizing *Pilumnopeus convexus*.

This new species does lie in the group of species (*C. xanthii* (Richardson), *C. knudseni* (Danforth) and *C. choprae* (Nierstrasz and Brender a´ Brandis)) among the eight species in having mid dorsal projections on last three preomeres and resembles *C. multituberosum* of An *et al*., (2012) in having biramous pleopods whose endopodites are smaller than the exopodites and are lobate.

Etymology: The specific name *pilumnopeusiae* is the genitive form of host generic name.



female, dorsal view ventral view male

Fig. 164. *Cancricepon pilumnopeusiae*.

Fig. 165. Host.

***G.? *Apocepon* Nierstrasz and Brender à Brandis, 1930**

* ***Apocepon* sp.** (Fig. 166-167)

Alternate names, updated and Pakistani records.

Dactylocepon sp., Kazmi *et al*., 2002

Material: One male 4mm, 1 female in fragments, Karachi Fish Harbour, 12 March, 1983, right gill chamber.

Pakistani host: *Coleusia biannulata*, male, CL, 21mm

Notes: Earlier Kazmi *et al*. (2002) included this male specimen under *Dactylocepon* .According to Dr. Adkison (pers. comm.) the sixth pleomere of the male is most unusual for *Dactylocepon*. The generic placement is difficult since keponine genera are diagnosed based on the medial bosses of the female. As the female was in fragments, more material is required for confirmation. Now I place it under *Apocepon* considering that all the three species of the genus *Apocepon* are parasites of hosts with the Leucosiidae. An *et al*. (2006) reported *A. leucosiae* infesting *Leucosia anatum* (Herbst) from the South China Sea.

S. F. Orbioninae Codreanu, 1967: All isopods of the subfamily Orbioninae are branchial parasites of penaeid shrimps with eight genera known to date (An *et al.*, 2013), only *Parapenaeon* is recorded from Pakistan and one *Parapenaeolla lamellata* Bourdon, 1979 (now= *Parapenaeonella distincta* Shiino, 1949) infesting *Metapenaeus monoceros* by Bourdon (1979) from the Arabian Sea (west coast of India).

G. *Parapenaeon* Richardson, 1904

***Parapenaeon expansa* Bourdon, 1979** (Fig. 168)

Alternate names, updated and Pakistani records.

Epipeneon qadrii Qazi, 1959; Ahmad, 1978; Kazmi and Tirmizi, 1994
Epipenaeon japonica Thielemann, 1910

Bopyrid Tirmizi and Bashir, 1973
Parapenaeon japonica–Markham, 1994 (see for complete synonymies); Kazmi and Tirmizi, 1994; Fatima, 2001; Kazmi *et al.*, 2002; Ayub and Ahmed, 2004; Kazmi and Yousuf, 2013.
Parapenaeon expansa An *et al.*, 2015

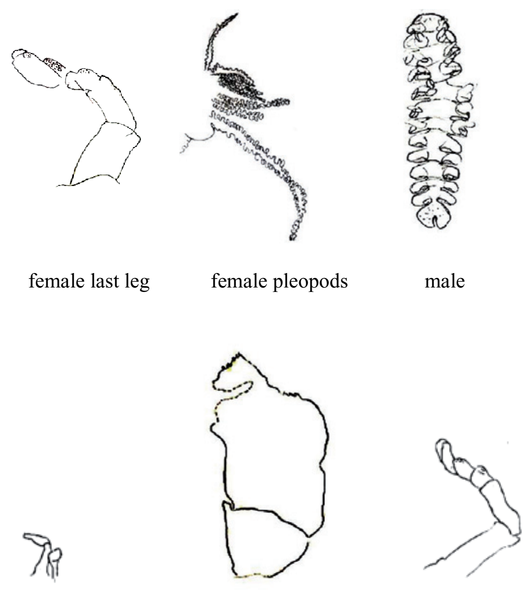


Fig. 166. *Apocepon* sp.

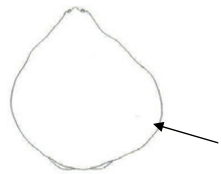


Fig. 167. Host carapace carrying parasite (marked by an arrow).

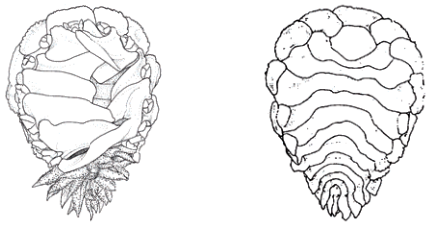
Material: No new material. It has been collected several times. One female TL17mm, 1 male 4mm 26-7- 1966; 1 female TL2 1mm, 1 male TL mm, May, 1993; 1 female TL 15mm, 1 male TL 5mm 8-7-1993; 1 female TL 19mm, 1 male TL 7mm, 15-7-1993

Pakistani hosts: *Penaeus merguiensis, Penaeus monodon, Parapenaeopsis stylifera, Parapenaeopsis sculptilis*, and *Parapenaeopsis hardwickii*

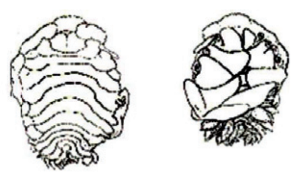
Notes: *P. expansa* have been described often and well enough as *P. japonica,* it is therefore not described here. Kazmi and Tirmizi (1994) recognized *Epipenaeon qadrii* Qazi, as separate species as they missed Markhams' (1982) report in which he considered it as synonym of *P. japonica*. An *et al*. (2015) considered Pakistani *P. japonica* reported by Kazmi and Tirmizi (1979) actually is *P. expansa*. I have taken the other Pakistani reports the same.

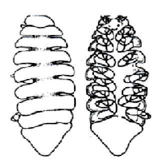
No marked change was observed in weight of the shrimps infected by *P. japonica*; however, a single male shrimp infected with bopyrid possessed a female like rostrum and all the infected male and female shrimps were found to be sexually immature (Ayub and Ahmed, 2004).This was previously also noticed in a male (CL27mm) of *P.merguiensis*, its petasma , appendix masculinae and coxal out-growths of legs were under developed as compared to uninfested male of the same size, female like thelical lateral plates were also seen on the last thoracic sternite. (see Tirmizi and Bashir, 1973)

Found elsewhere and of their hosts there and elsewhere: Japan, Australia. **Hosts:** *Penaeus japonicus, Penaeus teraoi, Penaeus latisulcatus, Penaeus longistylus, Penaeus plebejus, Penaeus indicus, Penaeus merguiensis, Penaeus penicillats*



Females





male

Figs. 168. *Parapenaeon expansa* .

***Parapenaeon* sp.** (Fig. 169)

Material: No data, one female TL 15mm, MW 9mm

Pakistani host: Not recorded

Note: The present undescribed species is near to *P. consolidata* given in An *et al*., (2015, key)

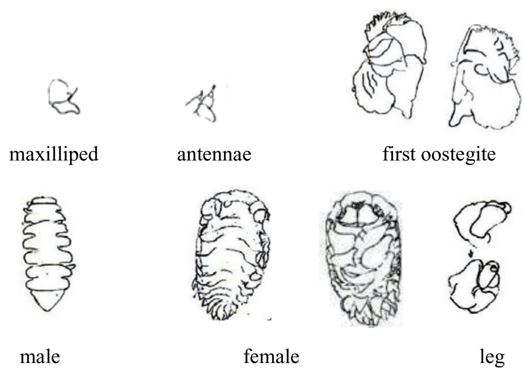


Fig. 169. *Parapenaeon* sp.

S. F. Pseudioninae Codreanu, 1967

***G. *Parapagurion* Shiino, 1933:** It is a small genus with only two species: *P. calcinicola* Shino and *P. imbricata* Markham. The present material will represent the third species, being new to science.

Parapagurion farooqi n sp. (Fig. 170)

Material: Female, holotype, TL 3.5mm, gravid, allotype, male, TL 2mm , 7-6-2008 Manora Island

Pakistani host: *Areopaguristes perspicax* female SL 2.5mm, also infested by a rhizocephalan det. of host F.A. Siddiqui

Female holotype: Nearly symmetrical. Pereon broadest are across pereomere 3. Narrow coxal plates and round dorsolateral bosses are present on both sides of pereomeres 1–4. Oostegites incompletely enclose brood pouch. All pereopods are visible in dorsal view, similar in structure but larger posteriorly, all with minute dactyli. Pleon is made up of 6 pleomeres, all bear prominent lateral plates, first three bear biramous pleopods, last three have uniramous pleopods and uropods. Prominent anal cone is present between widely separated uropods, with them creating trifid posterior margin.

Male allotype: All body regions and segments are distinctly separated. Head is suboval, its convexly curved posterior margin is slightly embedded in first pereomere. Small round dark eyes are seen near posterolateral corners. Pereon is widest across pereomere 3, tapering smoothly posteriorly, all pereomeres are laterally separated. Pleon is abruptly narrower than pereon, tapers smoothly posteriorly. Five pairs of flaplike pleopods extend medially. Sixth pleomere is produced into triangular uropods.

Etymology: The species name is after the name of my elder son Farooq

Note: Only two species are included in the genus, one from Japan and one Caribbean Sea. This will be the first record of the genus from the western Indian Ocean. The male of the new species differs from the known species in having the terminal pleomere extending laterally, and not into three points or single median cone.

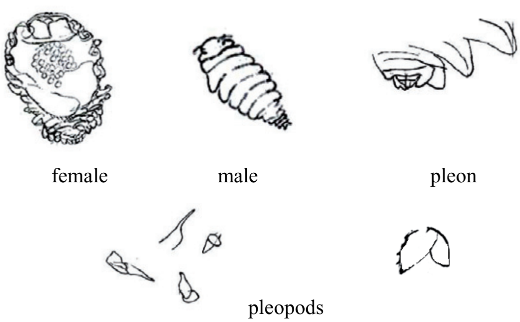


Fig. 170. *Parapagurion farooqi*.

***G. *Pseudionella* Shiino, 1949:** Distribution of described species of *Pseudionellla* Shiino is from Venezuela, North Carolina, Brazil, Columbia, Japan, South China Sea, and Easter Island. This will be its first record from the Indian Ocean. *Pseudionella* species predominantly infest hosts belonging to the family Paguridae, only *P. akuaku* being known to infest a diogenid hermit crab (An *et al*., 2013). There are till now five species in the genus. This will be the sixth one.

****Pseudionella raboae* n. sp.** (Fig. 171)

Material: One female holotypeTL 4mm, 1 male allotype 7-5-2007, Bulleji; paratypes 1 ov. female TL 4mm, 1 male, 11-4-2008, Bulleji.

Pakistani hosts: *Areopaguristes perspicax,* 2 males 3-4mm SL. det. of host F.A. Siddiqui

Female holotype: Body is twisted, broad at pereon and narrow at pleon and elongated, has seven laterally distinct pereonites and five pleonites and a pleotelson. The head is deflected to the left. The lateral plates are very short. The antennae have three articles, all segments provided with fine scales bearing setae. The well-developed oostegites enclose a marsupium, oostegites sparsely covered in minute tubercles. The pleopods are lamellar in five pairs and the uropods are uniramous.

Male allotype: The eyes are present. The antennae are made of of 3 and 4 articles, respectively; distal setae are present on first two segments of antennules and scales on two basal segments. The head is narrow. There are seven pereonites and five distinct pleonites ending in a pleotelson; pereon widest across pereomere 4, tapering smoothly anteriorly and posteriorly, the first is not separated from head and last two are also not separated; all pereomeres laterally separated by deep anterolateral notches ;the pleon is abruptly narrower than pereon, tapering smoothly posteriorly. The sixth pleomere is produced into uropods bearing sparse setae posteriorly. The posterior projections of terminal pleomere are simple.

Etymology: After the nick name Rabo of my younger daughter Rabia.

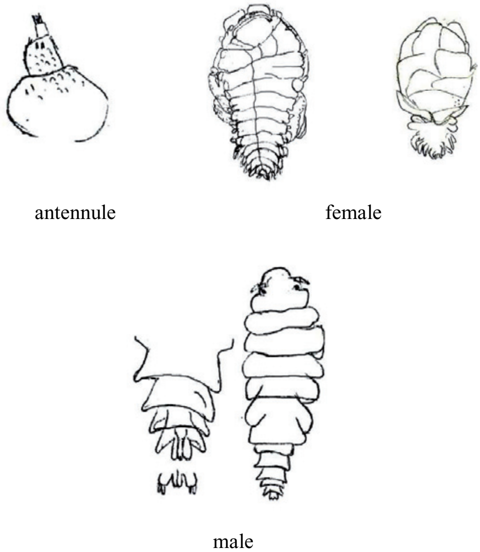


Fig. 171. *Pseudionella raboae*.

G. ***Aporobopyrus*** **Nobili, 1906:** There are 21 species the world over (William and Madad, 2010). *Aporobopyrus* is the largest genus of bopyrids all found parasitizing porcellanids, with only two species parasitizing non-porcellanid hosts.

Aporobopyrus ryukyuensis **Shiino, 1939** (Fig. 172)

Alternate names, updated and Pakistani records.

Aporobopyrus rukyuensis Shiino, 1939; Markham, 1980; Schotte, 1995; Kazmi and Yousuf, 2013

"Bopyrid." Ahmed and Mustaquim, 1974

Pakistani host: *Petrolisthes boscii* (false crab)

Notes: *Aporobopyrus ryukyuensis* has been very well described by the original author, discussed and illustrated, Bourdon (1976), Markham (1982), so a redescription is not included here.

Found elsewhere and of their hosts there and elsewhere: Japan. **Hosts:** *Petrolisthes hastatus, P. lamarcki, P. fimbriatus* and *P. asiaticus*

female male

Fig. 172. *Aporobopyrus ryukyuensis*.

***Aporobopyrus megacephalon* (Nierstraz and Brender a Brandis, 1929)** (Figs. 173-174)

Alternate names, updated and Pakistani records.

Pleurocryptosa megacephalon Nierstraz and Brender a Brandis, 1929; Ahmed and Mustaquim, 1974; Bourdon, 1976; Kazmi *et al*., 2002

Aporobopyrus megacephalon -Adkison, 1988; Kazmi and Yousuf, 2013

Material: No new material. 1 female TL 6.5 mm, MW 4mm, 1 male TL 2mm, MW 1.75mm, 1995, left gill chamber, with cryptoniscus larvae, Sindh

Pakistani host: *Petrolisthes rufescence* (false crab)

Found elsewhere and of their hosts there and elsewhere: Gulf of Thailand and Hong Kong. **Host:** *Pachycheles pectinicarpus*

male, dorsal male ventral

Fig. 173. *Aporobopyrus megacephalon*.

Fig. 174. Host.

G. *Progebiophilus* Codreanu and Codreanu, 1963

***Progebiophilus assisi* Kazmi and Bourdon, 1997** (Figs. 175-176)

Alternate names, updated and Pakistani records.

Progebiophilus assisi Kazmi and Bourdon, 1997; Markham and Boyko, 2005; Kazmi *et al.*, 2012; Kazmi and Yousuf, 2013

Material: No new material. 1 female TL 7mm, 1 male TL 3mm, Bulleji, 12-12- 1996 (MRC ISOP-6); 1 ov. female TL 5mm, 1 male TL2 mm, Pacha, 21-10-1995.

Pakistani host: *Upogebia assisi,* female right gill chamber (ghost shrimp)

Found elsewhere and of their hosts there and elsewhere: Not outside Pakistan.

female

Fig. 175. *Progebiophilus assisi* .

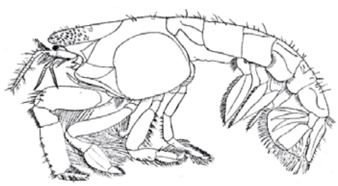


Fig. 176. Host.

G. *Upogebiophilus* Nobili, 1906

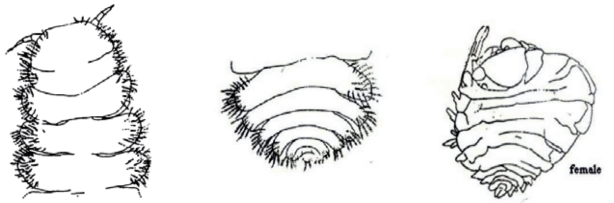
Upogebiophilus sp. (Figs. 177-178)

Alternate names, updated and Pakistani records.

Upogebiophilus sp. Ghani, 1995; Kazmi and Yousuf, 2013

Material: One female, 1 male, November, 1988, Pacha

Pakistani host: *Upogebia quddusiae* (ghost shrimp)



male, anterior and posterior

Fig. 177. *Upogebiophilus* sp. (After Ghani, 1995).

Fig. 178. Host.

G. *Asymmetrione* Codreanu, Codreanu and Pike, 1965: The genus *Asymmetrione* now contains eleven species. Two are reported from here, both are new to science.

Asymmetrione sp.1 (Fig. 179)

Alternate names, updated and Pakistani records.

Asymmetrione sp., Kazmi *et al*., 2002, Kazmi and Yousaf, 2013.

Material: One female 8.5mm, Ibrahim Hyderi, 7-8-1995; one female TL 5.42 mm, MW 3.56 mm, head length 1.44 mm, head width 1.44 mm, pleon length 1.29 mm, 1 male 2.2mm. 1-12-1997 Ibrahim Hyderi.

Female: The body is sinistral. All body regions and segments are distinct. The head is subquadrate. The antennae are well developed. The eyes are absent. The posteroventral border has lateral projections and irregularly shaped and toothed lobes on each side. The maxilliped is completely lacking palp and has a nonextending spur. Pereomeres are irregularly shaped both laterally and transversely; coxal plates are prominent on right side of pereomeres. The oostegites completely enclose the brood pouch; the oostegites 1-4 are subrectangular, with tuberculate surface and fringe of posterior setae. All pereopods are of the same structure, somewhat become larger posteriorly. The pleomeres 1-5 bear similarly biramous pleopods and a pair of similar biramous uropods on pleomere 6.

Male: The male has five articles in its second antenna, the pleomeres are tapered.

Notes: *Asymmetrione* sp. 1 is clearly one of the less distorted species of the genus. It is being described somewhere else as new species.

Pakistani hosts: *Diogenes custos,* right gill chamber; *D. planimaus* right gill chamber det. of hosts F.A. Siddiqui.

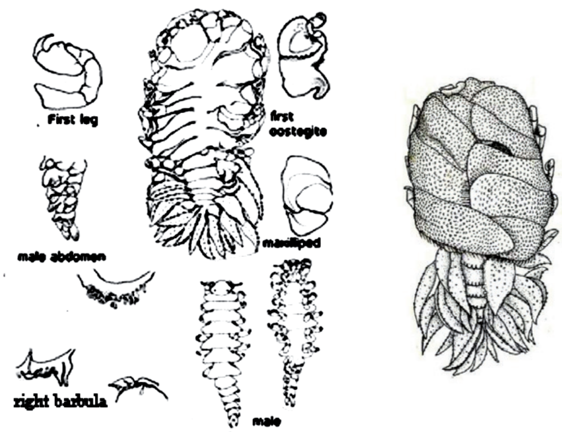


Fig. 179. *Asymmetrione* sp.

Asymmetrione imrani n.sp. (Figs. 180-181)

Material: Holotype female (not in gill chamber but attached to posterior margin of host carapace, when alive, host seemed to detaching it with its legs), allotype male in left gill chamber, 22-12-2003 Sandspit, boat collection, ISOP. 11.

Pakistani host: *Diogenes violaceus.* Det. of host F.A. Siddiqui.

Description of holotype female: the body is slightly distorted, longer than wide, right side is concave. The head is imbedded in pereon. The pereon has no constriction. The oostegites loosely enclose the brood pouch. The pereomeres are distinct on the left side. The eyes are present. The antennae are three and four segmented respectively both tipped with setae. The first pair of legs is extending beyond the head; the propodus of pereopods is produced into large flat section with depression to receive sharply pointed dactylii; all 6 pleomeres have lamellar lateral plates; the pleopods and uropods are biramous, all about the same size, lanceolate and crenulated.

Male allotype: Pigment spots are observed. The male is elongated tapering to narrow posterior end. All the segments are distinct. There are 6 pleomeres, all with ventrally extended posterolateral corners; the uropods are absent but the posterlateral borders of last pleomere are extended posteriorly, with anal cone between them.

Note: Of the eleven previously described *Asymmetrione* species the new species belongs to the group of seven dextral species, resembles *A. dardani* Bourdon, 1968 in having tubercles on the pleopods and *A. sallyae* (Williams and Schuerlein, 2005).

Etymology: After the name of my younger son Imran.

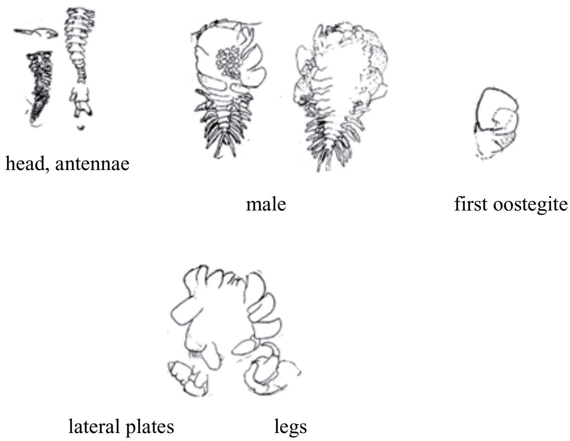


Fig. 180. *Asymmetrione imrani*.

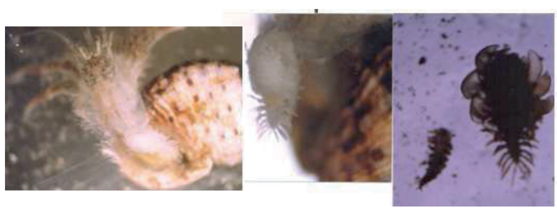


Fig. 181. *Asymmetrione imrani* with host and separated.

G. *Aporobopyrina* Shiino, 1934

***Aporobopyrina lamellata* Shiino, 1934** (Fig. 182)

Alternate names, updated and Pakistani records.

Aporobopyrina lamellata–Bourdon, 1983; Markham, 1980; 1985, 2010; Schotte, 1995; Kazmi and Bourdon, 1997; Hussain, 2001; Kazmi *et al*., 2002; Kazmi and Yousuf, 2013.

Bopyrid Ahmed and Mustaquim, 1974

Material: No new material, 1female TL 6.5mm, MW 4mm, 1 male TL 2mm, MW 1.75mm, 1995, left gill chamber.

Pakistani hosts: *Petrolisthes rufescence*, *Pachycheles tomentosus* (false crabs)

Found elsewhere and of their hosts there and elsewhere: Australia and Thailand, Japan and Indonesia across the Indian Ocean. **Hosts:** All host species belong to the porcellanid genus *Petrolisthes: P. lamarckii, P. penicillatus*, *P. coccineus, P. hastatus, P. scabriculus, P. pubescence.*From Pakistan the genus is reported also from *Pachycheles*.

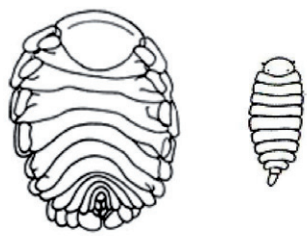


Fig. 182. *Aporobopyrina lamellata*

S. F. *Hemiarthrinae Markham, 1972: There are 27 genera and 55 spp., in the subfamily. The females are mostly ventral ectoparasites of caridean shrimps, to which they attach themselves with the pereopods of only one side, the opposite half of the body undergoing a pronounced hypertrophy and resulting highly asymmetrical body due to brood pouch greatly expanded and formed by oostegites from one side of body. The resultant asymmetry leads to a marked inequality of the oostegites on the ventral side, where they enclose an incubatory cavity which also extends over to the dorsal surface. The first four oostegites of the same side predominate; the fifth on that side being absent. The rule of ventral attachment seems to be universal among adults of the subfamily (Markham, 1972). The cryptoniscids of abdominal parasitizing species in both Athelginae and Hemiarthrinae first lodge in the branchial chamber and subsequently move back to the abdomen (Pike, 1961)

The species *Diplophryxus jordoni* Richardson infests *Palaeomon semmelinki* in Thailand (Markham, 1985); I have examined the species *Palaeomon semmelinki* in hundreds of specimens recently but surprisingly did not find any infested specimen.

***G.? *Apophrixus* Nierstrasz and Brender à Brandis, 1931**

****Apophrixus afzali* n. sp (**Figs. 183-184)

Material: One female, holotype, TL 5mm, 1 male, allotype, TL 0.1mm, larvae, Port Bin Qasim, 8-8-2008.

Pakistani host: *Alpheus* sp. (probably new) TL15mm, CL5mm (pistol shrimp)

Female holotype: The head is distinct but other body regions and segments are obscure; head is deeply embedded in pereon and tapers posteriorly. Both second oostegites are arched far beyond the anterior margins and are tightly pressed; body is greatly distorted. The eyes are present. The pereomeres are distinct on shorter side; only five tiny pereopods are present on long side of body; fourth or fifth pereopods are smaller than the proximal pereopods tightly bunched. The pleon is made up of five pleomeres, distinct laterally. The pleotelson has a serrated tip lacking appendages; lateral plates on pleomeres are oval, lamellar, projecting freely. There are four(or five) pairs of uniramous pleopods, similar to lateral plates.

Male allotype: 2 or 3 small pigment spots are present. The cephalon is fused with the first thoracic segment; the thoracic segments are distinct; the anterior margin of cephalon is slightly convex. The abdominal segments are completely fused in one piece, rounded on the sides and ending in anal cone; the pleopods and uropods are absent.

Notes: The two specimens of *Aprophrixus* (1 female, 1 male) were collected in 2008 by me during an ecological survey from Port Bin

Qasim, Karachi. The isopods were found infesting an undescribed species of alpheid shrimp, *Alpheu*s and were tentatively thought to be a possible species of *Aprophrixus* Nierstrasz and Brender à Brandis, 1931 by spending some time examining the female, limiting my examination and illustrating to easily visible external characters in order to not to damage the specimen. The presence of seven pereopods on short side of body and 5 on long side allows only a tentative identification as *Aprophrixus*.

Only two species of *Apophrixus* are described worldwide: *Apophrixus consrictus* Markham, 1982 and *Apophrixus philippinensis* Nierstrasz and Brender a Brandis, 1931. Based upon this examination the specimens were most likely a new species, one which was similar in general appearance to *Aprophrixus consrictus* thus representing the third species of the genus, as well as the first record of the subfamily as *Aprophrixus* in Pakistan.

Etymology: After my husband’s first name Afzal

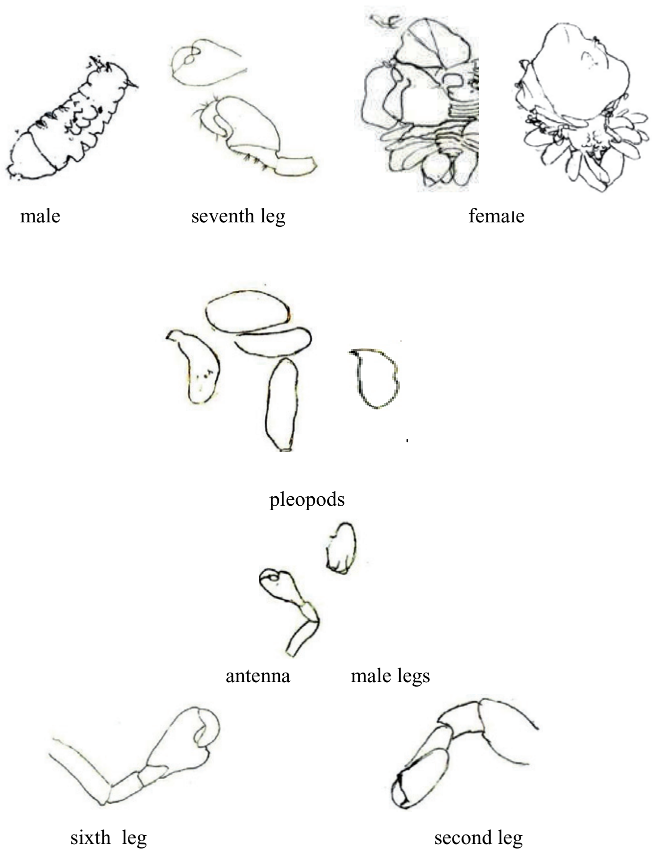


Fig. 183. *Apophrixus afzali*.

Fig. 184. Host.

SUP. F. Cymothooidea Leach, 1814: One major isopod group the Cymothooidea are exclusively parasitic and infests both marine and freshwater fishes, both as immature forms and adults initially enter their hosts through the gills, beginning as males but changing sex as they grow older.

Eight families are included in the superfamily,four are present here.

Key to the Pakistani families of the Superfamily Cymothooidea

1. Pereopods 4-7 prehensile (dactyls longer than propodi); antenna reduced, without clear distinction between peduncle and flagellum; maxillipedal palp of 2 articles ……………………….. Cymothoidae

\- Pereopods 4-7 ambulatory (dactyls shorter than propodi); antenna not as above, with clear distinction between peduncle and flagellum; maxillipedal palp of 2 or 5 articles ………………………………... 2

2. Maxilliped, first and second maxillae with stout recurved, apical spines; mandible without 1acinia or molar process; first maxilla reduced to a single slender stylet ………………………… Aegidae

\- Maxilliped and second maxilla without stout, recurved, apical spines; mandible with or without lacinia and molar process; first maxilla not a slender stylet ……………………………………... 3

3. Mandible with lacinia and molar process generally reduced, vestigial, or absent; mandibular incisor narrow; first maxilla with outer lobe simple or falcate; second maxilla reduced; pereopods 1—3 usually prehensile (occasionally ambulatory) ……... Corallanidae

\- Mandible with distinct 1acinia, and large bladelike molar process; incisor generally broad, 3-dentate; first maxilla not as above, outer lobe often bearing several (10—14) stout spines; second maxilla with palp and exopod present; pereopods l—3 always ambulatory ……………………………………………………... Cirolanidae

F. Aegidae White, 1850: The Aegidae includes the isopods whose adults are temporary parasites of marine, brackish and fresh water fish, feeding on their host's blood before dropping off to digest the meal. They are most often captured free living on the ocean bottom (often in large numbers) .Brusca (1981) more appropriately considered them "carnivorous scavengers and micropredators." Some aegids may be associated fairly regularly with groups of specific species of fishes in given localities.

Aegids are some of the largest known isopods, attaining lengths to at least 60 mm, but taxonomically not large, only 8 genera are included.

G. *Alitropus* H. Milne-Edwards, 1840

***Alitropus typus* (Milne-Edwards, 1840)**

Alternate names, updated and Pakistani records.

Alitropus dimorphus Pillai, 1954
Alitropus foveolatus Schiödte and Meinert, 1879
Rocinela simplex Chilton, 1926
Alitropus typus–Feroze *et al.*, 2008; Rameshkumar and Ravichandran, 2010b; Mitra and Roy, 2011;Ahmed et al,2016

Pakistani hosts: *Labeo gonius, Labeo rohita, Cirrinus mrigala, Mystus bleekri*, *Labeo calbasu, Cyprinus carpio, Crossocheilus lalius, Notopterus notopterus, Wallago attu, Ompok pabda, Sperata sarwai, Chana marulies, Chanada baculis, Xenentodon cancilla, Gudusia chapra, Puntius sophore* **(**fish)

Note: It is a notorious species which parasitizes fishes in South Asia in fresh and brackish waters. The harmful effect of parasitic isopods on their hosts includes destruction of host tissue resulting from the pressure of the parasite's body. When found in the gill cavity, the isopod can impair respiration by causing atrophy of the gills. In the mouth cavity, the isopod prevents normal feeding. In young fish, the attached isopod can weigh down the fish and prevent normal behavior such as swimming and food gathering (Kabata, 1985). The parasites attack fish to feed but retain their free-swimming capability as adults. They do not appear to be protandrous hermaphrodites.

Found elsewhere and of their hosts there and elsewhere: India, Southeast Asia, European waters. **Hosts:** *Tilapia mossambica*, *Channa striatus, Cirrhina molitorella***,** *Giuris margaritacea, Oreochromis niloticus, Ophiocara aporos, Apogon thermalis, Therapon plumbeus*, *Chanos chanos* and crayfish.

F. Cymothoidae Leach, 1818: Representatives from the family Cymothoidae are obligate parasites of both marine and freshwater fishes and there are currently 40 recognized cymothoid genera and more than 380 species worldwide. Cymothoids make up about 62% of isopods associated with fishes (Bunkley-Williams and Williams, 1998). Some are highly host specific, even in the manca stage, some reasonably species-specific. Some of these parasitic cymothoids have been reported to parasitize the same host fish species for over 100 years, showing this species specificity. They are found from various parts of the fish (Fig. 185), on the skin, on the fins, in the buccal or branchial cavities, sometimes in a pouch, burrow beneath the skin where they live in a pocket or capsule formed within the musculature of the host, their position is thus often highly specific (Tsai *et al*., 1999). For instance, adult *Ceratothoa, Cymothoa*, and *Irona* are commonly found in the buccal cavity, whereas *Nerocila, Renocila*, and *Anilocra* adults generally infest the skin (Brusca, 1981; Jones *et al*., 2007). However, several species show a poor host specificity and the mancae may attach and feed on optional intermediate hosts belonging to different fish families (Sarusic, 1999) and sometimes even on several other organisms (Trilles and Öktener, 2004; Wunderlich *et al*., 2011). The stages normally found are the non-swimming, permanently attached mature females, often with a small male nearby. Cymothoids are protandrous hermaphrodites. The first male to parasitize a fish changes into a female. Males attaching to the same fish remain as males. Cymothoids harm the fish in several ways.

Mancae, the larvae feed voraciously and easily kill fry and fingerlings through the tissue damage they cause. Permanently attached adults stunt the growth of fish and retard or inhibit reproduction. Those in the gill chamber are usually associated with stunted gills, partly from pressure atrophy and partly from damage associated with feeding and attachment. They have also been frequently associated with anaemia. Those in the mouth affect the development of oral structures and may completely replace the tongue .Though cymothoids penetrate the skin with their pereopods and mouthparts, and the tissue-inhabiting forms maintain a small opening to the outside. Double and triple parasitisms infection of fish simultaneously by a cymothoid isopod and a copepod was observed (Rajkumar *et al.*, 2006).

No clear distribution pattern is apparent for the freshwater cymothoids. South America has a greater diversity than any other region of the world.

G. Anilocra Leach, 1818: More than 50 species are found in the world; in Pakistan 2 species have been reported.

***Anilocra dimidiate* Bleeker, 1857** (Figs. 186-187)

Alternate names, updated and Pakistani records.

Anilocra dimidiata–Bruce and Nelson, 1988; Shireen, 2001; Rameshkumar *et al.,* 2011; Kazmi and Yousuf, 2013

Material: One female 35mm x 10.25mm, 9-5-1993

Pakistani host: Without a reference to the host.

Found elsewhere and of their hosts there and elsewhere: Queensland, Australia, Java Sea, Mozambique Channel, Papua New Guinea, Philippines, Sri Lanka and India. **Hosts:** *Sardinella longiceps, Nemipterus, Psetus evansi.*

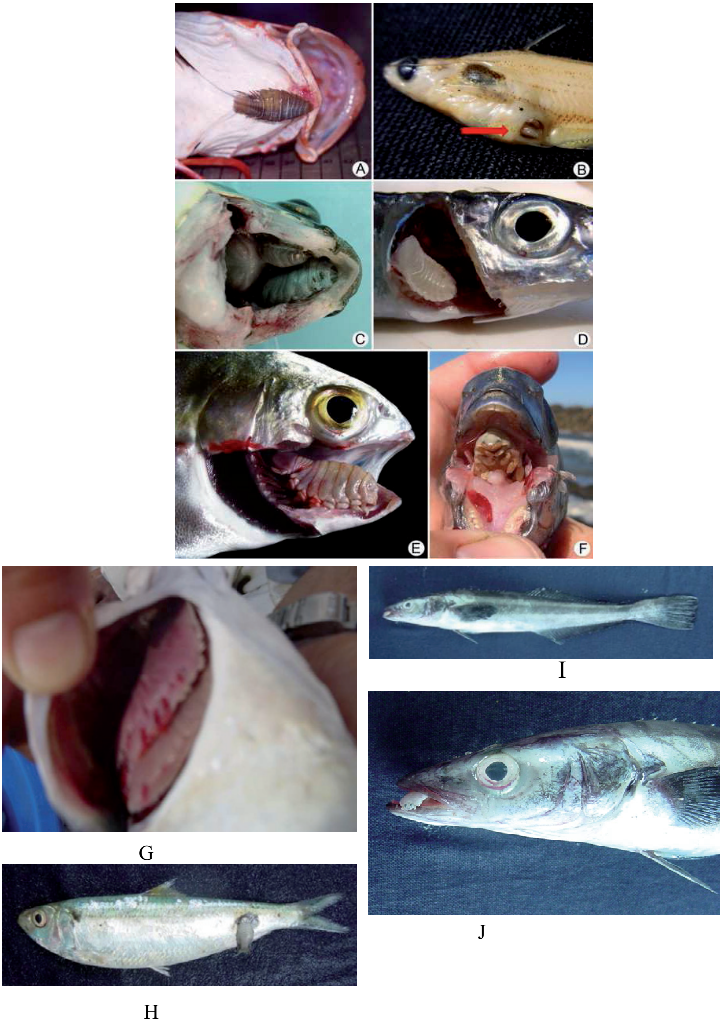


Fig. 185 Different attachment sites of cymothoids: A. External or scale attaching , B.flesh-burrowing , C, E, F. buccal dwelling and D. gill attaching (A-F from Smit *et al.*, 2014. G – J courtesy of Moazzam)

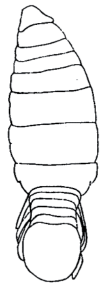


Fig. 186. *Anilocra dimidiate* (after Shireen, 2001).

Fig. 187. Host.

***Anilocra cavicauda* Richardson, 1910**

Alternate names, updated and Pakistani records.

Anilocra cavicauda–Karim, 1975; Bruce and Harrison-Nelson, 1988; Poore and Houston, 2002

Pakistani host: *Nematolosa nasus* (fish)

Found elsewhere and of their hosts there and elsewhere: Phillipines, China. **Host:** *Samida tumbil*

G. *Catoessa* Schiodte and Meinert, 1884: Only four species of *Catoessa* occur in the world- *Catoessa scabricauda, C. ambassae, C. gruneri* and *C. boscii*, all four are widely distributed. This isopod genus is a buccal parasite, attaches to the lateral internal face of the buccal cavity, with the isopod dorsal surface medial.

***Catoessa ambassae* Bruce, 1990** (Fig. 188)

Alternate names, updated and Pakistani records.

Catoessa ambassae–Ghani and Ali, 1998; Kazmi and Yousuf, 2013

Pakistani hosts: *Carangoides malabaricus, Chorinemus tala* and *Chorinemus lysan* (fish)

Found elsewhere and of their hosts there and elsewhere: New South Wales. **Host:** *Ambassis jacksoniensis* attaching in buccal cavity.

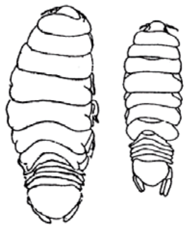


Fig. 188. *Catoessa ambassae* (after Ghani and Ali, 1998).

*** *Catoessa gruneri* Bowman and Tareen, 1983**(Fig. 189)

Alternate names, updated and Pakistani records.

Catoessa gruneri Bowman and Tareen, 1983; Bruce, 1990

Material: Nine females TL 12-21mm, five males TL 12-14mm 15-1-1994, 14-2-1994,Karachi FishHarbour

Pakistani hosts: *Selar malam, Chorinemus tala, Caranx djidaba* (fish)

Found elsewhere and of their hosts there and elsewhere: Persian Gulf. **Hosts:** *Leiognathus fasciatus, Leiognathus dau, Therapon puta.*

G. *Cymothoa* Fabricius, 1787: The genus *Cymothoa* can be considered to be relatively poorly known in the western Indian Ocean.

***Cymothoa eremita* (Brunnich, 1783)** (Fig. 190)

Alternate names, updated and Pakistani record.

Cymothoa eremita–Shireen, 1999, 2000, Ramesh Kumar *et al.*, 2012; Kazmi and Yousuf, 2013; Sethi *et al.*, 2013.

Material: Female TL 32.00mm male TL12.00mm.

Pakistani host: *Parastromateus niger* (Fish)

Found elsewhere and of their hosts there and elsewhere: From the Western Indian Ocean to the Western Pacific. India, Japan, Arabian Gulf, South China Sea and Philippines. **Hosts**: *Liza vaigiensis*, *Arothron leopardus*, *Hime japonica*, *Pampus argenteus*, *Pampus cinereus*, *Parastromateus niger, Peprilus paru, Psettodes erumei, Siganus canaliculatus, Plectorhinchus nigrus* and *Sphyraena obtusata*, y (Trilles, 1994). On *Crangoides oblongus* (Sethi *et al*. (2013).It seems that its parasitism depends particularly on the season and on the host sex (Rameshkumar *et al.*, 2012). Oktener (2008) reported *C. eremita* as a parasite of dolphin, *Coryphaena apus*, in a list of dolphin parasites.

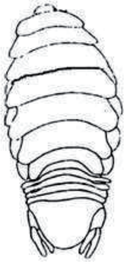


Fig. 189. *Catoessa gruneri* female.

Fig. 190. *Cymothoa eremite* female.

G. *Elthusa* Schiodte and Meinert, 1884

***Elthusa raynaudii* Milne Edwards, 1840)** (Fig. 191)

Alternate names, updated and Pakistani records.

Livoneca Raynaudii Milne-Edwards, 1840
Livoneca raynaudi Nierstrasz, 1915; Barnard, 1920; Pillai, 1954
Elthusa raynaudii Bruce, 1990 (for complete synonyms and description); Shireen, 2001; Kazmi and Yousuf, 2013

Material: Five ov. females, one male

Pakistani host: *Nematolosa nasus* (fish).

Found elsewhere and of their hosts there and elsewhere: S. Africa, Chile, Japan, Australia, Uruguay, St. Paul Is, Amsterdam Is., South Wales coast. **Hosts**: *Physiculus* sp., *Graigmin, Zenopsis nebulosus, Pseudolabrus tetricus, Pseudolabrus miles, Meuschenia freycineti, Pseudophycis bachus, Cyttus transversa, Gnathanacanthus goetzei, Hemiamphus intermedius, Pellona brachysoma* and *Stolopherus commersoni*. This isopod naturally occurs in the gill chamber of fishes however, a female *Elthusa raynaudii* was found accidentally attached on the roof of the mouth facing inward in a lantern shark, *Etmopterus* sp. in Taiwan (Williams *et al.*, 2010).

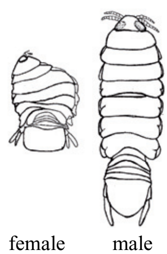


Fig. 191. *Elthusa raynaudii* (after Shireen, 2001).

G. *Joryma* Bowman and Tareen, 1983

***Joryma engraulidis* Barnard, 1936** (Fig. 192)

Alternate names, updated and Pakistani records.

Joryma engraulidis–Shireen, 2000 (description); Veerappan and Selvamathi, 2003; Kazmi and Yousuf, 2013.

Material: Three females 16-25mm, one male TL10mm

Pakistani hosts: *Sardinella* spp. (fish).

Found elsewhere and of their hosts there and elsewhere: India, Honduras. **Hosts**: *Thryssa dussumieri, Anchoviella zollingeri.*

Fig. 192. *Joryma engraulidis* (After Shireen, 2000).

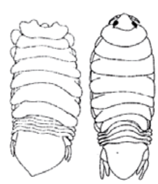
***Joryma sawayah* Bowmanand Tareen, 1983** (Fig. 193)

Alternate names, updated and Pakistani records.

Joryma sawayah–Ghani and Shireen, 2000; Sethi, 2012; Kazmi and Yousuf, 2013

Pakistani hosts: *Sardinella* spp.

Found elsewhere and of their hosts there and elsewhere: Kuwait, Persian Gulf, India. **Host:** *Pellona ditchela*



female male

Fig. 193. *Joryma sawayah* (after Ghani and Shireen, 2000).

G. *Mothocya* Costa in Hope, 1851

***Mothocya karobran* Bruce, 1986** (Figs. 194-195)

Alternate names, updated and Pakistani records.

Mothocya karobran Bruce, 1986; Schotte *et al*., 1995 onward; Kazmi and Yousuf, 2013; Rameshkumar *et al.*, 2014

Pakistani host: *Strongylura strongylura* (fish).

Found elsewhere and of their hosts there and elsewhere: India, New South Wales and Queensland. Eastern and northern Australia. **Hosts**: *Tylosurus gavialoides, Strongylura strongylura*.

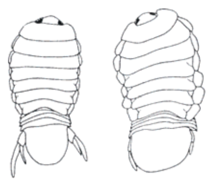


Fig. 194. *Mothocya karobran*.

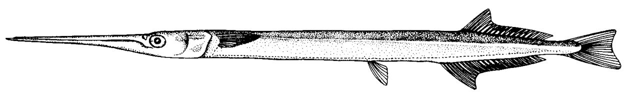


Fig. 195. Host.

Mothocya renardi (Bleeker, 1857)

Alternate names, updated and Pakistani records.

Livoneca Renardi Bleeker, 1857.
Irona Renardi. Schioedte and Meinert, 1884
Livoneca renardi Gerstaecker, 1881
Irona melanosticta Barnard, 1914
Irona renardi Karim, 1975
Mothocya renardi-Bruce, 1986; Kazmi and Yousuf, 2013; Aneesh *et al.*, 2013

Mothocya renardi can be distinguished by the large size (24–36 mm in length), narrow pleon and long narrow uropods, which extend well past the posterior margin of the pleotelson.

Pakistani host: Mackeral Fish and *Rachycentron canadum*

Found elsewhere and of their hosts there and elsewhere: South Africa, India, Indonesia, Australia, Thailand, N.S. Wales, Japan, Philippines, Madagascar; Kuwait, Kenya, Mozambique and Papua New Guinea, China. Hosts: *Strongylura leiura, Strongylura strongylura, Strongylura incisa, Strongylura anastomella, Strongylura ciconia, Tylosurus crocodilus, Tylosurus choram, Hyprampus sajori* and *Tylosurus gavialoides*.

G. *Nerocila* Leach, 1818: *Nerocila* is a large genus including at least 65 species living attached on the skin or on the fins of fishes. The eyes, which are obvious in the larval and young forms, in the adults as a rule gradually disappear, this being obviously in connection with the assumption of a parasitic life.

Nirocila sundaica Bleeker, 1857

Alternate names, updated and Pakistani records.

Rameshkumar *et al.*, 2014, insectoid. Info.

Pakistani hosts: No information

Found elsewhere and of their hosts there and elsewhere: Asia Hosts: *Ilisha melastoma*, *Otolithes ruber*, *Sardinella fimbriata*, *Thryssa mystax, Epinephelus*, *Terapon*.

***Nerocila phaiopleura* Bleeker, 1857** (Figs. 196-197)

Alternate names, updated and Pakistani records.

Nerocila (*Nerocila*) *phaiopleura* -Bowman and Tareen, 1983

Nerocila phaiopleura–Shireen, 2001(description of female); Ravichandran and Kumar, 2004; Rameshkumar and Ravichandran, 2010a; Trilles *et al.*, 2013; Kazmi and Yousuf, 2013; Raja *et al.*, 2014.

Pakistani hosts: *Chirocentrus nudus, Sardinella sindensis* (fish)

Material: Collected several times, 1 ov. female TL 24mm, 18-1-1992, 1 ov. female TL 23 mm, 23-2-1993; 1ov. female TL 24mm, 12-3-1992; 2ov. females TL 20mm-35mm, 27-5-1992; 1 ov. female TL 19mm, 30-6-1992; 1ov. female TL 20mm, 27-8-1992; 2ov. females TL 23-24mm, 26-4-1993; 3-6-2004,no further details.

Note: Pelagic while young, parasite as adults. The male is very small.

Found elsewhere and of their hosts there and elsewhere: India, Bay of Bengal, S. Africa, Persian Gulf, W. Australia, Hong Kong, East coast of Peninsular Malaysia, Thailand. **Hosts:** *Chirocentus dorab, Rastrelliger kanagurta, Dussumieria acuta, Gazza minuta, Leiognathus splendens, Sardinella longiceps, Sardinella gibbosa, Sardinops melanosticta, Clupea, Engraulis japonica, E. australis, Selaroides leptolepis, Sphyraena jello, Thryssa mystax, Illisha melasoma, Parastmateus niger, Stolephorus indicus, Liza argentea, Cnidoglannus macrocephalus, Carangoides malabaricus, Tenualosa ilisha,Histophorus gladius.*

Fig. 196. *Nerocila phaiopleura*.

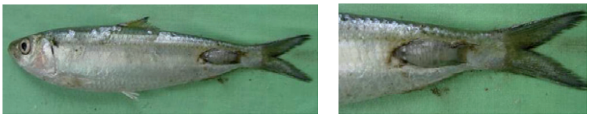


Fig. 197. Attached on host

***Nerocila orbignyi* (Guerin Meneville, 1832)** (Fig. 198)

Alternate names, updated and Pakistani records.

Ichthyophilus orbignyi Guerin-Meneville, 1832
Nerocila maculate H. Milne Edwards, 1840
Nerocila neapolitana Schiodte and Meinert, 1879
Nerocila orbignyi–Bruce, 1987 (full synonyms); Shireen, 1997 (unpublished data); Ramdane *et al*., 2007; Kayış and Ceylan, 2011; Kazmi and Yousuf, 2013; Al-Zubaidy and Mhaisen, 2013; Ozcan *et al*., 2014

Material: A large collection, twenty seven ov. females TL 8-25mm

Pakistani hosts: *Tachysurus maculates, Pseudarius jella, Chirocentrus nudus, Aroides dussumieri, Neyuma thalassinus* (fish)

Note: It is a euryxenic species which may develop in or on unrelated host species.

Found elsewhere and of their hosts there and elsewhere: Atlantic, Mediterranean, South Africa, Pacific, Turkey, Red Sea, Algeria, and India. **Hosts:** *Plicofollis dussumieri, Dicentrarchus labrax, Callorhynchus milli, Acanthopagurus australis, Chrysophrys auratus, Pseudocaranx dentex, Mola mola, Sillago bassensis, Pomatomus saltatrix, Pagrosomus auritus, Crenimugil labrisus, Acanthopagus butcheri, Girella tricuspidata, Solea solea, Liza aurata, L.ramada, Mugil cephalus, Chelon labrosus, Alosa agone, Trigla lyra, Symphodus tinca, Serranus scriba, Serranus cabrilla, Diplodus vulgaris, Scorpaena porcus, Crenilabrus pavo* and *Moolgarda seheli. N. orbignyi* generally infects fishes of the family Mugilidae (Trilles, 1994; Öktener and Trilles, 2004; Kayis and Ceylan, 2011).

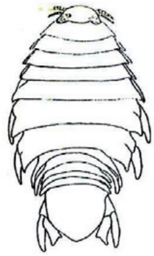


Fig. 198. *Nerocila orbignyi.*

***Nerocila kisra* Bowman and Tareen, 1983** (Figs. 199-200)

Alternate names, updated and Pakistani records.

Nerocila (Emphyla) kisra Bowman and Tareen, 1983

Nerocila kisra Bruce, 1987; Shireen and Ghani, 2000; Oktener and Trilles, 2004; Kazmi and Yousuf, 2013.

Material: Three ov. females 18-1-1992; ten ov. females 23-2-1992; two ov. females 11-4-1992; four ov. females 9-5-1992; one ov. female 30-6-1992; two ov. females 30-7-1992; six ov. females 27-8-1992; one female TL 25.00 mm 30-4-1995, Korangi Creek.

Pakistani hosts: *Johnius sina, Otolithes ruber, Pomadasys maculates, Johnius axillaries, Johnius argentatus, Pristipoma hasta*.

Found elsewhere and of their hosts there and elsewhere: Arabian-Persian Gulf. **Hosts:** *Helotes* and *Therapon*

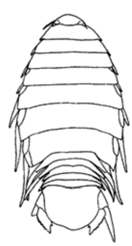


Fig. 199. *Nerocila kisra.*

Fig. 200. Attached to Host.

***Nerocila barramundae* Bruce, 1987** (Fig. 201)

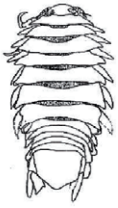
Alternate names, updated and Pakistani records.

Nerocila barramundae–Shireen and Ghani, 2000; Beesley and Houston, 2002; Kazmi and Yousuf, 2013.

Material: Twenty five females TL 8-21mm; new material 1 specimen 20-3-2006, Gharo backwaters

Pakistani hosts: *Arius jella, Netuma thalassina, Plicofollis dussumieri* (fish)

Found elsewhere and of their hosts there and elsewhere: Karumba, Gulf of Carpentaria, Queensland. **Hosts:** *Lates calcarifer, Lobotes surnamensis*.



female

Fig. 201. *Nerocila barramundae* (after Shireen, 2000).

***Nerocila depressa* Milne Edward, 1840** (Figs. 202-203)

Alternate names, updated and Pakistani records.

Nerocila dolichostylis Koelbel, 1879
Nerocila pigmentata Bal and Joshi, 1959; Karim, 1975

Nerocila depressa–Bruce and Harrison-Nelson, 1988; Shireen, 2001 (description of female); Trilles *et al.*, 2013 (full synonyms); Kazmi and Yousuf, 2013

Material: No new material, few females, TL 17-25mm

Pakistani host: *Coila dussumieri* (fish)

Found elsewhere and of their hosts there and elsewhere: India, Hong Kong, Thailand. **Hosts:** *Sardinella albella, Sardinella gibbosa, Sardinella fimbriata, Cyclocheilichthyes apogon, Opisthopterus tuto*or.

Fig. 202. *Nerocila depressa* (after Shireen, 2001).

Fig. 203. Host.

***Nerocila sigani* Bowman and Tareen, 1983** (Fig. 204)

Alternate names, updated and Pakistani records.

Nerocila (Nerocila) sigani Bowman and Tareen, 1983
Nerocila (Nerocila) aress Bowman and Tareen, 1983
Nerocila sigani–Kensley,2001; Ghani, 2003; Rameshkumar *et al*., 2012; Trilles *et al.*, 2013; Kazmi and Yousuf, 2013.

Material: One ov. female TL 28mm, 12-3-1999

Pakistani host: *Netuma thalassia* (fish)

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Hosts:** *Siganus oramin, Sciaenia dussumieri, Argyrosomus hololepidotus, Formio niger, Pennahia macrocephalus, Atrobucca nibe, epinephalus tauvina, Acanthopagurus latus, Nemipterus talu, Terapon theraps*.

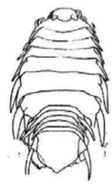


Fig. 204. *Nerocila sigani* (after Ghani, 2003).

***Nerocila serra* Schiodte and Meinert, 1881** (Figs. 205-206)

Alternate names, updated and Pakistani records.

Nerocila Serra Schiodte and Meinert, 1881

Nerocila serra–Karim, 1975; Bowman and Tareen, 1983; Shireen and Ghani, 2000; Trilles *et al.*, 2013; Saravanakumar *et al.*, 2012 Kazmi and Yousuf, 2013

Material: Five ov. females TL 23-27mm; new material 3-6-2004

Note: Transparent white. Pelagic while young, adult parasitic on fish

Pakistani hosts: *Pomadasys maculatus, Arius jella, Netuma thalassinus, Hexanematichthys sagor, Osteogeneiosus militaris* (fish)

Found elsewhere and of their hosts there and elsewhere: Indonesia, India, St. Lucia, South Africa, Delagoa Bay, Mozambique, Thailand, Sri Lanka, Peninsular Malaysia, Australia and Queensland. **Hosts:** *Arius maculatus, A. sagor, Plicofollis dussumieri, Hydrophis obscures,* massive infestation of the sea snake*, Enhydrina schistosa* during the monsoon period (Saravanakumar *et al.*, 2012).

Fig. 205. *Nerocila serra* (after Shireen and Ghani, 2000).

Fig. 206. On host.

G. *Norileca* Bruce, 1990

***Norileca borealis* Javed and Yasmeen, 1999** (Figs. 207-208)

Alternate names, updated and Pakistani records.

Norileca borealis Javed and Yasmeen, 1999; Kazmi and Yousuf, 2013

Material: Two females, 1 ov., TL 25mm, 2 males TL 23-26mm, 9-5-1993

Pakistani host: *Rastrelliger kanagurta* (fish)

Found elsewhere and of their hosts there and elsewhere: Not outside Pakistan

Fig. 207. *Norileca borealis*.

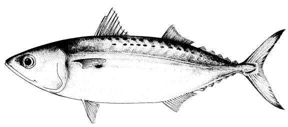


Fig. 208. Host.

***Norileca indica* (Milne Edwards, 1840)** (Fig. 209)

Alternate names, updated and Pakistani records.

Livoneca indica Milne-Edwards, 1840

Lironeca indica Trilles, 1976, 1979

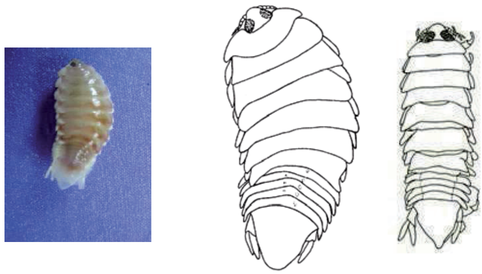
Livoneca ornata Helier, 1868

Norileca indica–Bruce, 1990; Ghani and Shireen, 1995 (description); Yu and Li, 2003; Yamauchi *et al*., 2005; Ramesh Kumar *et al.*, 2013, 2014; Kazmi and Yousuf, 2013; Neeraja *et al.*, 2014.

Material: A large collection, thirty five females TL 13-32mm, thirteen males TL 10-24mm Ibrahim Hyderi;new material 26-6-2001.

Pakistani hosts: *Rastrelliger kanagurta, Decapterus russelli* (fish)

Found elsewhere and of their hosts there and elsewhere: Australia, India, Sumatra, China, Thailand, Indonesia, Philippines, New Guinea, off Mozambique. **Hosts:** *Herklotichthyes* sp., *Selar crumenophthalmus, Coryphaena hippurus.*



female (courtesy of Moazzam) male

Fig. 209 *Norileca indica* (after Ghani and Shireen, 1995)

***Norileca triangulata* (Richardson, 1910)** (Fig. 210)

Alternate names, updated and Pakistani records.

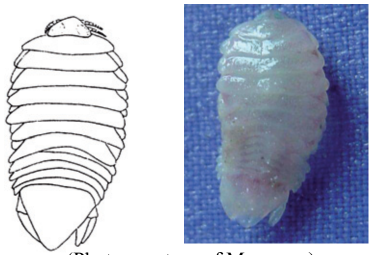
Livoneca triangulata Richardson, 1910.-Nierstrasz, 1931

Norileca triangulata–Bruce, 1991; Ghani and Ali, 1998; Kazmi and Yousuf, 2013

Material: Three females TL 13-26mm; 18-7-2005

Pakistani host: *Rastrelliger kanagurta* (fish)

Found elsewhere and of their hosts there and elsewhere: India, Philippines Island, Queensland. **Hosts:** *Parexocoetus brachypterus, Sardinella gibbosa*.



(Photo courtesy of Moazzam)

Fig. 210. *Norileca triangulata* (after Ghani and Ali, 1998).

F. Corallanidae Hansen, 1890: The Corallanidae are mostly free living but have a few representatives that are parasites of fish, such as the present genus *Argathona* which is common in the nasal passages of serranids and lutjanids. They also feed on Leatherback turtles (Williams *et al*., 1996), green turtle (Monod, 1975). They show many morphological adaptations towards an increasingly parasitic life style.

G. *Argathona* Stebbing, 1905

***Argathona muraeneae* Bal and Joshi, 1959** (Fig. 211)

Alternate names, updated and Pakistani records.

Argathona muraeneae–Bruce, 1982 (genus inquirenda); Delaney, 1989; Ghani and Shireen, 1995 (description); Kazmi and Yousuf, 2013

Material: No new material ,1 female TL 16mm, 24-12-1992; 1 female TL 15mm, 30-12-1992; 4 females TL 15-17mm, 14-1-1993; 1 female TL 16mm, 9-1-1994; 5 juveniles TL 5mm, 2 females TL 12mm, 27-1-1994.

Pakistani hosts: *Epinephelus chlorostigma* and *Argyops spinifer* (fish)

Found elsewhere and of their hosts there and elsewhere: India. **Hosts:** *Gymnothorax favagineus*, *Gymnothorax favagineus, Muraena tessellate*.

Fig. 211. *Argathona muraeneae* (after Ghani and Shireen, 1995).

G. *Lanocira* Hansen, 1890: There are ten species of *Lanocira*, all species occur within the tropics with the exception of one record from southern Chile (Delany, 1989).Two occur here. Bruce and Sidabalok (2011) suggested that 'the record of *L. gardineri* from Karachi (Javed and Yasmeen, 1992) is probably undescribed species as there are several points of difference between their figures and description, most notably in the relative length of the uropodal rami and in having an anteriorly acute rostrum”. Yasmeen and Javeds’ (2000) another species *Lanocira wowine* from Pakistan seems not to differ from *Lanocira gardineri* and is placed in its synonymy (Bruce and Sidabalok, 2011). Same is followed here.

***Lanocira gardineri* Stebbing, 1904** (Fig. 212)

Alternate names, updated and Pakistani records.

Lanocira gardineri Stebbing, 1904, Bruce and Sidabalok, 2011
Lanocira wowine Yasmeen and Javed, 2000; Kazmi and Yousuf, 2013
Non *Lanocira gardineri* Javed and Yasmeen, 1992 (misidentification, probably undescribed species)
Lanocira capensis Barnard, 1914

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Widely distributed in the tropical and subtropical Indian Ocean. **Hosts:** Sponges, *Sabellaria* tubes, ascidians, corals.

Fig. 212. *Lanocira gardineri.*

F. Gnathiidae Leach, 1814: The family Gnathiidae comprises 12 genera known mostly from marine environments .Gnathiids are a small, relatively homogeneous group of isopods that are temporarily parasitic as juveniles on teleosts and elasmobranchs. Strong sexual dimorphism is characteristic of the family Gnathiidae where sessile males live with a harem of females while juvenile praniza stages are ectoparasites of fish.

Adult males develop formidable jaws, adult females resemble juveniles. The adults do not feed. Resting larvae and adult stages are found in small groups in marine cavities such as in mud banks, in dead barnacles or coral, or in sponges, tunicates and tubes of serpulid worms (Wagele, 1988). Eggs are brooded in the ventral brood pouch and they hatch to produce a 'zuphea' or unfed juvenile. These leave the place, a cavity, and seek a fish to which they attach and engorge themselves on the host's blood; their mid-section becomes greatly distended and, the parasites, now are called 'praniza' and may appear reddish. After several hours or days the praniza leave the host and enter a cavity in the water where they digest the meal and eventually moult to the second zuphea stage. This is repeated twice more until the third stage praniza leaves the fish to seek a cavity to mature. On teleosts, praniza may remain for only a few hours while they feed. Praniza on elasmobranchs however may remain for weeks.

The prevalence of gnathiids is often underestimated because many species leave their host immediately the host is captured, and others only feed on fish at night. The taxonomy of gnathiids is solely based on the morphology of the adult males since they are more frequently encountered than the other life stages, therefore female and larval gnathiid descriptions are sometimes absent from species descriptions. Anatomical observations cast doubt on the classification of Gnathiidae as Cymothoida, in agreement with recent phylogenetic studies (Wilson *et al.*, 2011).

G. *Paragnathia* Omer-Cooper, 1916

***Paragnathia* sp.** (Fig. 213)

Alternate names, updated and Pakistani records.

Paragnathia cf. *formica* **-**Kazmi and Yousaf, 2007
Paragnathia sp. Ghory *et al*., 2010

Material: Praniza stage TL 1.48mm - 1.51mm, Ghora Bari (Makri Creek), May 29 2006

Praniza greyish with only five pairs of ambulatory pereiopods. Late pranizas with the pereon segments 3 to 5 fused and inflated, particularly in females, which incubate the eggs internally. Eight-segmented antennal flagellum and telson with rounded posterior border.

Pakistani hosts: Fish juveniles. Since the fish were dead and the gnathids were detached it is not clear that praniza were detached from buccal cavity or body and that the larvae belonged to cohort of one female or different females.

Note: The present material is close to *P.varanus* Svavarsson and Bruce, 2012.

Praniza larva.

Zuphea larva

Fig. 213. *Paragnathia* sp.

***G. *Gnathia* Leach, 1814**

***Gnathia* sp.** 1

Material: 3-12-2005, Bulleji

Pakistani host: Unknown

***Gnathia* sp.** 2 (Fig. 214)

Alternate names, updated and Pakistani records.

Gnathia sp. Shireen (unpublished data), 1997

Material: One praniza stage TL2mm

Pakistani host: *Plectorhinchus schotaf*

Note: *Gnathia arabica* was reported coast of northern India, implying that its range includes the coast of Pakistan (Schotte, 1995), then Kensley (2011) reported 11species from the western Indian Ocean; the larvae could be of any of these.

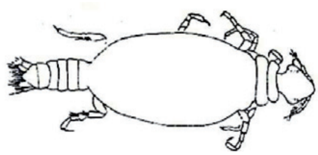


Fig. 214. *Gnathia* sp. 2 (after Shireen, 1997).

F. Cirolanidae Dana, 1852: The Cirolanidae are scavenging marine animals which can sometimes swarm in vast numbers and are familiar as pests that attack damaged or dying fish, sharks or spiny rock lobsters and can cause collapse of commercial fisheries.

G. *Cirolana* Leach, 1818: The genus *Cirolana*, the largest genus in the family includes 129 species (Bruce and Schotte, 2013). Some species are carnivorous (C. *fluviatilis*), inflicting serious mortalities in a tropical cage-rearing system.

***Cirolana manorae* Bruce and Javed, 1987** (Fig. 215)

Cirolana manorae Bruce and Javed, 1987; Sadiq, 1993; Kazmi and Yousuf, 2013

Pakistani hosts: *Sargassum swartzii, Padina pavonia, Ulva fasiata, Colpomenia sinousa, Stockeyia indica, Laurenia obtusa*

Found elsewhere and of their hosts there and elsewhere: India. **Host:** Not specified.

Fig. 215. *Cirolana manorae*.

SUP. O. Eucarida Calman, 1904

O. Decapoda Latreille, 1803

Decapod crustaceans form symbiotic relationships with a variety of invertebrate hosts (Bruce, 1976; Ross, 1983) specially with certain sessile invertebrates such as sponges (Porras *et al*., 1996; Caruso *et al*., 2005), corals and anemones, on or under the bell of jelly fish, sometimes as phyllosoma larvae, worm tubes (Nalesso *et al*., 1995; Nascimento and Torres, 2006), echinoderms (Wirtz *et al*., 2009) and bryozoans (Morgado and Tanaka, 2001). Many symbiotic decapods are kleptoparasitic, feeding on particles gathered by the host, and occasionally even feed on host tissue Some crab species despite not being a typical crustacean occurring in association with sea anemones, they evidently possesses the ability to protect itself from the stinging cells of the anemone (Fautin *et al*., 1995). Some of them may simply be parasites or hosts of barnacles, isopods, amphipods and weeds. Parasitic crustaceans may offer insight into the evolutionary histories of their decapod host and vice versa. Fish eggs and larvae can be found as parasite in the gill chamber of King crabs. Pearl-like structures have been found embedded in the muscles inside the claw of a lobster, caridean and *Penaeus indicus* could be only an ingrowth of chitin due to some vagary of the process of regeneration.

S.O. Dendrobranchiata Bate, 1888

F. Penaeidae Rafinesque, 1815: Penaeids are mostly benthic and mainly found on soft bottom of sand and/or mud, but a few species are pelagic and others are known to inhabit coral reefs and sea grass, for example, some *Metapenaeopsis* species. There is no such information present about the Pakistani *Metapenaeopsis* (*M. stridulans* and *M. mogiensis*). Post larvae and juveniles of some species are found exclusively in see grass beds (Coles and Lee Long, 1985); *Penaeus monodon* appears to select muddy mangrove channels and often associates with marginal or floating vegetation (de Freitas, 1986). Penaeid genus *Funchalia* were found inside living *Pyrosoma atlanticum.*

S.O. Pleocyemata Burkenroad, 1963

I. O. Brachyura Latreille, 1803: The infraorder Brachyura contains about 93 families. Some crabs (Jellyfish crab *Ethusa* spp.) sometimes carry jellyfish on their backs to serve as a very effective protective shield; young crabs and some juvenile fish, can live unharmed among a jellyfish's venomous tentacles. There, protected from prey, they feed on jellyfish leftovers like zooplankton or larval fish and remove parasites from their accommodating hosts. *Dorippe frascone,* the urchin crab or carrier crab, often has a symbiotic relationship with a long-spined sea urchin and carries one around on its carapace, these long, hollow spines may provide protection to the crab by reducing the risk of predation by fish while not being too heavy to carry. The urchin obtains benefit by being transported to new feeding grounds. Three other families of brachyuran crabs are closely associated symbiotically with various species of echinoderms, viz. the Eumedoninae, Portunidae and Pinnotheridae.

Some dromiids crabs have taken to molluscan protection too. Their backs are shaped so as to fit snugly into half of a clam shell, the hind legs grasp the shell. Genus *Lybia*, a xanthid carries intentionally living anemones as a means of defense for which their claws are adapted. The anemones are used not only defensively but also gather food particles with their tentacles which the crab scrapes off for its own use. A crab carapace is a biologically active surface -a mobile platform. The decorator crabs (Superfamily Majaoidea) actively select rocks and specific species of symbionts to facilitate camouflaging their carapaces. The algal growth gives a furry appearance, which also helps it blend into its environment and hide from predators. Six families are found associated with the mangal ecosystem-the Grapsidae (*Nanosesarma*), the Portunidae (*Scylla* and *Portunus)*, the Ocypodidae (*Serenella*, *Illyoplax,* M*acrophthalmus,Uca, Metaplax, Dotilla, Nasima* and others), xanthid genera *Eurycarcinus, Epixanthus, Heteropanope, Ozius, Pilumnius, Myomenippe* and leucosid genus *Ebalia.* In the landward fringe *Cardisoma* have been reported from Pakistan (Kazmi and Perveen, 2005). None of genera are restricted to the mangal environment, and many are only occasional visitors therefore not all are dealt herewith. An association between *Grapsus strigosus* now=*Grapsus albolineatus* Latreille, in Milbert, 1812 and *Enteromorpha procera* is mentioned by Hameed *et al*. (2001). At other places the crab is given associated with coral reef. The calappid *Matuta planipes* inhabits sandy seagrass beds.

S. Podotremata G**uinot, 1977**

SUP. F. Homolodromioidea Alcock, 1899

F. Homolidae De Haan, 1839: Members of the Homolidae have their last pair of walking legs in a sub-dorsal position, which allows them to hold objects in place over the rear half of the carapace. The objects carried include sponges, black corals and gorgonians, and this behaviour may be a defense mechanism against predators. Some species have been observed carrying living sea urchins in a symbiotic relationship which allows them to benefit from the protection of the urchin's dangerous spikes.

G. *Homolax* Alcock, 1899

***Homolax megalops* (Alcock, 1894)** (Fig. 216)

Alternate names, updated and Pakistani records.

Homola megalops Alcock, 1894; Tirmizi and Kazmi, 1986

Material: No new material, small collection of 1976 from offshore waters, without any indication of carried material.

Found elsewhere and of their hosts there and elsewhere: Indian Ocean. **Commensal:** *Octolasmis stellata* on gills (Annandale, 1909).

Fig. 216. *Homolax megalops*.

SUP. F. Dromioidea De Haan, 1833

F. Dromiidae de Haan, 1833: They are small or medium-sized crabs which get their name sponge crabs from the ability to shape a living sponge or ascidian into a portable shelter for themselves. A sponge crab cuts out a fragment from a sponge and trims it to its own shape using its claws. The sponge grows along with the crab, providing a consistent shelter. The crab's camouflage is so good that it is almost impossible to spot unless it moves. The disguise usually tastes bad and provides additional protection by discouraging predators from taking a bite out of the crab even if it is discovered. The figure given below explains the manner in which a dromiid crab puts on the sponge coat. (Fig. 217).

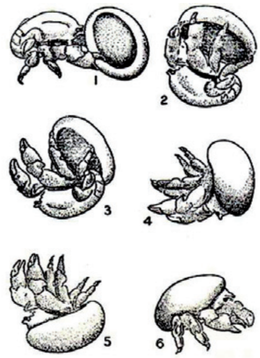


Fig. 217. Manner in which a dromiid crab puts on the sponge coat (after Schmitt, 1973).

G. *Ascidiophilus* Richters, 1880

***Ascidiophilus caphyraeformis* (Richters, 1880)** (Fig. 218)

Alternate names, updated and Pakistani records.

Pseudodromia integrifrons Henderson, 1888*;* Tirmizi and Kazmi, 1988
Pseudodromia murrayi Gordon, 1950
Ascidiophilus caphyraeformis Lewinsohn, 1977

Pakistani host: Unidentified sponge

Found elsewhere and of their hosts there and elsewhere: Indian Ocean. **Associates:** an intimate association with ascidians or sponges wherein almost the whole body of the crab is tightly enclosed in a compound ascidian (Henderson, 1892; McLeay, 1993).

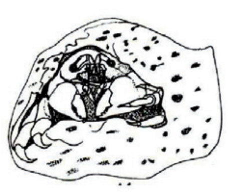


Fig. 218. *Ascidiophilus caphyraeformis* enclosed in sponge associate.

G. *Conchoecetes* Stimpson, 1858

***Conchoecetes artificiosus* (Fabricius, 1798)** (Fig. 219)

Alternate names, updated and Pakistani records.

Conchoeodromia alcocki Chopra, 1934
Dromia artificiosa Weber, 1795 (nomen nudum)
Dromia artificiosus Fabricius, 1798
Dromia conchifera Haswell, 1882
Conchoecetes artificiosus–Alcock, 1901; Ahmed *et al*., 1972; Tirmizi and Kazmi, 1988

Material: One male only, CL 20.5mm, Karachi Fish Harbour(MRC BRAC -18)

Pakistani associates: Unidentified sponge

Found elsewhere and of their hosts there and elsewhere: Indian Ocean. The species of *Conchoecetes* are unusual in that they carry bivalve shells as camouflage (Morton and Morton, 1983; McLay, 1993; Ng *et al*., 2000).

Fig. 219. *Conchoecetes artificiosus* carrying sponge.

G. *Lewindromia* Guinot and Tavares, 2003

***Lewindromia unidentata* (Rüppell, 1830)** (Fig. 220)

Alternate names, updated and Pakistani records.

Cryptodromia incise Zarenkov, 1971
Cryptodromia unilobata Campbell and Stephenson, 1970

Cryptodromiopsis unidentata Rüppell, 1830
Dromia unidentata Rüppell, 1830
Dromidia unidentata hawaiiensis Edmondson, 1922
Dromidia unidentata–Tirmizi and Kazmi, 1988
Lewindromia unidentata–McLay, 1993; Yaldwyn and Webber, 2011

Material: One male, CL 10.75mm, housed in the British Museum (BM No. 1903, 7.29.7)

Pakistani associate: No record

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. It covers its back with colonial anemones (Day, 1974) or an ascidia or a mass of sponge on its back (Sakai, 1976), an anthozoa, Octocorallia or *Acyonaria* (Lewinsohn, 1984).

Fig. 220. *Lewindromia unidentata* enclosed by sponge.

S. Eubrachyura de Saint Laurent, 1980

S.S. Heterotremata Guinot, 1977

SUP. F. Dorippoidea MacLeay, 1838

F. Dorippidae Macleay, 1838: These are the species of crabs that have learnt to place anemones on their backs, using the stinging tentacles of the anemone to fend off potential predators. The relationship between this and its anemone is the most intimate, the anemone actually growing with the crab. This specialized defence of certain species often used by those that have little or none of their own is called inquilinism. These crabs can carry sea urchins or may hold half a bivalve in which a small fish, a small crustacean, or some other small animal is enclosed or to which an anemone is attached. It seems likely that the association starts with a young crab holding a small bivalve shell, or part of one, on which the anemone settles; when, during growth, the base of the anemone starts to extend beyond the shell, the part of the base not touching the shell hardens and takes over the role of the shell.

G. *Dorippoides* Serène and Romimohtarto, 1969

***Dorippoides nudipes* Manning and Holthuis, 1986** (Fig. 221)

Alternate names, updated and Pakistani records.

Dorippe (Dorippoides) fucchino (sic) Tirmizi and Kazmi, 1983
Dorippoides facchino Tirmizi and Kazmi, 1988; Kazmi, 1995
Dorippoides nudipes insectoid info.

Material: Several specimens; 6-1994 ;1 male CL 32 mm, 1 female TL 33mm, Korangi Creeks, 17-4-1995.

Pakistani associate: The male crab carried *Spisula* sp.; the female carried *Anadara*, sea anemone.

Found elsewhere and of their hosts there and elsewhere: Indian Ocean. **Associates:** Henderson (1893), Alcock (1896), Serene and Romimohtarto (1969) noted the species is protected by valve of Lamellibranch to which an actinian is attached.

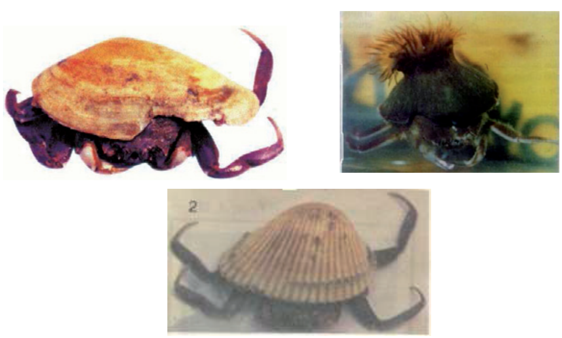


Fig. 221. *Dorippoides nudipes* carrying sea anemone/shell.

G. *Neodorippe* Serene and Romimhtarto, 1969

***Neodorippe callida* (Fabricius, 1798)** (Fig. 222)

Alternate names, updated and Pakistani records.

Neodorripe callida–Manning and Holthuis, 1981*;* Sin *et al*., 2009
Dorippe astuta Alcock, 1896; Hashmi, 1963; Ahmed *et al.*, 1972; Khan and Ahmad, 1975
Dorrippe (Neodorippe) astuta–Tirmizi and Kazmi, 1988; Kazmi, 1994, 1995

Note*:* *N. callida* holds mangrove leave over its back as a mobile hiding place, with its two prehensile posterior short legs that are bent permanently over the back. These legs are tipped with hairy pads to cling onto the leaf; it may also "carry" a clam shell that can weigh upto 2.06 grm and everage size of 2mm, a flat piece of wood or other bits of flotsam. It swims with the leaf under it, to hide from aquatic predators below. If it senses danger from above, however, it will quickly flip under the leaf. During the day, it often hides under the leaf, half buried in the sand or mud (Serene and Romimohtarto, 1969; Khan and Ahmad, 1975; Ng *et al*., 1986). Weights of the selected shell are not related to the body weight of the crabs; they prefer larger but lighter shells.

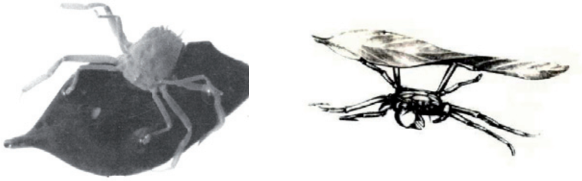


Fig. 222. *Neodorippe callida* carrying a mangrove leaf.

SUP. F. Majoidea Samouelle, 1819

F. Inachidae McLeay, 1838.

Note: These crabs stick the ascidians, algae or sponges to the hooked hairs on their exoskeletons.

G. *Camposcia* Latreille, 1829

***Camposcia retusa* Latreille, 1829** (Fig. 223)

Alternate names, updated and Pakistani records**.**

Maia retusa Latreille, 1829
Camposcia retusa–Tirmizi and Kazmi, 1983, 1988; Jeyabaskaran *et al*., 2000

Material: Fairly common in fish trash

Pakistani Epibionts: It is called decorator spider or valcro crab.It decorates itself with various objects that it finds on the sea floor. These objects can consist of sponges, rocks, shells, corals, snipped-off fragments of local seaweeds and other objects, in order to blend in with the environment. These decorations make it less likely to be spotted by predators and also make it easier to stalk its prey. These are stuck firmly onto the fine, hooked hairs which densely cover its body and legs and thus act like the 'velcro' after which it is named. According to Stimpson (1907) the thick growth of ulvae indicates the sluggish habit of crab. For seaweeds to stay alive, they must see the sunlight, and for this reason camouflage crabs are often found in the open where they can easily be stepped on.

The attached sponges and algae often continue to grow. Tiny animals like amphipods might settle on the sponges. When sessile organisms are scarce, the Decorator Crab may attach shell fragments and small stones to itself as well, have been seen with anything from steel chain, plastic to paper on it (Fig. 23).

Found elsewhere and of their hosts there and elsewhere: Indian Ocean. **Commensal epibionts:** Weeds, sponges, zoophytes, amphipods, barnacles. Host of: *Pinnotherion setoensis* (Shiino, 1942).

Fig. 223. *Camposcia retusa*.

G. *Achaeus* Leach, 1817

***Achaeus lacertosus* Stimpson, 1858** (Fig. 224)

Alternate names, updated and Pakistani records.

Achaeus breviceps Haswell, 1880
Achaeus spinifrons Sakai, 1938
Achaeus lacertosus–Tirmizi and Kazmi, 1988; Poore, 2004

Pakistani symbionts: Algae and invertebrate colonies

Found elsewhere and of their hosts there and elsewhere: Tropical Indo-Pacific. It may be found clinging to gorgonian colonies (Chhapgar, 1957) or inhabits weedy rocky bottom (Sakai, 1976).

Fig. 224. *Achaeus lacertosus*.

F. Majidae Samouelle, 1819

G. *Schizophrys* White, 1847

***Schizophrys aspera* (H. Milne Edwards, 1834)** (Fig. 225)

Alternate names, updated and Pakistani records.

Schizophrys aspera–Hasmi, 1963; Ahmad *et al.*, 1972; Tirmizi and Kazmi, 1986; Jeyabaskaran *et al.*, 2000

Found elsewhere and of their hosts there and elsewhere: Wide spread in Indo-Pacific, Suez. **Associates:** Basibiont to Barnacles, sometimes covered with ascidians (Jeyabaskaran and Ajmal Khan, 2000). Protozoa *Ephelota gemmipara*; Hydrozoa *Obelia geniculata*, *O. dichotoma*; Polychaeta *Hydroides elegans*; Cirripedia *Balanus amphitrite*, *B. eburueus*; *Bryozoa, Bugula neritina*; Tunicates *Styela partita*, *S. canopus*, *Ciona intestinalis*, *Microcosmus pupa, Polyclinum constellatum* (Ibrahim, 2012; El-Serehy *et al.*, 2012).

Fig. 225. *Schizophrys aspera*.

G. *Cyphocarcinus* A. Milne-Edwards, 1868

***Cyphocarcinus sargassumi* Kazmi and Tirmizi, 1995** (Fig. 226)

Alternate names, updated and Pakistani records.

Cyphocarcinus sargassumi Kazmi and Tirmizi, 1995; Kazmi and Naushaba, 2000

Pakistani hosts: Gorgonian coral *Muricella* sp., *Sargassum* weeds.

Found elsewhere and of their hosts there and elsewhere: Not outside type locality.

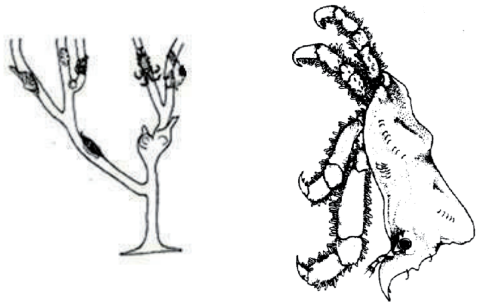


Fig. 226. *Cyphocarcinus sargassumi* on gorgonian branch.

G. *Pseudomicippe* Heller, 1861: The genus *Pseudomicippe* is represented by 11 species, only one occurs here.

***Pseudomicippe griffini* Kazmi and Tirmizi, 1999** (Fig. 227)

Alternate names, updated and Pakistani records

Pseudomicippe griffini Kazmi and Tirmizi, 1999; Simoes *et al*., 2001

Described Material: One male, CL 20mm, 16-5-1987; one ov. female CL 22 mm, 26-3-1986, Bulleji; one spent female CL 16mm, 17-10-1993, Sonari

Pakistani hosts: *Sargassum* and *Jania*.

Found elsewhere and of their hosts there and elsewhere: Yemen **Host:** not mentioned

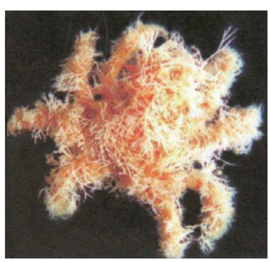


Fig. 227. *Pseudomicippe griffini*

F. Epialtidae MacLeay, 1838

G. *Hyastenus* White1847: The abdomen of *Hyastenus* is commonly covered with polychaetes, followed by barnacles while tunicates dominate on mouth parts, carapace and limbs (Ibrahim, 2012).

***Hyastenus pleione* (Herbst, 1803)** (Fig. 228)

Alternate names, updated and Pakistani records.

C*ancer pleione* Herbst, 1803
Hyastenus pleione–Kohli, 1922; Tirmizi and Serene, 1971; Tirmizi and Kazmi, 1988

Pakistani associates: Hydroids and algae.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Hosts:** Found in the coral reef densely covered by seaweeds (Jeyabaskaran *et al*., 2000).

Fig. 228. *Hyastenus pleione*.

G. *Doclea* Leach, 1815

***Doclea muricata* (Herbst, 1788)** (Fig. 229)

Alternate names, updated and Pakistani records.

Cancer muricatus Fabricius, 1787.
Inachus muricatus Weber, 1795
Maia muricata Bosc, 1802
Maia hybrida Bosc, 1802

Phalangipus hybridus Latreille, 1828
Doclea hybrida Alcock, 1895
Doclea hybrida Sankolli and Shenoy, 1975
Doclea muricata–Tirmizi and Kazmi, 1988

Pakistani epibionts: Acorn barnacles

Note: The epibionts could represent more weight for the crab and could reduce its mobility by modifying the hydrodynamic equilibrium of their appendages. These circumstances could cause crabs to be vulnerable to their predators (Williams and McDermott, 2004).

Found elsewhere and of their hosts there and elsewhere: Indian Ocean. **Associates:** not known.

Fig. 229. *Doclea muricata* infested with epizoic barnacles.

***Doclea aduncus* Wagner, 1986** (Fig. 230)

Doclea aduncus Wagner, 1986; Tirmizi and Kazmi, 1988; Imran *et al*., 2014

Described Material: Fish Harbour, Karachi; 30 January 1984; RMNH 36241 (holotype); 30 October 1966 (paratype).Manora; 7 June 1977; RMNH 36242: 1 9 (paratype); 7 June 1977; 1 juv.

Pakistani Basibiont: The carapace of one male (holotype) shows an impression marking the place where a sea anemone was situated.

Found elsewhere and of their hosts there and elsewhere: The species so far has only been found from Pakistan.

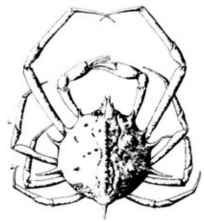


Fig. 230. *Doclea aduncus*.

G. *Acanthonyx* Latreille, 1828: In the Indian Ocean, five species of *Acanthonyx* have been found to occur, viz., *A. limbatus* Milne-Edwards, *A. elongatus* Miers, *A. inglei* Tirmizi and Kazmi, *A. consobrinus* Milne-Edwards and *A. euryseroche* Griffin and Tranter.

***Acanthonyx limbatus* A. Milne-Edwards, 1862** (Fig. 231)

Alternate names, updated and Pakistani records.

Acanthonyx limbatus–Tirmizi and Serene, 1971; Timizi and Kazmi, 1988; Naderloo and Turkay, 2012

Material: Several females and males

Pakistani hosts: *Sargassum virgatus, Padina pavonia, Codium iyngarii, Ulva fasiata, Gracilaria*

Note: Specimens colour matches with algae.

Found elsewhere and of their hosts there and elsewhere: Indian Ocean, Persian Gulf. **Hosts:** Sea weeds and pearl oysters.

Fig. 231. *Acanthonyx limbatus*.

***Acanthonyx inglei* Tirmizi and Kazmi, 1988** (Fig. 232**)**

Alternate names, updated and Pakistani records.

Acanthonyx aff. *elongatus* Tirmizi and Serene, 1971
Acanthonyx elongatus inglei Tirmizi and Kazmi, 1988
Acanthonyx inglei Ng *et al.*, 2008
Acanthonyx elongates Hameed *et al*., 2001

Material: Very common.

Pakistani hosts: *Sargassum tenerrinum, Sargassum virgatus, Caulerpa taxifola, Padina pavonia, Ulva fasiata, Spathoglossus variabile, Gracilaria andersoni*.

Found elsewhere and of their hosts there and elsewhere: Not outside Pakistan.

Fig. 232. *Acanthonyx inglei*.

G. *Menaethius* H. Milne Edwards, 1834

***Menaethius monoceros* (Latreille, 1825)** (Fig. 233)

Alternate names, updated and Pakistani records.

Pisa monoceros Latreille, 1825
Menaethius monoceros–Hashmi, 1963; Khan and Ahmed, 1975; Tirmizi and Kazmi, 1988

Pakistani epibionts: Weeds and invertebrates

Note: Highly polymorphic. The carapace is usually encrusted with weeds, and usually overgrown with sponges and hydroids. The crab takes the colour of fronds of *Sagassum* in which it inhabits (Henderson, 1892).

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Hosts:** Among the branches of *Sagassum* (Gohar and Alkholy, 1957). It is common in reef (Henderson, 1893), also Mangal-associated (Cooper, 1997).

Fig. 233. *Menaethius monoceros*.

G. *Simocarcinus* Miers, 1879

***Simocarcinus simplex* (Dana, 1852)** (Fig. 234)

Alternate names, updated and Pakistani records.

Huenia simplex Dana, 1852
Simocarcinus simplex–Tirmizi, 1978; Tirmizi and Kazmi, 1988

Material: No new material, one male, TL 13mm, Mekran, 21-11-1976

Pakistani host: Weeds

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Host:** Reefs.

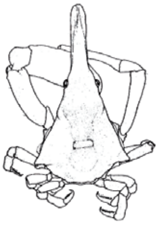


Fig. 234. *Simocarcinus simplex*.

G. *Stilbognathus* von Martens, 1866

***Stilbognathus? curvicornis* (Herbst, 1803)** (Fig. 235)

Alternate names, updated and Pakistani records.

Cancer Cervicornis Herbst, 1803
Stenocionops cervicornis Henderson, 1893; Alcock, 1896.
Ophthalmias cervicornis Tirmizi and Kazmi, 1988.
Stilbognathus cervicornis Griffin and Tranter, 1986
Stilbognathus sp. Kazmi, 1995
Stilbognathus? c*urvicornis* Kazmi and Tirmizi, 1999

Material: One male, May, 1994, Sand spit; one spent female TL 75mm, 11-8-1994, Bulleji

Pakistani commensals: Zoophytes and brown weed

Note: It might turn out be a new species which I wish to name after Dr. V.Neumann (Germany) in recognition of his help to me regarding identification of Pakistani majids

Found elsewhere and of their hosts there and elsewhere: Mozambique Channel, Mauritius, India, Japan, Indonesia, and Hawaiian Islands. **Commensals:** Living sponge, or alternatively a piece of soft coral as camouflage

Fig. 235. *Stilbognathus? curvicornis*.

SUP. F. Calappoidea de Haan, 1833

F. Calappidae Milne-Edwards, 1837

G. *Calappa* Weber, 1795

***Calappa gallus* (Herbst, 1803)** (Fig. 236)

Alternate names, updated and Pakistani records.

Cancer gallus Herbst, 1803
Calappa gallus–Timizi and Kazmi, 1988; Takeda and Shikatani, 1990; Jeyabaskaran and Ajmal Khan, 2000.

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Florida keys to Bahia, Brazil, Bermuda, Atlantic Coasts of Africa, Red Sea, India, Japan. **Host:** Coral reefs (Sakai, 1976).

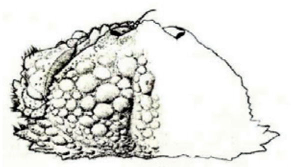


Fig. 236. *Calappa gallus*.

SUP. F. Trapezioidea Miers, 1886

F. Tetraliidae Castro, Ng and Ahyong, 2004

G. *Tetralia* Dana, 1851: The genus *Tetralia* currently consists of 10 species. *Tetralia* crabs are obligate symbionts of species of scleractinian corals of circumtropical distribution. (Galil, 1987).

***Tetralia glaberrima* (Herbst, 1790)** (Fig. 237)

Alternate names, updated and Pakistani records.

Cancer glaberrimus Herbst, 1790.
Trapezia integer Latreille, 1828

Tetralia glaberrima–Alcock, 1898 (part); Castro *et al*., 2004; Trautwein, 2007
Tetralia armata Dana, 1852
Tetralia serratifrons Jacquinot, 1842-1853 (1852)

The exorbital width is less than the maximum width of the carapace. The proximal part of the supero-external margin of the palm of the larger cheliped has a tomentose cavity more or less developed. The cutting margin of the fixed finger of the smaller cheliped is denticulate. The first pleopod of the male has, on the distal third of both its margins, a tuft of more than 50 spines (movable) more or less entangled and of about the same size. (Serène, 1984).

Pakistani host: Coral of unkown identity

Found elsewhere and of their hosts there and elsewhere: Throughout the Indo-West Pacific region, Red Sea, Persian Gulf. **Host:** Coral *Acropora*.

Fig. 237. *Tetralia glaberrima*.

F. Trapeziidae Miers, 1886: The species of the family are known as obligate commensals of anthozoans throughout the tropical Indo-Pacific ocean (Serene, 1984). The World Register of Marine Species lists three subfamilies and seven genera.

G. *Trapezia* Latreille, 1825: The crab can best be identified to the species level by the colour patterns they display .These crabs depend on their Pocilloporid host for food and shelter, and in return they have been reported as defending Pocilloporid corals from predation. The genus includes 22 described species.

***Trapezia cymodoce* (Herbst, 1801)** (Fig. 238)

Alternate names, updated and Pakistani records.

Cancer cymodoce Herbst, 1801
Trapezia cymodoce –A. Milne Edwards, 1873 - Alcock, 1898 - Castro, 2003 (full synonymy); Khvorov *et al*., 2012

Note: *Trapezia cymodoce* is an obligate commensal of branching corals *Pocillopora* sp. The crab feeds on the mucus produced by the coral, gathering these with the minute comb-like structures at the tips of their legs. In turn, it protects the coral from predators such as the Crown-of-Thorns sea star. It discourages the sea star by using its sharp pincers to nip at the sensitive tube feet of the sea star.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific: from Red Sea, Oman and east Africa to Japan, Australia and Polynesia. **Hosts**: *Pocillopora, Seriatopora,* and *Stylophora.*

Fig. 238. *Trapezia cymodoce*

G. *Quadrella* Dana, 1851: All eight species of *Quadrella* so far known are symbionts of alcyonaceans, antipatharians, and ahermatypic scleractinian corals.

***Quadrella reticulata* Alcock, 1898** (Fig. 239)

Alternate names, updated and Pakistani records.

Quadrella coronata var. *reticulata* Alcock, 1898
Quadrella reticulata reticulata -Serène, 1968
Quadrella reticulata–Serène, 1973; Castro, 1999; Castro *et al*., 2004; Naderloo and Sari, 2005b; Kazmi and Moazzam, 2012

Quadrella boopsis (not Alcock, 1898) Galil, 1986.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific: north Indian Ocean ,Persian Gulf and the west Pacific Ocean. **Host:** *Antipathes*. Only one pair lives on a single host coral.

Fig. 239. *Quadrella reticulata*.

SUP. F. Pilumnoidea Samouelle, 1819

F. Pilumnidae Samouelle, 1819

G. *Harrovia* Adams and White, 1849

***Harrovia elegans* de Man, 1887** (Fig. 240)

Alternate names, updated and Pakistani records.

Harrovia elegans–Tirmizi and Kazmi, 1982a; Chia and Ng, 1998

Pakistani host: No information on host accompanying the species though comatulid crinoids were once a prominent component of the benthic fauna of Mekran coast (the collection site)forming dense beds on shallow reefs (Moazzam, pers. comm.).

Found elsewhere and of their hosts there and elsewhere: From the Indian Ocean to Indonesia and various parts of the western Pacific. **Hosts:** Wholly symbiotic with echinoderms, lives on crinoids *Comanthina schlegeli*, *Comanthus (Comanthus) parvicirra* and *Comanthus (Cenolia) japonica*. Jones and Sankarankutty (1960) recorded one specimen per crinoid.

Fig. 240. *Harrovia elegans*.

G. *Pilumnus* Leach, 1815

***Pilumnus vespertilio* (Fabricius, 1793)** (Fig. 241)

Alternate names, updated and Pakistani records.

Cancer vespertilio Fabricius, 1793
Pilumnus vespertilio–Alcock, 1898; Sakai 1976; Tirmizi and Ghani, 1996; Jeyabaskaran *et al*., 2000

Pakistani host: Information lacking

Found elsewhere and of their hosts there and elsewhere: South Africa, East coast of Africa, Red Sea, Thailand, Singapore, Japan, Hawaii, India, Mauritius, Taiwan, China. **Hosts:** the dead coral beds of *Acropora* and *Montipora* species, Ectoprocta *Schizoporella* and *Sargassum* covered areas. Common in the reef (Henderson, 1893).

Fig. 241. *Pilumnus vespertilio*.

SUP. F. Eriphioidea McLeay, 1838

F. Eriphiidae MacLeay, 1838

G. *Eriphia* Latreille, 1817

***Eriphia sebana* (Shaw and Nodder, 1803)** (Fig. 242)

Alternate names, updated and Pakistani records.

Cancer sebana Shaw and Nodder, 1803.
Eriphia laevimana Latreille, 1817
Eriphia sebana–Sakai, 1976; Tirmizi and Kazmi, 1983; Ng *et al*., 2001

Pakistani host: Information lacking

Found elsewhere and of their hosts there and elsewhere: East Africa, Samoa, India, Sri Lanka, Myanmar, Japan, Oman, and Red Sea. **Host:** Corals (Henderson, 1893)

Fig. 242. *Eriphia sebana*.

SUP. F. Portunoidea Rafinesque, 1815: From convoluted history of the classification of the group, it shows that the superfamily is diverse (Karasawa *et al*., 2008).

F. Portunidae Rafinesque, 1815

Notes: The portunid crabs may be ectosymbionts, living externally on the sea cucumber, usually near the mouth or anus or they may be hosts for barnacles and isopods and other invertebrates, there are positive correlations between intensity of infection and host size**.** Juveniles of *Charybdis feriata* ride on the oral arms of the rhizostome scyphozoan seem to become hitchhikers for dispersal, frequently encountered as a symbiont on rhizostomes such as *Rhopilema esculentum*, *R. hispidum,* *Mastigias* sp., *Stomolophus meleagris, Nemopilema nomurai* and *Versuriga anadyomene* in Asian waters (Towanda and Thuesen, 2006; Ohtsuka *et al*., 2009). In total, 20 species of *Thalamita* and 7 species of *Charybdis* can be classified as "rock, rubble and reef dwellers" (Galil and Vannini, 1990).

G. *Charybdis* De Hana, 1833

***Charybdis feriata* (Linnaeus, 1758)** (Fig.243)

Alternate names, updated and Pakistani records.

Charybdis (*Goniosoma) cruciata*-Hashmi, 1963
Charybdis feriata–Tirmizi and Kazmi, 1996

Pakistani host: Corals **(**mostly crab lives in shallow sandy or rocky areas).

Found elsewhere and of their hosts there and elsewhere: tropical Indo-West Pacific from East Africa the Persian Gulf through to Indonesia and Japan, and throughout most of Australia. crab lives in shallow sandy or rocky areas. **Commensal host:** Scyphozoan Jellyfish *Stomolophus nomurai*.

Fig. 243. *Charybdis feriata.*

Commensal with the Scyphozoan Jellyfish.

***Charybdis* sp.** (Fig. 244)

Material: One unidentified male, 16-11-1993, Bulleji

Note: An unidentified *Charybdis* and an ophurid *Ophiopeza fallax* were collected from the same spot were, both had similar colour schemes of cream and reddish bands. A similar case of commensal association is described by Sillman *et al.* (2003)

Fig. 244. *Charybdis* sp. and host.

G. *Thalamita* Latreille, 1829: *Thalamita* species are facultative inhabitants of coral reef habitats but also live on rocky bottom or mussel clumps. Three of the species *Thalamita admete* (Herbst), *Thalamita prymna* (Herbst) and *Thalamita crenata* Rüppell which also occur here.

***Thalamita prymna* (Herbst, 1803)** (Fig. 245)

Alternate names, updated and Pakistani records.

Cancer prymna Herbst, 1803.

Thalamita prymna–Mustaquim and Rabbani, 1976; Tirmizi and Kazmi, 1996a; Apel and Spiridonov, 1998; Vannini and Innocenti, 2000; Poore, 2004; Spiridonov and Neumann, 2008.

Note: Information of their association with local reefs is lacking. My specimens were generally obtained from rocky shore or from trawl catch; it is possible, that they were obtained from small living coral colonies which were situated in the littoral collection sites.

Found elsewhere and of their hosts there and elsewhere: Red Sea and throughout the tropical Indo-Pacific. **Hosts:** Mostly found on rocky shores but frequently recorded from coral-associated habitats "in a dense stand of *Acropora*", sea grass meadow inside the coral reef: *Stylophora pistillata*, *Acabaria* and *Tubastrea* (Spiridonov and Neumann, 2008).

Fig. 245. *Thalamita prymna*.

G. *Portunus* Weber, 1795

***Portunus segnis* (Forskål, 1775)**

Alternate names, updated and Pakistani records

Portunus pelagicus–Tirmizi and Kazmi, 1996
Portunus segnis Özcan, 2012

Notes:On morphological, biogeographical and molecular grounds *P. segnis* has recently been defined as a separate species to *Portunus pelagicus* and is now placed with three other species in the *P. pelagicus* species group.

Pakistani hosts: Reefs, mangrove and sea grass and algal beds.

Found elsewhere and of their hosts there and elsewhere: Red Sea, Mediterranean, Persian Gulf, restricted to the Western Indian Ocean. **Hosts:** green alga (*Caulerpa prolifera*) and seagrass (*Posidonia oceanica*).

SUP. F. Xanthoidea MacLeay, 1838

F. Xanthidae MacLeay, 1838: Currently, 13 subfamilies are recognised in the brachyuran family Xanthidae: Actaeinae, Antrocarcininae, Chlorodiellinae, Cymoinae, Etisinae, Euxanthinae, Kraussiinae, Liomerinae, Polydectinae, Speocarcininae, Xanthinae, Zalasiinae and Zosiminae.Four are dealt here as associated from Pakistan.

S. F. Cymoinae Alcock, 1898

G. *Cymo* De Haan, 1833: The facultative coral-symbiotic crab genus *Cymo* occurs predominantly in acroporid and pocilloporid scleractinians (Castro, 1976; Serène, 1984; Goh *et al*., 1990). It currently includes eight species. The coral gains protection and house cleaning services while giving up a few polyps, mucus and captured/settled food particles in exchange for those services by the crab, the coral seems little harmed by this**.**

Cymo andreossyi **(Audouin, 1826)** (Fig. 246)

Alternate names, updated and Pakistani records.

Pilumnus andreossyi Audouin, 1826.
*Cancer (Cymo) Andreossji-d*e Haan, 1833-1849 (1833)
*Cymo andreossyi–*Alcock, 1898; Jeyabaskaran and Ajmal Khan, 2000
Cymo Andreossii Kossmann, 1877.
Cymo andreossyi var maculata S. pentagonalis Klunzinger, 1913

The carapace is relatively broad furnished with acute granules (sometimes spinose). All regions of the carapace are indistinct and smooth. The almost straight margin of each frontal lobe is covered with numerous small, acute granules that are also found on the exorbital angle. The surface of the carapace is furnished with similar but blunt granules near the antero-lateral margins. The chelipeds have some coarse granules mixed with small ones, particularly on the superior and external surfaces of the larger cheliped, carpus and palm.

Found elsewhere and of their hosts there and elsewhere: Red Sea, Persian Gulf; Dares Salaam; Coëtivy Islands; Mayotte; Madagascar; Mauritius; Sri Lanka; Andaman Islands; Nicobar Islands; Japan; Taiwan; China; Malaysia; Philippines; Indonesia; New Britain, Fiji; Samoa; Tahiti. **Hosts:** both the live and dead branches of coral *Pacillopora, Acropora and Montipora*.

Fig. 246. *Cymo andreossyi*.

S. F. Chlorodiellinae Ng and Holthuis, 2007

G. *Chlorodiella* Rathbun, 1897

***Chlorodiella nigra* (Forskål, 1775)** (Fig. 247)

Alternate names, updated and Pakistani records.

Cancer niger Forskal 1775
Chlorodius niger Alcock, 1898
Chlorodiella nigra–Sakai, 1976; Tirmizi and Ghani, 1996; Neumann and Spiridonov, 1999.

Pakistani host: Information lacking

Found elsewhere and of their hosts there and elsewhere: Red Sea, Persian Gulf, Madagascar and South Africa to Hawaii, Sydney, and Tuamotu. **Hosts**: Facultative dweller of branching corals of the species *Acropora, Montipora* and *Echinopora*. Abundantly seen in dead corals than in live (Borrodaile, 1903).

Fig. 247. *Chlorodiella nigra*.

S. F. Xanthinae MacLeay, 1838

G. *Leptodius* A. Milne-Edwards, 1863: Two species are found in Pakistan. Of which *L.exaratus* (H. Milne Edwards, 1834) is commonly found in crevices of rocks or under stones between low and high tide marks, mostly occurs in the crevices of dead corals and live branching (Jeyabaskaran and Ajmal Khan, 2000).It is a host for *Sacculina* (Siddiqui and Ahmed, 1993), the other is *L. gracilis* recently reported from Pakistan (Kazmi and Moazzam, 2012).

***Leptodius gracilis* (Dana, 1852)** (Fig. 248)

Alternate names, updated and Pakistani records.

Chlorodius gracilis Dana 1852
Xantho exaratus gracilis Miers 1884
Leptodius gracilis–de Man 1887; Sakai 1976; Kazmi and Moazzam, 2012.

Found elsewhere and of their hosts there and elsewhere: Japan, Hawaii, Red Sea, Kenya, Singapore, Carolinas, and Marshall, Tahiti and Cocas Keeling. **Hosts:** Found in large numbers in the coral reefs having thick vegetation of seaweeds like *Sargassum* and *Turbinaria* species.

Fig. 248. *Leptodius gracilis*.

S. F. Zoziminae Alcock, 1898

G. *Platypodia* Bell, 1835

***Platypodia cristata* (A. Milne Edwards, 1865)** (Fig. 249)

Alternate names, updated and Pakistani records.

Lophactaea cristata A. Milne Edwards 1865; Alcock 1898

Platypodia cristata–Galil and Vannini 1990; Jeyabaskaran and Ajmal Khan, 2000; Trivedi *et al*., 2012

Found elsewhere and of their hosts there and elsewhere: Western Indian Ocean islands, Tanzania, Kenya, Somalia, Red Sea, lndia. **Host:** Mostly found in coral reefs.

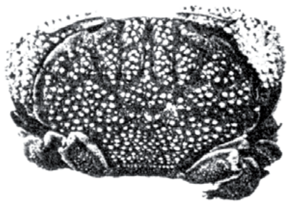


Fig. 249. *Platypodia cristata*.

G. *Atergatis* De Haan, 1833

***Atergatis integerimmus* (Lamarck, 1801)**

Alternate names, updated and Pakistani records.

Atergatis integerimmus Alcock, 1898; Khan, 1977b; Tirmizi and Ghani, 1996; Al-Sinawi *et al*., 2012

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific, Iranian Gulf, Oman. **Host:** Coral reef (Stephensen, 1945)

***Atergatis ocyroe* (Herbst, 1801)** (Fig. 250)

Alternate names, updated and Pakistani records.

Atergatis floridus–Alcock, 1898; Tirmizi and Ghani, 1996

Atergatis ocyroe–Ng and Davie, 2007; Ghotbeddin and Naderloo, 2014

Pakistani host: Not observed

Found elsewhere and of their hosts there and elsewhere: Indian Ocean, Red Sea. **Hosts:** Coral reef (Henderson, 1892).

Fig. 250. *Atergatis ocyroe*.

G. *Xanthias* Rathbun, 1897

***Xanthias sinensis* (A. Milne Edwards, 1867)** (Fig. 251)

Alternate names, updated and Pakistani records.

Pseudozius sinensis M.Milne Edwards, 1867
Xanthias sinensis–Simoes, 2001
Lioxantho asperatus Alcock, 1898

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Red Sea, Somalia, Oman, Lackshwadeep and China. **Host:** Corals.

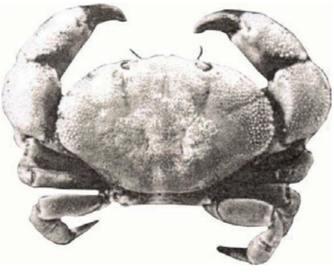


Fig. 251. *Xanthias sinensis*.

G. *Etisus* H. Milne Edwards, 1834

***Etisus laevimanus* Randall, 1840** (Fig. 252)

Alternate names, updated and Pakistani records.

Etisus laevimanus- Alcock and Anderson, 1894; Trivedi and Vachhrajani, 2013

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: Seychelles, Red Sea, India, Oman, Maldives, Lackshwadeep, Torres Strait, and Hawaiian Island. **Host:** Corals (Henderson, 1892).

Fig. 252. *Etisus laevimanus*.

Subsection Thoracotremata Guinot, 1977

SUP. F. Pinnotheroidea De Haan, 1833

F. Pinnotheridae De Haan, 1833: Pinnotherids are small crabs symbiotic to a variety of invertebrates infesting bivalves and sea squirts, unusually in gastropods. Pinnotherid species use a setae comb ventrally on the claw to brush mucus and the accumulated food particles from the bivalve gills. Thus, the pea crabs can be regarded as truly parasitic in their relations to bivalves - at least in the case of the adult female, which is an obligate symbiont (Sun *et al*., 2005) and is morphologically strongly adapted to the parasitic life phase. The male instead is in part free-living and just a facultative commensal. Owing to the described damages to their hosts, pinnotherids can have a negative commercial impact on aquaculture and fisheries of bivalves (Navarte and Saiz, 2004).

G. N*epinnotheres* Manning, 1993

***Nepinnotheres villosulus* (Guérin, 1831)**

Alternate names, updated and Pakistani records.

Pinnotheres villosulus Guérin, 1831
Nepinnotheres villosulus–Siddiqui, 2012, Jahangir *et al*., 2015

Described material: Sonmiani, May-April, 2009

Pakistani hosts: *Meretix casta* var *ovum*, *Protapes cor*, *Amianlis umbonella*, *Gastrana multantgula, Marcia marmorata, Tellinimectra angulata, Anadara antiquata*.

Found elsewhere and of their hosts there and elsewhere: Indonesia. **Hosts:** *Pinna*, *Meleagrna.*

G. *Arcotheres* Manning, 1993. The genus *Arcotheres* Manning, 1993, includes several Indo-West Pacific crabs endosymbiont in the mantle cavity of bivalves.

***Arcotheres tivelae* (Gordon, 1936)** (Fig. 253)

Alternate names, updated and Pakistani records.

Pinnotheres tivelae Gordon, 1936- Moazzam and Rizvi, 1985

Arcotheres tivelae–Naderloo and Turkay, 2012

Pakistani hosts: *Tivela pandorsa* (bivalve)

Found elsewhere and of their hosts there and elsewhere: Persian Gulf. **Host:** *Amiantis umbnella*

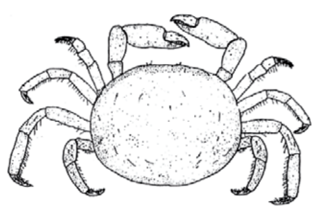


Fig. 253. *Arcotheres tivelae*. (After Moazzam and Rizvi, 1983)

***Arcotheres placunae* (Hornell and Southwell, 1909)** (Fig. 254)

Alternate names, updated and Pakistani records.

Pinnotheres placunae Hornell and Southwell, 1909; Hashmi, 1963; Khan and Ahmed, 1975; Tirmizi and Ghani, 1996
Arcotheres placunae–Davie, 2009

Material: Two females 24-1-1973, Pasni; one male, three females, 14-3-1985, Korangi Creek; one female 26-9-1987, Korangi Creek.

Note: *A. placunae* described by Tirmizi and Ghani (1996, fig 33H) as *P. placunae* has questionable identification. (Naderloo and Turkay, 2012).

Pakistani hosts: Females live inside the mantle cavity of *Placuna placenta*, *Tivela ponderosa, Meretrix meretrix, Marcia cor,* while males are generally free living.

Found elsewhere and of their hosts there and elsewhere: Indian Ocean: India, Iran. The crab's markedly dorsoventrally flattened body enables it to live in *Placuna placenta* which itself is greatly flattened indicating host specificity (Silas and Alagarswami, 1966). **Hosts:** *Placuna placenta, Amiantis umbonella.* Jose and Deepthi (2005) report from *Perna viridis* needs verification (Ng and Kumar, 2015).

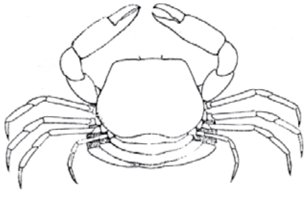


Fig. 254. *Arcotheres placunae.*

***Arcotheres* aff. *alcocki* (Rathbun, 1909)** (Fig. 255)

Alternate names, updated and Pakistani records.

Pinnotheres parvulus (not Stimpson, 1858) Alcock, 1900b
Pinnotheres alcocki Rathbun, 1909

Arcotheres alcocki–Ahyong and Ng, 2007; Watanabe and Hemi, 2009.

Material: Fifty five females, Korangi Creek

Note: All the females (except one) lie in the group of *A.guinotae* Campos, *A.simlis* Berger, *A .alcocki* and *A.vicaji* (Chhapgar) but closest to *A.alcocki*

Pakistani commensal: *Placuna placenta* in mantle cavity, generally 2-3 females were found in one shell, however up to 7 crabs were also taken out at a time.

Found elsewhere and of their hosts there and elsewhere: India, China, and Gulf of Thailand, Mergui archipelago, Philippine Islands, and Indonesia. **Host:** *Anadara granosa*, *Cvtheria, Mytilus*.

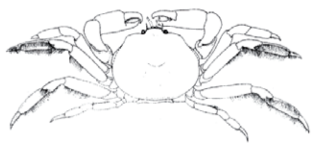


Fig. 255. *Arcotheres* aff. *alcocki*.

G. *Sindheres* Kazmi and Manning, 2003

***Sindheres karachiensis* Kazmi and Manning, 2003** (Figs. 256-257)

Alternate names, updated and Pakistani records.

Sindheres karachiensis Kazmi and Manning, 2003

Described material: female 3.25 x 5mm, Bulleji, 21 August, 1997

Carapace is fragile; its greatest width is posterior to mid-length. The front is very slightly produced beyond outline of carapace. The propodus of maxillipede 3 is stout; length is about twice its height. The movable fingers of chela is more than half the length of palm, latter is about 0.6 times height; the movable finger has a proximal tooth and approximated cutting edge with a row of more than 22 anteriorly directed spines, fixed finger is armed with a triangular tooth proximally, 2 + 1 2 anteriorly directed teeth on approximated cutting edge, and rows of setae. Walking legs are slender, propodi of leg 2 is about five times and leg 3 about four times longer than high; their relative lengths increase from leg 2 to leg 4. Leg 4 does not extend to dactylus of leg 3; carpus is shorter than the propodus on all legs; Leg 1 – Leg 4 are setose on posterior margin, dactylus of right leg 2 is setose on anterior and posterior margins. Leg 1 - 3 dactyli are subequal, dactylus of leg 4 are short.

Pakistani host: Female inside the mantle cavity of *Gastrochaena* sp.

Found elsewhere and of their hosts there and elsewhere: Found not outside Pakistan.

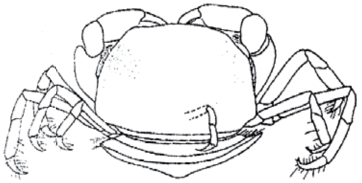


Fig. 256. *Sindheres karachiensis*.

Fig. 257. With host.

G. *Indopinnixa* Manning and Morton, 1987: Naruse and Maenosono (2012) suggested that *Indopinnixa* will probably have to be redefined.

***Indopinnixa* aff.*sipunculata* Manning and Morton, 1987** (Fig. 258)

Alternate names, updated and Pakistani records**.**

Indopinnixa sipunculata Manning and Morton, 1987- Rahayu and Ng, 2010

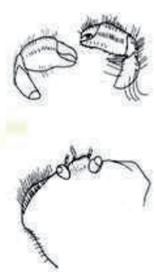
Indopinnixa aff. sipunculata Kazmi and Moazzam, 2012

Material: One subadult female

Carapace regions are poorly defined without a defined cardiac ridge, anterolateral border marked by a crest, border form a slender shoulder. Telson is rounded, spatulate resembling that of a male. Merus is broad of third maxilliped; terminal segment of palp is long, provided with long setae on margin and on diagonal crest. Chelipeds are subequal, dentition on fingers is almost lacking. Leg 3 is much stouter; leg 4 is much smaller than the others. The first pleopod abruptly narrows distally, its tip is pointed and slightly curved.

Pakistani associates: Unknown

Found elsewhere and of their hosts there and elsewhere: Hong Kong. **Host:** Associated with sipunculids.



cheliped

carepace

Fig.258. *Indopinnixa sipunculata.*

SUP.F. Grapsoidea MacLeay, 1838

F. Varunidae H. Milne-Edwards, 1853

S. F. Gaeticinae Davie and Ng, 2007

G. *Sestrostoma* Davie and Ng, 2007: Three species of the genus *Sestrostoma* have been recorded worldwide (Ng *et al*., 2008): *Sestrostoma balssi* (Shen), *S. depressum* (Sakai), and *S. toriumii*

(Takeda).The members of the genus *Sestrostoma* occur in the burrows of thallassinids, annelids, callianassids and echiurans (Anker *et al*., 2005). These crabs are at least occasional kleptoparasites, and may steal appreciable quantities of food from the host.

***Sestrostoma balssi* (Shen, 1932)** (Fig. 259)

Alternate names, updated and Pakistani records.

Acmaeopleura balssi Shen, 1932; Ghani and Tirmizi, 1991
Sestrostoma balssi–Davie and Ng, 2007; Marin *et al*., 2011

Material: Two females, Bulleji, 1991 no new material

Pakistani associate(s): *Upogebia quddusiae* (ghost shrimp)

Note: Identity of *S. balssi* reported by Ghani and Tirmizi (1991) as *A. balssi* was doubted by Davie and Ng (2007) but they deferred giving it a new name.

Found elsewhere and of their hosts there and elsewhere: Japan, China, Korea, and Madagascar. *S. balssi* may also be free-living (Itani *et al*., 2002). **Hosts:** Symbiotic with *Upogebia major and U. Issaeffi*.

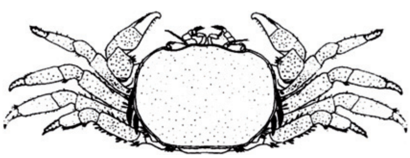


Fig. 259. *Sestrostoma balssi*.(after Ghani and Tirmizi,1991)

G. *Planes* Bowdich, 1825

***Planes major* (MacLeay, 1838)** (Figs. 260-261)

Alternate names, updated and Pakistani records

Nautilograpsus angustatus Stimpson, 1858
Nautilograpsus major MacLeay, 1838
Planes cyaneus–Tirmizi *et al*., 1982

Varuna atlantica Mellis, 1875

Note: The colouration of *Planes major* is variable, and camouflages the crab against the Sargassum weed it often lives on. The base colour is yellow to white, often with large patches of brown, although the colour pattern tends to match that of the substrate on which the crab is found, the colouration is only able to change slowly after a change of substrate.

Fig. 260. *Planes major.* (courtesy of Moazzam)

Fig. 261. With epibiont.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific and Atlantic. **Hosts:** Living on a wide variety of floating substrata, such as drifting algae (*Sargassum*), scyphozoans (*Velella*), gastropods (*Janthina* sp.) and the shells of cephalopods *Spirula* (Chace, 1951; Geiselman, 1983; Davenport, 1994), loggerhead sea turtles (*Caretta caretta*) clinging with the walking legs, onto the underside of the turtle around the tail, cloaca, and hind limb. It is also possible that epibiotic crabs clean epibiota from sea turtle (Pons *et al*., 2011).

SUP.F.Grapsoidea McLeay, 1838

F. Plagusiidae Dana, 1851

G. *Plagusia* Latreille, 1804: The genus can often be seen clinging to flotsam and marine animals

***Plagusia squamosa* (Herbst, 1790)**

Alternate names, updated and Pakistani records.

Cancer squamosus Herbst, 1790
Grapse tuberculatus Latreille, in Milbert, 1812
Plagusia depressa tuberculata Lamarck, 1818, Crosnier, 1965
Plagusia orientalis Stimpson, 1858
Plagusia tuberculata Lamarck, 1818
Plagusia squamosa–Schubart *et al*., 2001, Ng *et al*., 2008

Note: There is a paucity of information concerning the occurrence of *P. squamosa* as commensal of other marine animals.

Found elsewhere and of their hosts there and elsewhere: Eastern Tropical Pacific, Indian Ocean. Red Sea, Persian Gulf, Mediterranean. **Host:** *Lepidochyles olivacea*, living in sympatry with *Planes* (Frick *et al*., 2011).

I. O. Caridea Dana, 1852

Notes: De Grave and Fransen (2011) provided a complete checklist of caridean shrimps with 389 genera and 3438 species**.** Carideans live with Porifera, Hydrozoa, Alcyonacca, Actinaria, Scleractinaria, Annelida, Decapoda, Gastropoda, Bivalvia, Crinoidca, Echinoidea, Asteroidea*,* Ascidacea and Pisces. Bruce (1976) reported 62% of total carideans contained species known to associate with other animals, this association is rarely reported in deep-sea and fresh water environments. Caridean shrimp and anthozoan symbioses are usually viewed as commensalistic, as the shrimps derive benefits like food scraps and protection from their hosts, without having any obvious effect on them (Shick, 1991). A few associations have been found to be mutualistic, e.g., the shrimp *Alpheus* that associates with the anemone, in fact the shrimp chases away the polychaete *Harmodice* that would otherwise prey upon the anemone (Smith, 1977). The association between the shrimp *Periclemenes brevicarpalis* and its host anemones has been found to be intermittently parasitic. In laboratory studies, *P. brevicarpalis* has been seen to tear tentacles from its host for food when deprived of other food sources (Fautin *et al*., 1995). A commensal shrimps on crinoids at the Pasni coast, Mekran were difficult to identify without microscopic examination. The colouration of the species matched its host crinoid (Moazzam, pers comm.). Sillman *et al*. (2003) describe a commensal association between *Alpheus heterochaelis* and the black-clawed mud crab (*Panopeus herbstii*). Mud crabs did not prey on the snapping shrimp although they regularly consume similarly sized crustaceans. Of particular ecological interest are the only two freshwater commensal species: *Limnocaridina iridinae* Roth-Woltereck from the mantle cavity of a unionid clam from Lake Tanganyika and a *Caridina* species from Lake Towuti in Sulawesi living with freshwater sponges.

Symbiotic species occur among Pakistani families Alpheidae, Pandalidae, Hippolytidae and Palaemonidae.

SUP. F. Alpheoidea Rafinesque, 1815

F. Alpheidae Rafinesque, 1815

Note: Although the Alpheidae are one of the most species-rich shrimp families, a few freshwater species are known. Alpheidae is of particularly interest to the biologists because associations occur in many aspects in this family, such as interspecific communication, protandric hermaphroditism, host protection and eusociality. Alpheid shrimps are actually second in number and diversity of associations after the palaemonid subfamily Pontoniinae.

At least 20 species of alpheids are known as infaunal symbionts of burrows of other burrowing animals. Many shrimp in the family have symbiotic relationships with organisms like sponges, cnidarians, echinoderms, molluscs, crustaceans, and gobiid fish (Zeng and Jaafar, 2012). Alpheid shrimp and gobiid partnerships are widespread across the tropics; *Alpheus brevirostris* species group contains the majority of goby-associated species. Gobies have good eyesight and warn the shrimp of any nearby predators in the exchange of the food that *Alpheus* shrimp provides to their host, gobies. The partnering between these two creatures is only that of a watchman and housekeeper and do not compete for food symbiosis between gobies and pistol shrimp. About 130 species of gobies are associated with about 20 species of *Alpheus* shrimp. The majority of these are found in the Indo-Pacific and adjacent regions. There are goby generalists that live together with different shrimp, but there are also specialists living with just one species (Karplus *et al*., 1981). The genus *Synalpheus* includes more than 150 species that inhabit the interstices of coral rubble, the internal spaces of sponges, and, in the Indo-Pacific, the arms of crinoid echinoderms. Sponge-dwelling shrimp in the genus *Synalpheus*, living in colonies, have in particular helped in studying the evolution of social biology and host use in marine invertebrates. It has been shown that colonies contain in hundreds of individuals, but only one reproductive female. The genus *Athanas* is mostly free living but also includes a number of symbiotic taxa associated with various marine invertebrates-, stomatopods, mud shrimps, hermit crabs, fan clams, feather stars, brittle stars, and sea urchins (Duris and Anker, 2014).

G. *Alpheus* Fabricius, 1798

***Alpheus barbatus* Coutière, 1897** (Fig. 262)

Alternate names, updated and Pakistani records.

Alpheus barbatus–Kazmi and Kazmi, 2012

Note: The present specimens belong to pantropical *A. barbatus* species complex (*A. barbatus* clade of Anker *et al*., 2007). They also resemble *A. aequus*, that also belongs to the same species complex and *A. aequus* may be just variation of *A. barbatus* (Kim and Able, 1988). Anker *et al.* (2005) also reported association between *A. barbatus* and echuirans

Ochetostoma in the western Pacific, for Pakistani specimens no such observation was made, although the same echuirian genus occurs here.

Found elsewhere and of their hosts there and elsewhere: Tropical Indo-West Pacific from the Red Sea to Madagascar, Japan and Australia **Hosts:** This species has been so far thought to be a free-living species, but many examples were observed to dwell commensally in tunnels of echiurans, C*hetostoma* sp. *o*r *Ikedesoma* sp., which live in crevices or under stones on the rear reef flats (Nomura, 2000). The shrimp uses echiuran dwellings as shelter and may occasionally directly profit from the echiurans feeding activities, so the relationship between the echiuran and the shrimp can be described as facultative commensalism. It has been collected among roots of *Syringodium* and *Cymodocea* (Banner and Banner*,* 1983).

Fig. 262. *Alpheus barbatus*.

***Alpheus splendidus* Coutière, 1897** (Figs. 263-264)

Alternate names, updated and Pakistani records.

Alpheus splendidus–Kazmi and Kazmi, 1979; 2012

Note: A slender bright yellow band from rostrum to the telson, bordered with two brown bands, the rest of the body reddish except for two straight white lines contiguous to the brown bands makes the identification easy. It is a species complex, in particular the Indo-Pacific material.

Pakistani host: Sea urchin and goby

Found elsewhere and of their hosts there and elsewhere: Red Sea, Indo-Pacific. **Host:** Goby.

Fig. 263. *Alpheus splendidus*.

Fig. 264. *Alpheus splendidus* with associate urchin and goby.

***Alpheus strenuus strenuus* Dana, 1852** (Fig. 265)

Alternate names, updated and Pakistani records.

Alpheus strenuus var. *angulaatus* Coutiere 1905
Alpheus doris White 1847
Alpheus strenuus–Kazmi and Kazmi, 1979
Alpheus strenuus strenuus Banner and Banner, 1982; Kazmi and Kazmi, 2012

Note: Banner and Banner (1982) separated *Alpheus strenuus* into *A. strenuus strenuus* and *A. strenuus cremnus* on the basis of a few morphological differences, and also suggest that ecological differences may separate the subspecies, with *A. s. strenuus* on coral reefs and islands in clean sand and cleaner waters and *A. s. cremnus* more common in muddy and estuarine environments.

Found elsewhere and of their hosts there and elsewhere: Indo-West Pacific and Indian Ocean. **Hosts:** *A. strenuus strenuus* shares its home not only with fire worms in the genus *Eurythoe*, but occasionally brittle stars and lives in tubes constructed of dense coralline algae (Banner and Banner, 1982) .Symbiotic poecilostomatoid copepods on the carapace of this snapping shrimp are also observed (Anker, 2010)

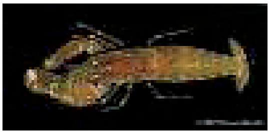


Fig. 265. *Alpheus strennus strennus*.

***Alpheus rapax* Fabricius, 1798** (Fig. 266)

Alternate names, updated and Pakistani records.

Alpheus rapax–Kazmi and Kazmi, 2012; Zeng and Jaffar, 2012

Note: Interphyletic communication is known to occur in a behavioural, mutualistic symbiotic association with goby and this species (Zeng and Jaffar, 2012). I did not observe this in the field.

Found elsewhere and of their mutuals there and elsewhere: Indo-Pacific. **Commensal**: *Psilogobius mainland*.

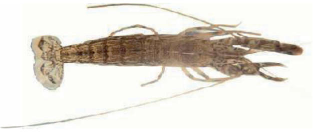


Fig. 266. *Alpheus rapax*.

***Alpheus edwardsii* (Audouin, 1827)** (Fig. 267)

Alternate names, updated and Pakistani records.

Alpheus audouini Coutière, 1905
Alpheus edwardsii–Kazmi and Kazmi, 1979; 2012.

Found elsewhere and of their mutuals there and elsewhere: Tropical Indo-Pacific, Persian Gulf. **Host:** Reef (Henderson, 1892), primarily intertidal rocks.

Fig. 267. *Alpheus edwardsii*.

G. *Synalpheus* Spence Bate, 1888

***Synalpheus neptunus neptunus* (Dana, 1852)** (Fig. 268)

Alternate names, updated and Pakistani records.

Alpheus neptunus Dana, 1852
Synalpheus neptunus neptunus- Davie *et al*., 2002; Kazmi and Kazmi, 2012
Alpheus minor neptunus (Miers 1884)
Synalpheus theano (sensu Banner and Banner 1966).

Pakistani host: Not known

Found elsewhere and of their mutuals there and elsewhere: Indo-west. **Hosts:** Reef and sponges *Coscinoderm*a aff *mathewsi*, *Aximissa* aff *cavernosa* and *Ircinia* sponges (Henderson, 1892, Didderen *et al*., 2006).

Fig. 268. *Synalpheus neptunus neptunus*.

F. Hippolytidae Bate, 1888: The Hippolytidae is the fourth largest family within the Caridea, currently containing over 330 described species in 37 genera, and the classification of this family has been rather controversial (Grave *et al.*, 2014). Best known association of decapods crustaceans with other animals are those between Hippolytidae and sea anemone.

G. *Laureutes* Stimpson, 1860

Note*:* May be commensal with other marine invertebrates, particularly cnidarians, or free-living among algae or sea grasses common in *Sargassum* in some tropical zones.

***Latreutes anoplonyx* Kemp, 1914** (Figs. 269-270)

Alternate names, updated and Pakistani records.

Material: 2 ov. females and one juvenile

Latreutes anoplonyx–Kazmi, 1971, Kazmi and Kazmi, 1979, 2012; Kazmi, 1996; Tahira and Kazmi, 2006; Grave and Fransen, 2011

Pakistani host: *Catostylus mosaicus* (may be *C.perezi* Ref. Gul *et al.*, 2013)

Found elsewhere and of their hosts there and elsewhere: Hosts: The association of *L. anoplonyx* with medusa is well known since it was reported by Kishinouye (1902). A*cromitus flagellatus, Mastigias papua, Nemopilema nomurai, Rhizostoma* sp., *Rhopilema esculentum, R.*

hispidum, Phyllorhiza punctata and *Versuriga anadynomene* (Bruce, 1995; Hayashi *et al*., 2004).

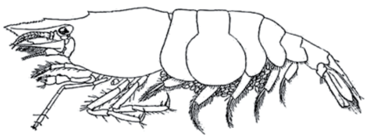


Fig. 269. *Latreutes? anoplonyx*.

Fig. 270. *Latreutes? anoplonyx* on host.

***Latreutes mucronatus* (Stimpson, 1860)** (Fig. 271)

Alternate names, updated and Pakistani records.

Latreutes gravieri Nobili, 1904
Latreutes mucronatus var. *multidens* Nobili, 1905
Latreutes natalensis Lenz and Strunck, 1914
Rhynchocyclus mucronatus Stimpson, 1860
Latreutes mucronatus–Ghani and Tirmizi, 1991; De Grave, 2007; Kazmi and Kazmi, 2012

Pakistani host: No information available.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific and Persian Gulf. **Hosts:** *Tetrostoma setouchiana* (Ohtsuka *et al*., 2011), among leaves of seagrass beds or algae.

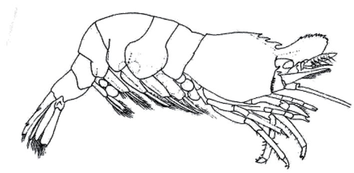


Fig. 271. *Latreutes mucronatus*.

G. *Gelastocaris* Kemp, 1914: Highly specialized epibiotic symbiotic species of the genus *Gelastocaris paronae* is found here. It lives in sponge, a perfect shelter of the inhabitants by toxicity of the sponges from large predators is provided.

***Gelastocaris paronae* (Nobili, 1905)** (Fig. 272)

Alternate names, updated and Pakistani records.

Latreutes Paronae Nobili, 1905.
Gelastocaris paronae–Kazmi and Kazmi, 2012.

Material: One female, 13mm TL, 27-3-1980, its exact depth of capture cannot be precisely determined.

Note: The amount of morphological variation in the few available descriptions of this shrimp may indicate merely a very plastic species, possibly with different sponge host associations may be represented.

Pakistani host: The associate species in the case of the present specimen were not recorded.

Found elsewhere and of their hosts there and elsewhere: Indo-west Pacific, Persian Gulf. **Commensals**: various sponge hosts (*Xestospongia, Axinella* species), where its colour and patterns almost completely camouflage it, camouflage is so effective that it appears to literally melt into its host.

Fig. 272. *Gelastocaris paronae* on host. (Google image)

G. *Hippolyte* Leach, 1914: Of species occurring in the Indo-West Pacific the genus is poorly understood. d'Udekem d'Acoz (1999) re-described Indo-West Pacific species including *Hippolyte ventricosa* H. Milne Edwards, 1837 in details. However, there are still many taxonomic problems in this genus and the Pakistani specimens remain to be verified. The genus *Hippolyte* is only found associated with pelagic Sargassum, well known for its ability to cling to its algal habitat. *Hippolyte* is coloured in such a way that it seems to be broken up into 2 parts (cephalothorax-abdomen), each of which looks very like a vesicle of *Sargassum* (Gurney, 1936).

***Hippolyte ventricosa* H. Milne-Edwards, 1837** (Figs. 273-274)

Alternate names, updated and Pakistani records.

Virbius australiensis Stimpson, 1860
Hippolyte orientalis Heller, 1862
Caridina cincinnuli Haswell, 1882
Hippolyte ventricosus H.Milne- Edwards, 1837; Kemp, 1916
Hippolyte ventricosa–Tirmizi and Kazmi, 1984; Bruce, 1986; Chace, 1997; Udekem d' Acoz, 1999; Kazmi and Kazmi,2012
Hippolyte acuta Rathbun, 190; Edmondson, 1946

Pakistani host: Collected the specimens with the weed washed ashore. The species changes the body colour according to its habitat; when obtained from green algal belt, they were green and grey in colour, when they were captured from *Sargassum* belt, the body was of a brownish black.

Found elsewhere and of their hosts there and elsewhere: Indo-West-Pacific and Mediterranean region; Udekem d' Acoz, (1999) opines that the species is only known with certainty from India; most other Indo-Pacific records are probably based on other.He did not mention Pakistani record of the species (Tirmizi and Kazmi, 1984) **Host:** flotsam in the high sea.

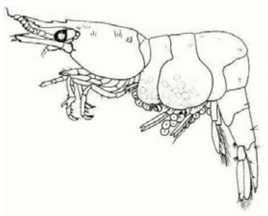


Fig. 273. *Hippolyte ventricosa*.

Fig. 274. On host.

G. *Lysmata* Risso, 1816: Recent cladistics analysis suggests the genus should be included in the family Lysmatidae (Bracken *et al*., 2009). It contain about forty described species which usually live on rock and coral reef or sponges.

***Lysmata vittata* (Stimpson, 1860)** (Fig. 275)

Alternate names, updated and Pakistani records.

Hippolysmata vittata Stimpson, 1860
Nauticaris unirecedens Bate, 1888
Lysmata (*Hippolysmata*) *vittata*–Kubo, 1951
Hippolysmata (Hippolysmata) vittata–Karim and Rehman, 1974; Bruce, 1986
Lysmata vittata–Chace, 1997; Kazmi, 2003b; Kazmi and Kazmi, 2004, 2012

Pakistani associates: Not noted

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Host:** Coral reefs.

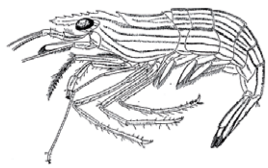


Fig. 275. *Lysmata vittata*.

SUP.F. Palaemonoidea Rafinesque, 1815

F. Palaemonidae Rafinesque, 1815

Note: Several species are dispersed by means of floating objects such as macroalgae, often associated with wood or sea grass (Emmerson, 1986), this suggests that rafting provides a likely additional mode of long-distance dispersal in this group.

S.F. Pontoniinae Kingsley, 1879

Recent studies on Indo-Pacific shrimps of the subfamily Pontoniinae have indicated that the vast majority of species live in permanent commensal association with another marine invertebrate. The relationship between the commensal pontoniine shrimps and their hosts is the issue of most concern.

G. *Anchistus* Borradaile, 1898

***Anchistus custos* (Forskal, 1775)** (Fig. 276)

Alternate names, updated and Pakistani records.

Anchistia aurantiaca Dana, 1852
Anchistus inermis Barnars, 1950
Cancer custos Forskål, 1775
Harpilius inermis Miers, 1884

Pontonia inflata H. Milne Edwards, 1840 [in H. Milne Edwards, 1834-1840]

Pontonia pinnae Ortmann, 1894

Pontonia spinax Dawydoff, 1952

A*nchistus custos*–Tirmizi and Kazmi, 1982; Chace and Bruce, 1993; Grave and Fransen, 2011; Kazmi and Kazmi, 2012.

Described material: One female, one male, orange-red, female darker than male; one spent female, 28-5-1994, Bulleji, with a black leathery rounded fish egg embedded in the merus of right cheliped.

Pakistani host: Commensal with pinnid, *Atrina* (155mm)

Note: Rumphius (1705) mentions the commensalisms between *Anchistus custos* and *Pinna* and called the shrimp the pinna guards. No tissue harm to the host is observed so that *A. custos* nicely fits the definition of a commensal. Hipeau-Jacquotte (1973) studied territoriality and interspecific aggression among *A. custos* and two other pontonines: *Paranchistus ornatus* Holthuis and *Conchodytes biunguiculatus* (Paulson).He observed that *Paranchistus ornatus* Holthuis is regularly expelled by *Anchistus custos* and *Conchodytes biunguiculatus* displaces both of these species.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific, Red Sea, and Persian Gulf. **Hosts:** *Pinna bicolor, P. saccata, P.muricata, P.artropurpurea*, *Atrina vaxillum* and *Vasum* sp. The association with the gastropod *Vasum* must be considered to be highly aberrant (Bruce, 1996).

Fig. 276. *Anchistus custos*, taken out from host shells.

G. *Cuapetes* Clark, 1919: *Cuapetes* now includes 24 species, some are free living and some commensally associated with other invertebrates.

***Cuapetes elegans* (Paul'son, 1875)** (Fig. 277)

Alternate names, updated and Pakistani records.

Anchistia elegans Paulson, 1875.
Periclimenes elegans–Kazmi and Qureshi, 1974; Kazmi and Kazmi, 1979; 2004a
Periclimenes (Falciger) dubius Borradaile, 1915
Periclimenes (*Ancylocaris*) *elegans*–Kemp, 1922.
Periclimenes (Harpilius) elegans–Holthuis, 1952.
Kemponia elegans–Bruce, 2004; Li, 2008
Cuapetes elegans–Okunu, 2009; Kazmi and Kazmi, 2012

Pakistani host: No commensalism was reported from Pakistan.

Found elsewhere and of their hosts there and elsewhere: Indo-West Pacific: East Africa, Madagascar, Seychelles, Red Sea, Gulf of Aden, Persian Gulf, Gulf of Oman, India, Bay of Bengal, Sri Lanka, Andaman Is., Nicobar Is., Malay Archipelago, Hong Kong, Philippines, Ryukyu Is., Japan, Papua New Guinea, Australia, Solomon Is., Caroline Is., Marshall Islands, Society Is., Tuamotus, Hawaiian Is. **Host:** Occurs in coral reef habitat of *Pocillopora damicornis* (Bruce, 2004).

Fig. 277. *Cuapetes elegans*.

S.F. Palaemoninae Rafinesque, 1815

G. *Palaemon* Weber, 1795

***Paleomon pacificus* (Stimpson, 1860)** (Fig. 278)

Alternate names, updated and Pakistani records.

Leander pacificus Stimpson, 1860

Palaemon pacificus–Holthuis, 1950; Tirmizi and Kazmi, 1984; Chace and Bruce, 1993; Li *et al*., 2004, Kazmi and Kazmi, 2012

Pakistani host: Seaweeds in low tide zones.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Host:** Sea grass *Zostrea capensis* (Emmerson, 1986).

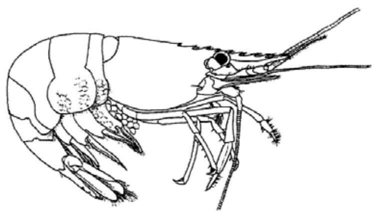


Fig. 278. *Paleomon pacificus*.

F. Gnathophylidae Dana, 1852.

G. *Gnathophyllum* Latreille, 1819

***Gnathophyllum americanum* Guérin-Méneville, 1855**

Alternate names, updated and Pakistani records.

Gnathophyllum americanum–Chace and Bruce, 1993; Ali, 2006.

Pakistani associates: not noted

Note: It is likely that a complex of sibling species occurs (Davei *et al*., 2002). Often associated with echinoderms but not permanently associated, most likely micropredators rather than symbiont tending towards parasitism (Bauer, 2004).

Found elsewhere and of their hosts there and elsewhere: Circumtropical. **Hosts:** Sea anemone *Stichodactyla haddoni* or echinoids, asteroids and opiuroids.

I.O. Achelata Scholtz and Richter, 1995

F. Scyllaridae Latreille, 1825

S.F. Arctidinae Holthuis, 1985

G.*Scyllarides* Gill, 1898

***Scyllarides tridacnophaga* Holthuis, 1967** (Fig. 279)

Alternate names, updated and Pakistani records.

Scyllarides tridacnophaga–Tirmizi and Kazmi, 1983;Sultana et al,2009

Pakistani host: Not noted**.**

Found elsewhere and of their hosts there and elsewhere: Red Sea, East Africa, Gulf of Aden, Yemen and the west coast of Thailand. **Host:** reef .

Fig. 279. *Scyllarides tridacnophaga.*

I. O. Anomura MacLeay, 1838

SUP. F. Paguroidea Latreille, 1802: Hermit crabs (Superfamily Paguroidea) are adapted to use empty gastropod shells as shelter from biotic factors, preventing mechanical damage to their soft abdomen (Angel, 2000; Barnes, 2003), and as protection against predation (Leonard *et al*., 2001). Shell utilization appears to be based on a complex and interactive factors, including shell weight, architecture, volume, height, width, colour and aperture size (Garcia and Mantelatto, 2000, 2001). Almost all 1100 species of hermit crab are mobile while sheltered (Figs. 280, 281). Only one genus lives without gastropod shell.

Fig. 280. Hermits in shells

The well-known symbiosis has been observed between anemones and hermit crabs in which latter carry former on their shells. These associations are mutualistic because both the crab and anemone can protect each other from predation; the hermits will often pick up sea anemones and 'plant' them on their backs, and when they move to another shell, will take their resident anemone with them.

Most frequently hermit crabs use the shells of gastropods (Figs. 280-281) although the shells of bivalves and scaphopods and even hollow pieces of wood and stone while plastic shelters are even proposed as alternative shelters for hermit crabs, while others live in immobile domiciles provided by calcareous tubes of polychaetes or vermetid gastropods, corals, or sponges are used by some species. Several hermit crab species use "vacancy chains" to find new; when a new, bigger shell becomes available, hermit crabs gather around it and form a kind of queue from largest to smallest. When the largest crab moves into the new shell, the second biggest crab moves into the newly vacated shell, thereby making its previous shell available to the third crab, and so on (Randi *et al*., 2010). A heterogenous habitat wit more niches provides a wider choice of shells for the hermit crabs, minimizing interspecific competition for the available shell resources.

While unreliable reports have suggested that hermit crabs may be capable of removing live gastropods from their shells to access the essential shell resource, no systematic experiments have been conducted to investigate this possibility. Recently I have sighted that in one collection sample the gastropod (*Bullia*) was accessed by a hermit crab with gastropods' body still left intact inside the shell. Most of the Pakistani hermit crabs have no information on their associated gastropods ,also there is no information even in literature .

The other associates include species found on the shells occupied by hermit crabs (epibiotic species), species boring into these shells (endolithic species), and species living within the lumen of the shell (either free living or attached to the shell), species attached to the hermit crabs themselves, and hypersymbionts. In total over 550 invertebrates, from 16 phyla are found associated with over 180 species of hermit crabs. According to Conover (1979) there is a significant difference between the epifauna of empty shells and shells with hermit crab. Some organisms like calyptraeid genus *Crepidula* has been noticed in lumen of *Tonna* both with its soft body intact (31-8-1995, Ibrahim Hydery) or shell occupied with hermit crab (30-8-1995, Ibrahim Hyderi).

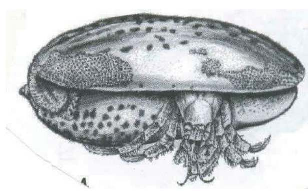


Fig. 281. Hermit crab in shell.

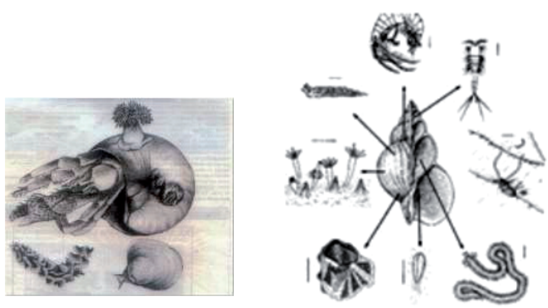


Fig. 282. Communities of hermit crab associates with the gastropod shell (after Kazmi, 1996; after Williams and McDermott, 2004).

Among the associates, 114 appear to be obligate commensals of hermit crabs, 215 are facultative commensals, and 232 are incidental associates (Fig. 282). The taxa exhibiting the highest number of associates are crustaceans. Other very close symbiotic relationships are known from encrusting bryozoans and hermit crabs forming bryoliths (Klicpera *et al*., 2013). The scale worms, barnacles and amphipods are suspected egg predator found living in the lumen of shells near the abdomen of hermit crabs, spionid worms bore hermit crab shells, holes created by polydorids, reduced the shell strength and increased successful predation on hermit crabs by other Decapods; the nature of the symbiosis is mutualistic, with nereid worms gaining food and protection from hosts, while hosts could possibly benefit by the worm removing parasites such as bopyrids and rhizocephalans before they have had a chance to parasitize hermit crabs; among cnidarians there are examples of mutualism whereby anemones and hydractinians provide protection from predators such as crabs, octopus and fish to host hermit crabs. A non obligate and non symbiosis is seen between a *Dardanus* and *Porcellana*. Symbiotic alpheid is reported inside the large strombid shell occupied by *Dardanus* (Marin, 2010).

Key to families of Paguroidea of the Pakistan coast

1. Antennular flagella truncated at tip; terrestrial or semiterrestrial …. …………………………………………………...... Coenobitidae

- Antennular flagella terminating in a filament; marine.…................. 2

2. Outer maxillipeds usually contiguous at base; chelipeds equal or subequal, or left distinctly the larger ……….................. Diogenidae

- Outer maxillipeds widely separated at base; left cheliped never larger than right, right usually much the larger.................. Paguridae

F. Diogenidae Ortmann, 1892

G. *Calcinus* Dana, 1851

***Calcinus latens* Randall, 1840**

Alternate names, updated and Pakistani records.

Pagurus latens Randall, 1840.
Calcinus abrolhensis Morgan, 1988 {6}
Pagurus cristimanus H. Milne Edwards, 1848
Calcinus intermedius De Man, 1881
Calcinus terraereginae Haswell, 1882
Calcinus latens–Tirmizi and Siddiqui, 1981, 1982; Naderloo, 2012

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific region, Maldives, Seychelles, Australia, and east coast of Africa, Gulf of Oman, Aden and Red Sea. **Shells occupied:** Nassariidae, Planaxidae, Neritidae, Strombidae, Cerithiidae, Columbellidae, Conidae, Cymatiidae, Cypraefdae, Melongenidae, Thaididae, Trochidae, and Turbinidae. Associations: coral reef, sea grass in mangrove areas.

***Calcinus elegans* (H. Milne-Edwards, 1836)** (Fig. 283)

Alternate names, updated and Pakistani records.

Pagurus elegans H. Milne Edwards, 1836
? *Pagurus fasciatus* Bell, 1853
Calcinus elegans Siddiqui and Kazmi, 2003

Pakistani shells occupied: *Turbo coronatus*

Found elsewhere and of their hosts there and elsewhere: Hawaiian Island to East Africa. **Shells occupied:** Nassariidae, Muricidae, and Strombidae.

Fig. 283. *Calcinus elegans* in host shell.

G. *Clibanarius* Dana, 1852: As of 2009, about 60 species are recognized in *Clibanarius*.

***Clibanarius aequabilis* Dana, 1852.**

Alternate names, updated and Pakistani records

Pagurus aequabilis Dana, 1851; Ahmed and Khan, 1971; Tirmizi and Siddiqui, 1981, 1982; Siddiqui and Kazmi, 2003; McLaughlin *et al*., 2010.

Pakistani shell occupied: *Nerita textiles*.

Found elsewhere and of their hosts there and elsewhere: European waters; Sri Lanka, Mergui, Malaysia, Tahiti. **Shell occupied:** *Stramonita haemastoma* showing tendency to choose those with a larger internal volume and weight (Lopez, 2008).

***Clibanarius arethusa* de Man, 1888.**

Alternate names, updated and Pakistani records.

Clibanarius arethusa–Ahmed and Khan, 1971; Tirmizi and Siddiqui, 1981, 1982; Siddiqui and Kazmi, 2003; Chan, Tin-Yam, 2012

Pakistani shells occupied: *Drupa granulate, Monula amygdala*

Found elsewhere and of their hosts there and elsewhere: Mergui Archipelago, India, Vietnam and Taiwan. **Shells occupied:** *Trochus* spp., *Murex virgineus* and *Turbo* spp. **Host:** Shallow coral reefs.

***Clibanarius clibanarius* (Herbst, 1791).**

Alternate names, updated and Pakistani records.

Cancer clibanarius Herbst, 1791
Clibanarius vulgaris Dana, 1852
Pagurus clibanarius–Tirmizi and Siddiqui, 1981, 1982
Clibanarius clibanarius McLaughlin *et al*., 2010

Pakistani shells occupied: *Hexaplax kusterianus, Cymia cornifera* and *Melongena bucephala*

Found elsewhere and of their hosts there and elsewhere: Andamans to Tahiti. **Shells occupied:** Different species of *Murex, Bursa, Babylonia* or *Turitella* (Varadarajan and Subramanian, 1982).

***Clibanarius infraspinatus* Hilgendorf, 1869** (Fig. 284)

Alternate names, updated and Pakistani records.

Clibanarius infraspinatus–Ahmed and Khan, 1971; Tirmizi and Siddiqui, 1981, 1982; Siddiqui and Kazmi, 2003; Chan, Tin-Yam, 2012

Pakistani shells occupied: *Tonna, Telescopium, Hexaplax kusterianus, Cymia cornifera* **Associates**: *Crepidula* species, 30-8-1995, Ibrahim Hyderi

Found elsewhere and of their hosts there and elsewhere: Red Sea, Northern Arabian Sea, Bay of Bengal, Peninsular Malaysia, and East Australia. **Shells occupied:** *Tonna dolium, Turbo.*

Fig. 284. *Clibanarius infraspinatu* with host shell.

***Clibanarius padavensis* de Man, 1888**

Alternate names, updated and Pakistani records.

Clibanarius padavensis–Ahmed and Khan, 1971; Tirmizi and Siddiqui, 1981, 1982; Siddiqui and Kazmi, 2003.

Pakistani shells occupied: Cerithids, *Telescopium telescopium, Turitella cochlea*

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific: India, Singapore, Thailand, Australia and New Caledonia. **Shells occupied:** *Turritella attenuata, Thais bufo, Natica didyma, Murex tarpa, Babylonia spirata, Hemifusus* spp., and *Oliva* spp.

Clibanarius signatus **Heller, 1861.**

Alternate names, updated and Pakistani records.

Clibanarius semistratus Heller, 1862
Clibanarius signatus–Chopra and Das, 1940; Tirmizi and Siddiqui, 1981, 1982; Siddiqui and Kazmi, 2003; Abd El-Wakeil *et al*., 2010

Pakistani shells occupied: *Clypeomorus* sp., *Tenguella granulate*, *Cantheus undosus*

Found elsewhere and of their hosts there and elsewhere: Arabian Sea, Gulf of Aden, Oman and Red Sea. **Shells occupied:** *Nerita* spp., *Oliva* sp., *Conus* sp., *Strombus* sp., *Terebralia* sp., *Turritella* sp., *Trochus* sp., *Clanculus* sp., *Cerithium caeraleum, Lunella coronate, Planaxis sulcatus, Conumurex persicus, Semiricinula konkanensis, Priotrochus kotschyi, Nassarius* spp., *Clypeomorus persica, Thais savignyi, Tenguella granulata, Cantheus undosus*.

Clibanarius striolatus **Dana, 1852**. (Fig. 285)

Alternate names, updated and Pakistani records.

Clibanarius striolatus–Alcock, 1905 Tirmizi and Siddiqui, 1981, 1982; Siddiqui and Kazmi, 2003; Chan, 2012

Pakistani shell occupied: *Drupa*

Found elsewhere and of their hosts there and elsewhere: Seychelles eastward to Tahiti, Japan, Australia, Taiwan, Red Sea and Gulf of Aden. **Shells occupied:** Cerithiidae, Neritidae, and Planaxidae, *Clypeomeorus batillariaeformis*. This species hosts rhizocephalan *Septosaccus* and *Peltogaster*.

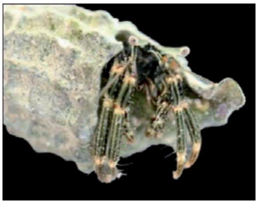


Fig. 285. *Clibanarius striolatus* in host shell.

***Clibanarius virescens* Krauss, 1843.**

Alternate names, updated and Pakistani records.

Pagurus virescens Krauss, 1843.
Clibanarius virescens–Tirmizi and Siddiqui, 1981; 1982; Rahayu, 2000

Pakistani shells occupied: *Bursa* sp., *Nerita* sp., *Turbo* sp., *Cymatium* sp., *Drupa, Morula, Clypeomonus* spp.

Found elsewhere and of their hosts there and elsewhere: Australia, Japan, Cebu and Fiji Islands, Hong Kong, East and south Africa, Oman, Gulf of Aden, Persian Gulf and Red Sea. **Shells occupied:** Ceriithidae. Seventeen gastropod species with *Burnupena lagenaria* predominating (Wait and Schoeman, 2012); *Burnupena cincta* and *Burnupena pubescens*, *Cypraea*, rarely *Cymatium dolarium* and *Stramonita capensis*.

***Clibanarius nathi* Chopra and Das, 1940**. (Fig. 286)

Alternate names, updated and Pakistani records.

Clibanarius nathi Chopra and Das, 1940; McLaughlin *et al*., 2010

Pakistani shell: Not noted

Found elsewhere and of their hosts there and elsewhere: India, Taiwan, Red Sea, Iran. **Shells occupied**: *Cerithium caerulium, Rhinoclavis sinensis, Clypeomorus* sp., *Murex* sp., *Turbo intercoastaliis* and *Nucella* sp. (Vaghela and Kundu, 2012).

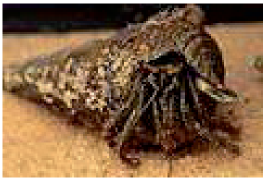


Fig. 286. *Clibanarius nathi* in host shell. (Google image)

G. *Dardanus* Paulson, 1875

***Dardanus setifer* (H. Milne Edwards, 1836).**

Alternate names, updated and Pakistani records.

Pagurus setifer H. Milne Edwards, 1836; Alcock, 1905.
Dardanus setifer–Tirmizi and Siddiqui, 1982 McLaughlin *et al*., 2007.

Pakistani shells occupied: Not noted.

Found elsewhere and of their hosts there and elsewhere: Northern Arabian Sea, India eastward to Hong Kong, Australia, south and east Africa. **Shells occupied:** *Cymatium*. **Hosts:** Seagrass roots, soft corals.

***Dardanus pedunculatus* (Herbst, 1804)**

Alternate names, updated and Pakistani records.

Cancer pedunculatus Herbst, 1804
Pagurus asper De Haan, 1849
Dardanus haani Rathbun, 1903
Neopagurus horai Kamalaveni, 1950
Dardanus pedunculatus–Rahayu, 2000; Ali, 2006; Poupin *et al*., 2013

Pakistani shells occupied: Not noted.

Found elsewhere and of their hosts there and elsewhere: Southern Japan, Kii Peninsula, Tosa Bay, Kyushu, and Okinawa; Taiwan; Philippines; Seychelles; Amboina; Timor; Hawaii; Australia. **Shell occupied:** Turban shell nearly always carries sea anemones on its shell, to protect itself from its main predator *Octopus*. The anemone attached to the shell provides camouflage, protection, and the two invertebrates share food. When the crab leaves its shell and finds a new, larger shell it transfers the anemone on to it or select a larger anemone (Cowles, 1919, Ross, 1975).

***Dardanus guttatus* (Olivier, 1812)**

Alternate names, updated and Pakistani records.

? *Pagurus catephractus* Boone, 1935
Pagurus guttatus Olivier, 1812
Dardanus guttatus–Holthuis, 1953; Ali, 2006; Poupin *et al*., 2013

Pakistani shells occupied: Not observed.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Shells occupied:** Conidae which probably accounts for the marked compression of the body on reef slope.

G. ***Diogenes* Dana, 1852.** *Diogenes* is currently represented by 61 species (Komai *et al*., 2012), most of which are distributed in shallow waters in the Indo-West Pacific region.

***Diogenes alias* McLaughlin and Holthuis, 2001** (Fig. 287)

Alternate names, updated and Pakistani records.

Diogenes diogenes Alcock, 1905
Diogenes alias McLaughlin and Holthuis, 2001; Siddiqui and Kazmi, 2003

Pakistani shells occupied: *Babylonia* and *Tibia*

Found elsewhere and of their hosts there and elsewhere: East coast of Indian Peninsula, S. China Sea, Indonesia. **Shells occupied:** Not known.

Fig. 287. *Diogenes alias*.

***Diogenes avarus* Heller, 1865** (Fig. 288)

Alternate names, updated and Pakistani records.

Diogenes pugilator Nobili, 1906.

Diogenes avarus–Alcock, 1905; Tirmizi and Siddiqui, 1981; Siddiqui *et al*., 2004; McLaughlin *et al*., 2012.

Pakistani shells occupied: *Rhinoclavus sinensis, Natica didyma, Natica josephinae*

Found elsewhere and of their hosts there and elsewhere: Indian Ocean, Kuwait, Red Sea, Mergui, Viet Nam, Philippine Island, Indonesia, Australia. **Shells occupied:** *Umbonium vestiarium, Cerithidea cingulata*, *Mitrella blanda, Semiricinula konkanensis, Clypeomorus persica, Clypeomorus bifasciatus, Nassarius arcularia, Osilinus kotschyi* and *Planaxis sulcatus*. *Cerithium* spp., *Turrebralia* spp., *Pyrene zebra*, *Trochus firmus, Clanculus gennesi, Potamides conicus, Terebra bathyrhaphe, Bullia tranquebarica, Ancilla farsiana, Euchelus asper, Turicula nelliae, Duplicaria duplicaria, Thais lacera, Lunella coronata, Polinies mammilla, Architectaria laevigata, Turritella fultoni* and *Nerita polita*.

Fig. 288. *Diogenes avarus*.

***Diogenes custos* Fabricius, 1798** (Fig. 289)

Alternate names, updated and Pakistani records.

Pagurus custos Fabricius, 1798

Diogenes custos–Siddiqui and Kazmi, 2003; Siddiqui *et al*., 2004; McLaughlin *et al*., 2010.

Diogenes affinis Henderson, 1893.

Diogenes? *affinis* Tirmizi and Siddiqui, 1982

Pakistani shells occupied: *Anachis fauroti, Babylonia spirata, Bufonaria echinata, Bullia tranquebarica, Bullia mauritiana, Bullia melanoides, Bursa spinosa., B. granularis, Cantharus erythrostomus, Cantharus undosus, Cerithida cingulata, Latirus bonniae, Morula granulata, Nassarius distortus, Nassarius hirtus, N. albescens, Natica alapapilionis, Nevrita didyma, N. peselphanti, Oliva gibbosa, Polinices mammilla, Ptychobela opisthchetos, Thais carinifera, Thais lacera, Thais rudolphi, Thais rugosa, Thais tissoti, Tibia curta, Tonna luteostoma, Turricula amicta, Turricula javana, Turritula bandorensi* (Fatima, 2007); ovigerous females show preference on *Bullia indusindic, B. kurrachensis, B.melanoides, Turbo brunneus* and *Surcula javana* (Shazia *et al*., 2013). **Shell associate:** *Siphopatella walshi* (Shazia, 2012).

Found elsewhere and of their hosts there and elsewhere: Bay of Bengal and Northern Arabian Sea and Australia. **Shells occupied:** *Natica* spp. and *Murex rapax.*

Fig. 289. *Diogenes custos*.

***Diogenes dubius* Herbst, 1804**

Alternate names, updated and Pakistani records.

Cancer dubius Herbst, 1804
Pagurus dubius Herbst, 1804
Diogenes dubius–Siddiqui and Kazmi, 2003

Pakistani shells occupied: Not observed

Found elsewhere and of their hosts there and elsewhere: Indo-west Pacific. **Shell occupied:** *Umbonium monilifeum*.

***Diogenes lophochir* Morgan, 1989.**

Alternate names, updated and Pakistani records.

? *Diogenes costatus*–Tirmizi and Siddiqui, 1982
Diogenes lophochir–Siddiqui *et al*., 2004

Pakistani shells occupied: Not observed.

Found elsewhere and of their hosts there and elsewhere: Dubai, Western Australia: Singapore. **Shells occupied:** *Murex tarpa*.

***Diogenes tirmiziae* Siddiqui and McLaughlin, 2003**

Alternate names, updated and Pakistani records.

Diogenes tirmiziae Siddiqui and McLaughlin, 2003; Naderloo *et al*., 2012; Naderloo and Türkay, 2012; Naderloo *et al*., 2013.

Pakistani shell occupied: *Rhinoclavis* sp.

Found elsewhere and of their hosts there and elsewhere: Northwestern Indian Ocean: Persian Gulf. **Shells occupied:** *Nassarius arcularia.*

***Diogenes guttatus* Henderson, 1888**

Alternate names, updated and Pakistani records.

Diogenes guttatus–Tirmizi and Siddiqui, 1981; Siddiqui ad McLaughlin, 2003; Siddiqui *et al*., 2004; McLaughlin *et al*., 2010.

Pakistani shells occupied: Not identified.

Found elsewhere and of their hosts there and elsewhere: Northwestern Indian Ocean: Persian Gulf. **Shells occupied:** *Nassarius arcularia.*

***Diogenes karwarensis* Nayak and Neelkantan, 1989**

Alternate names, updated and Pakistani records.

Diogenes karwarensis–Siddiqui and Kazmi, 2003; Kazmi *et al*., 2007

Pakistani shells occupied: Not known.

Found elsewhere and of their hosts there and elsewhere: India, Akola, Kuwait. **Shells occupied:** *Euchelus asper, Vaceuchelus angulatus, Osilinus kotschyi, Priotrochus obscurus*. *Cronia konkanensis, Trochus firmus, Nassarius himeroessa, Nassarius persicus, Cerithidea cingulata, Cerithium caeruleum, Ancilla farsiana* and *Clavetula naverchus*.

***Diogenes klaasi* Rahayu and Forest, 1995**

Alternate names, updated and Pakistani records.

Diogenes klaasi–Siddiqui *et al*., 2006; Reshmi and Bijukumar, 2011; Naderloo, 2012.

Pakistani shells occupied: *Bullia persica*.

Found elsewhere and of their hosts there and elsewhere: Indonesia, western Thailand, India, and Iran. **Shells occupied:** *Cerithiacea cingulata, C. batillariaeformis* and *Turris nelliae.* Associated with bed of *Saccostrea cucullata*

***Diogenes planimanus* Henderson, 1893** (Fig. 290)

New material: Ibrahim Hyderi 30-8-1995

Alternate names, updated and Pakistani records.

Diogenes custos var. *planimanus* Henderson, 1893
Diogenes planimanus–Tirmizi and Siddiqui, 1981; Siddiqui *et al*., 2004

Pakistani shells occupied: *Neverita, Thais* (Fatima, 2007).

Found elsewhere and of their hosts there and elsewhere: Northern Arabian Sea, Bay of Bengal, Malaysia, Thailand, and northern Australia. **Shells occupied**: *Neverita didyma, Polinices tumidus, Bullia tranquebarica, Babylonia spirata* and *Thais lacera, Murex, Natica*.

Fig. 290. *Diogenes planimanus* in host shells.

Diogenes violaceus **Henderson, 1893**

Alternate names, updated and Pakistani records.

Diogenes violaceus–Ahmed and Khan, 1971; Tirmizi and Siddiqui, 1981, 1982

Pakistani shells occupied: *Natica*.

Found elsewhere and of their hosts there and elsewhere: Madagascar, India. **Shells occupied:** *Bullia*.

Diogenes canaliculatus **Komai, Reshmi and Kumar, 2013**

Alternate names, updated and Pakistani records.

? *Diogenes bicristimanus*–Tirmizi and Siddiqui 1981, 1982; Siddiqui and Kazmi, 2003.

Diogenes fasciatus–Siddiqui *et al*., 2004

Diogenes canaliculatus Komai, Reshmi and Kumar, 2013

Pakistani shell: Not observed.

Found elsewhere and of their hosts there and elsewhere: India. **Shell occupied:** Tusk shell.

G. *Areopaguristes* Rahayu and McLaughlin, 2010

***Areopaguristes perspicax* (Nobili, 1906)**

Alternate names, updated and Pakistani records.

Paguristes jousseaumei var. *perspicax* Nobili, 1906
Paguristes perspicax Nobili, 1906; Tirmizi and Siddiqui, 1979, 1981, 1982; Titgen, 1982; Jones, 1986; Apel, 2001
Stratiotes perspicax Nobili, 1906
Areopaguristes perspicax–McLaughlin, *et al*., 2010; Naderloo *et al*., 2012; Naderloo and Türkay, 2012; Naderloo *et al*., 2013.

Pakistani shells occupied: *Nassarius*.

Found elsewhere and of their hosts there and elsewhere: Northern Arabian Sea, Persian Gulf and Red Sea, Madagascar and Bay of Bengal. **Shells occupied:** Damaged and eroded shells of *Conumurex* spp., and *Conus* spp. *Trochus firmus, Cerithidea cingulata, Nassarius himeroessa, Potamides conicus, Cronia konkansis* and many others.

F. Coenobitidae Dana, 1851: Hermit crabs of the family Coenobitidae have succeeded in invading the terrestrial environment.

G. *Coenobita* Latreille, 1829

***Coenobita perlatus* Milne Edwards, 1837** (Fig. 291)

Alternate names, updated and Pakistani records.

Coenobita perlatus var. *affinis* Miers, 1880
Coenobita perlata H. Milne Edwards, 1837
Coenobita perlatus Ahmed and Khan, 1971; McLaughlin and Hogarth, 1998.

Pakistani shell occupied: *Rhinoclavis*.

Found elsewhere and of their hosts there and elsewhere: Indo-Pacific. **Shells occupied:** *Turbo petholatus*, *Turbo fluctuosus*. *Turbo imperialis*, *Turbo argyrostomus*/ *T. setosus*/ *T. sparverius*/ *T. tumidulus, Turbo marmoratus*.

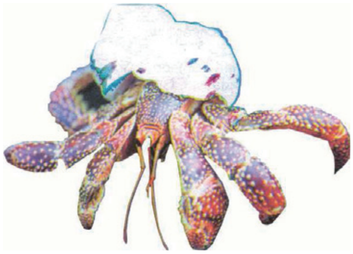


Fig. 291. *Coenobita perlatus*.

***Coenobita rugosus* Milne Edwards, 1837**

Alternate names, updated and Pakistani records.

Coenobita subrugosa Neumann, 1878
Coenobita rugosa var. *wagneri* Dofl ein, 1900
Cenobita rugosa H. Milne Edwards, 1837
Coenobita rugosus–Ahmed and Khan, 1971; Tirmizi and Siddiqui, 1981, 1982; Reay and Haig 1990.

Pakistani shells occupied: Not noted.

Found elsewhere and of their hosts there and elsewhere: Bay of Bengal, west coast of America, East and west coast of Africa and Red Sea. **Shells occupied:** Neritidae seldom Buccinidae *Rhinoclavis sinensis. Cerithium columna, Nerita pli cata, Cyma tiwnnicobarium, Cerithium nodulosum, Nerita polita, Cym atium muricinum, Cantharos undosus, Peristernia nassatula, Rhinoclavis articulatus, Turbo setosus, Turbo argyrostomus, Nassarius graniferus, Strombus gibberulus, Cerithium brevis, Peristernia columbarium, Vasum, Morula fiscella, Terebra maculata*.

***Coenobita scaevola* Forskal, 1775** (Fig. 292)

Alternate names, updated and Pakistani records.

Cancer scaevola Forskål, 1775
Coenobita rugosa var. J*ousseaumei* Bouvier, 1890

Coenobita rugosa var. *granulata* Bouvier, 1890

Coenobita scaevola–Tirmizi and Siddiqui, 1981; 1982; Apel, 2011; Seyfabadi *et al.*, 2013.

Pakistani shells occupied: Not noted.

Found elsewhere and of their hosts there and elsewhere: Northern Arabian Sea, Oman, Gulf of Aden and Red Sea. **Shells occupied:** Juveniles and small adults in: *Nerita* spp., *Neverita* sp., *Policies* sp., *Turritella* sp., and *Bufunaria* sp., *Cerithium caeruleum* shell and the adults go for *Turbo radiatus* and *Nerita longii* (Seyfabadi *et al.*, 2013) *Hexaplex* sp., *Thais* spp., *Babylonia* sp., *Turbo* sp., and *Rapana* sp.

Fig. 292. *Coenobita scaevola*.

F. Paguridae Latreille, 1802

G. *Pagurus* Fabricius, 1775

***Pagurus kulkarnii* Sankolli, 1961** (Fig. 293)

Alternate names, updated and Pakistani records.

Pagurus kulkarnii Tirmizi and Siddiqui, 1981; Moradmand and Sari, 2007

Pakistani shells occupied: *Drupa granulata*.

Found elsewhere and of their hosts there and elsewhere: India. **Shell occupied:** *Bursa*.

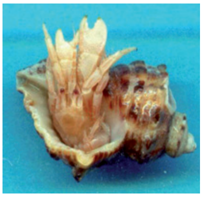


Fig. 293. *Pagurus kulkarnii*.

Pagurus nisari **Siddiqui and Komai, 2008** (Fig. 294)

Alternate names, updated and Pakistani records.

Pagurus nisari Siddiqui and Komai, 2008

Pakistani shells occupied: *Pyrene* sp., *Clypeomorus* sp., and others.

Found elsewhere and of their hosts there and elsewhere: Not reported outside type locality 24°50, 54N', 66°43.00E

Fig. 294. *Pagurus nisari* and host shell.

F. Porcellanidae Haworth, 1825

Note: Most of the known porcellain crabs in the tropics are free-living. However, commensal or ectosymbiont relationships are common in this family, with species frequently living in association with sponges, and on a variety of cnidarians such as Pennatulacea (sea pens), hard and soft corals, gorgonians, alcyonarians and ascidian. Some Porcellanidae are associated with polychaetes, algae, holothurians, others living with some large hermit crabs commonly found within the shell carried by hermit crabs. But report on our following two species *Polyonyx loimicola* and *Polyonyx hendersoni* belonging to commensal group has no information from Pakistan (Tirmizi *et al.*, 1989), they did not indicate where their specimens were collected from, or their possible hosts.

G. *Polyonyx* Stimpson, 1858

***Polyonyx loimicola* Sankolli, 1965** (Fig. 295)

Alternate names, updated and Pakistani records.

Polyonyx loimicola–Tirmizi *et al.*, 1989; Prakash *et al.*, 2013.

Pakistani host: Not known

Found elsewhere and of their hosts there and elsewhere: India. **Host:** Found under stones from the tube of tube-worm *Loimia medusa*.

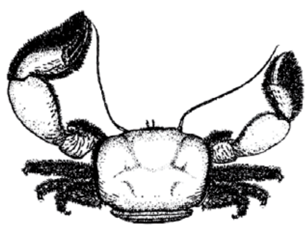


Fig. 295. *Polyonyx loimicola*.

***Polyonyx hendersoni* Southwell, 1909** (Fig. 296)

Alternate names, updated and Pakistani records.

Polyonyx hendersoni–Tirmizi *et al.*, 1989; Siddiqui and Kazmi, 2003; Hiller *et al.*, 2010; Prakash *et al.*, 2013.

Pakistani host: Tirmizi *et al.*, 1989 did not indicate their possible host.

Note: Werding (2001) commented on the taxonomy of several species of the genus. He suggested that *P. hendersoni* and *P. splendidus* should be assigned to a separate genus.

Found elsewhere and of their hosts there and elsewhere: Sri Lanka, Japan, Korea, Hong Kong and Australia, India. **Host:** Found in the water ducts of sponge (Demospongiae).

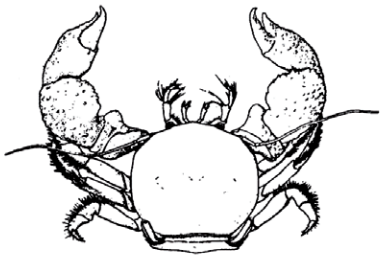


Fig. 296. *Polyonyx hendersoni*.

S. CL. Hoplocarida Calman, 1914

O. Stomatopoda Latreille, 1817

Note: Folliculinid protozoan, caprellids, bryozoans, molluscs have been recorded on thoracic legs and abdominal gills. Several *Divariscintilla* species on *Lysiosquilla scabricauda*, *Pseudopythina subsinuata* on *Miyakea nepa* and *Harpiosquilla raphidea* have been reported in literature outside Pakistan in host burrows or attached to body, *Acanthosquilla vicina* is known to live with *Balanoglossus.*

SUP. F. Gonodactyloidea Giesbrecht, 1910: Gonodactyloidea includes the majority of coral reef such as *Porietes* and sea grass and rocky shore stomatopods, most notably of the families Gonodactylidae, Protosquillidae and Odontodactylidae. Reef-dwelling stomatopods are especially sensitive to adverse conditions such as the introduction of petroleum, sewage, and agricultural runoff. Censuses of stomatopod populations on coral reefs are undertaken frequently in the world to estimate the health or contamination of the reefs. In Pakistan six genera in three families Protosquillidae Manning, Gonodactylidae Giesbrecht, Takuidae Manning in Gonodactyloidea occur (Kemp, 1913; Beg, 1954; Timizi, 1966; Tirmizi and Manning, 1968; Tirmizi and Kazmi, 1980) (Fig. 297) but no observation of them inhabiting corals is available. Cavities of mantis shrimps can be identified by a collection of shell fragments near the entrance of their home (Debelius, 2001).

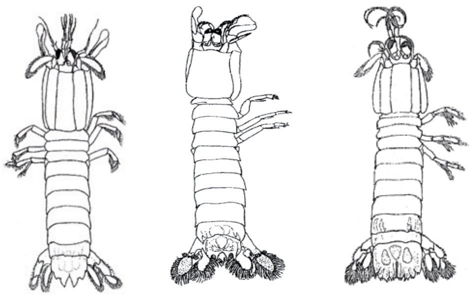


Fig. 297. Representatives of Pakistani Gonodactylidae, Takuidae and Protosquillidae respectively.

F. Takuidae Manning, 1995

G. *Mesacturoides* Manning, 1978

Mesacturoides fimbraitus (*Lenz, 1905*)

Alternate names, updated and Pakistani records

Mesacturoides raymondi Tirmizi and Kazmi, 1980

Pakistani Associate: not known.

Found elsewhere and of their hosts there and elsewhere: Indian ocean**. Hosts:** Lives in association with *Dardanus lagopodes* shells (Vannini *et al.,* 1993)*;* reported for the parasitic gastropod, *Caledoniella montrouzieri* Souverbie, lives at the base of dead *Pocillopora* and live *Acropora, Pocillopora, Stylophora,* and *Tubipora* (Cappola and Manning, 1993).

F. Squillidae Latreille, 1802.

Note: *Pseudopythina subsinuata* (Lischke) has been found by Morton (2009) in Hong Kong waters commensally associated with *Oratosquillina interrupta* and *O. perpensa,* in Pakistan one instance of symbiosis is reported.

G. *Clorida* Eydoux and Souleyet, 1842

Clorida sp. (Fig. 298)

Material: One specimen.

Alternate names, updated and Pakistani records.

Clorida–Tirmizi and Kazmi, 1984

Pakistani associate: unidentified bivalve attached to last thoracopod.

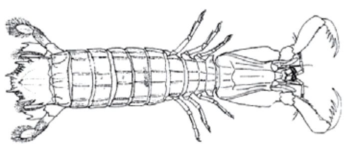


Fig. 298. *Clorida* sp.

Crustacean parasites from Galathoeids of IIOE Material

Introduction: Nearly all bopyrids occurring on galatheids and chirostylids are members of the subfamily Pseudioninae and live ectoparasitically in the branchial chambers of hosts where they modify the shape of the branchiostegite, giving the host a lopsided appearance; they are known to be infested by 11 genera (Boyko *et al*., 2012). Bourdon (1972) pointed out that galatheids constitute a group particularly exposed to bopyrid infestation and that approximately 60 species of galatheid are known to host bopyrid isopods.

Material: Although the Pakistani material forms the core of that studied for the present compendium but those collected from the Indian Ocean are also included here. The following bopyrid and rhizocephalan material originated from the host galatheids and chirostylids obtained by R/V Anton Bruun during IIOE Expedition (1963-64), loaned out from the Smithsonian Institution, Washington to the MRC, Karachi University. In the galatheid samples, infestation rate by the bopyrids was estimated 2.056%, in 11 specimens over 535 specimens. The low prevalence could not be related to any particular reason which caused it.The galatheids were described by Tirmizi and Javed (1993) but they observed bopyrids in only four specimens of three species (*Galathea lenis, G. australiensis, Munida andamanica*), others were overlooked by these authors. When the process of returning galatheids was half way the parasites were noticed by me, while coincidentally I was working on local bopyrids. The galatheids still in hand were rexamined the infested specimens belonged to Galatheidae Samouelle, Munididae Ahyong, Baba, Macpherson and Poore and Chirostylidae Ortmann. I have found specimens of bopyrids infesting individuals of the 7 host species. One has been already reported (Kazmi and Boyko, 2005). The host species were *Galathea balssi* (male, IIOE St.202C Cr.4B), *G. australiensis* (M5 IIOE), *G. lenis* (left chamber St. 401B, Cr.8), *Munida heterocantha* (=*M. oritea* right chamber St. 22

(b)-63), *M. arabica* (St. 447 Cr.-9), *M. andamanica* (3 males St. 397C cr. 8) and *Chirostylus micheleae.*Bopyrid parasites from these are recorded and two rhizocephalans, one on unidentified host. Parasites from *Galathea australiensis* from St M-5, Doty-S-I, a non IIOE project (1967) in Botic Island, Philippines and from *M. arabica* and *G. lenis* of IIOE are dislodged and missing. In those bopyrids that do not survive as long as the host, signs of the branchial enlargement remained. It is probable that any of the remaining parasites belongs to a new species; I do not know whether all are different as some are juveniles.

An interesting observation is the single *Munida andamanica* with a parasite in both sides (see Kazmi and Boyko, 2005 (Fig. 299).

Fig. 299. *Munida andamanica,* carrying double parasite
(after Kazmi and Boyko, 2005)

Actually, the absence of decapods with both sides infested may be explained by presuming that the parasite is harmful to its host by sucking blood and reducing gill function, and with both sides infested, the host would not survive long enough for the parasite to manifest its presence by a swelling of the carapace after the next ecdysis (Fig. 300). Sex reversal in galatheids has been reported in response to parasitic infestation (Wenner, 1982; Attrill, 1989).

Fig. 300. *Galathea australiensis* carrying parasite (after Tirmizi and Javed, 1993).

S. F. Pseudioninae Codreanu, 1967

G. *Pseudione* Kossmann, 1881

***Pseudione minimocrenulata* Nierstrasz and Brender a Brandis, 1913** (Fig. 301)

Alternate names and updated records.

Bopyrid species Tirmizi and Javed, 1993

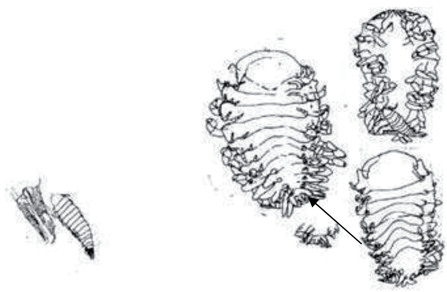
Pseudione minimocrenulata–Kazmi and Boyko, 2005

Material: 1 mature female TL 12.0 mm, 1 mature male TL 4.0 mm, left branchial cavity; 1 mature female TL11.5 mm, cryptoniscid larva, 1 mature male TL3.5 mm, right branchial cavity; 1 mature female TL 8.0 mm, 1 mature male TL3.5 mm, 1 mature female TL 9.5mm, 1 mature male TL4.0 mm from right and left, respectively, branchial cavities IIOE, R.V. Anton Bruun, cruise 8, st. 397C, off Mozambique, 600–665 m, 29 Sept. 1964; 1 juvenile female TL 2.1 mm, 1 male larva (illustrated) St. 447 Cr.9, CL without rostrum 8 mm. Data lost of second juvenile pair except that found from a rupture in the middle of host carapace.

IIOE host: *Munida andamanica*, CL without rostrum 8mm.

It is also infested by *Aporobopyrina javaensis* from Java, *Pseudione andamanica* from Madagascar, and *Aporobopyrus retrorsa* from the Philippines (Boyko, 2004). *Pseudione andamanica* infested *Munida* *incerta* from Madagascar (Bourdon, 1976) but not *Munida incerta* found in IIOE collection

Found elsewhere and of their hosts there and elsewhere: Madagascar, Indonesia, Kie island, West Indies. **Hosts;** *Munida flinti, M. incerta*.



male juvenile females

Fig. 301. *Pseudione minimocrenulata*.juvenile females and males

?*Pseudione crenulata **G. O. Sars, 1899** (Fig. 302)

Alternate names and updated records.

Pseudione crenulata Castriota *et al.*, 2010.

Material: 1 ov. Female dextral TL 5 mm, MW 3 mm, 1 male TL 1.25 mm; 1 ov. Female dextral TL 5 mm, MW 3.25 mm; 1 ov. Female dextral, TL 4mm, MW 3 mm; 1 ov. female, dextral, TL 1.5 mm illustrated CL 7 mm right chamber; 1 female TL 4 mm, 1 male left chamber.

IIOE hosts: *Munida arabica*, right chamber, female CL 5mm St 447, Cr.9; *Munida arabica* left chamber; *Galathaea balssi S*t 202 Cr4B.

Found elsewhere and of their hosts there and elsewhere: Norway; Mediterranean, Europe. **Hosts:** *Munida tenuimana. M. rugosa, M. intermedia.* This will be the first report of the parasite from the Indian Ocean.

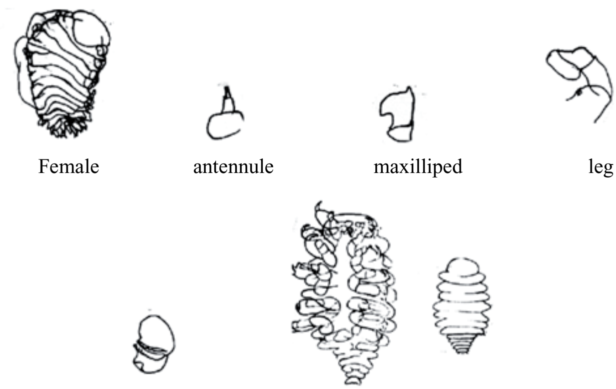


Fig. 302. *?Pseudione crenulata*.

***Aporobopyrus retrorsa* Richardson, 1910** (Fig. 303)

Alternate names and updated records.

Pseudione retrorsa Richardson, 1910; Nierstrasz and Brender à Brandis, 1923 (list); Shiino, 1958.

Pseudione lenticeps Shiino, 1958, 1972 (list).

Aporobopyrus lenticeps Adkison, 1988 (new combination).

Aporobopyrus retrorsa–Boyko, 2004 (new combination, synonymy); Kazmi and Boyko, 2005; Williams and Madad, 2010; Boyko and Williams, 2011; Boyko *et al.*, 2012 (list); An *et al.*, 2012.

Material: One female, one male.

IIOE hosts: *Munida arabica,* no further details.

Found elsewhere and of their hosts there and elsewhere: *Aporobopyrus retrorsa* parasitizes at least seven species of galatheids from Japan, the Philippines, and Taiwan (Boyko, 2012), An *et al.*, 2012), this is the first report from the Indian Ocean.

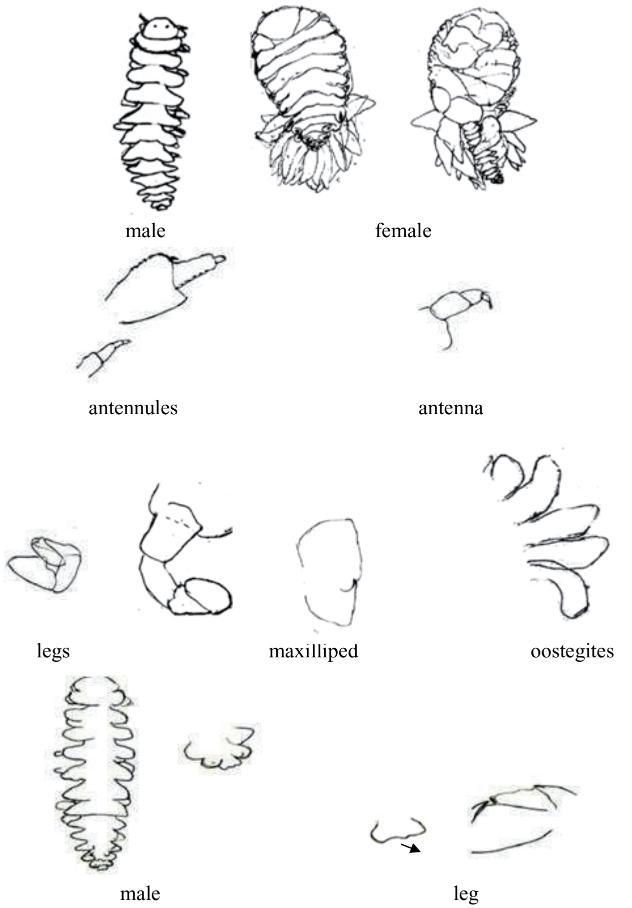


Fig. 303. *Aporobopyrus retrorsa*.

Undetermined juvenile pseudoine bopyrid near *Pleurocryptella* (Fig. 304)

Alternate names and updated records.

Bopyrid Timizi and Khan, 1979

IIOE host: Female *Chirostylus micheleae* CL+R 5mm Anton Bruun R/V St. No. 420A, Cruise 8 Off NE Coast, Somalia, Indian Ocean, depth m, 6 November 1964; *Chirostylus micheleae* c.l. + r. = 6 mm, St. No. 444, Cruise 9, 09°36'N 051°Ol'E-O51°03'E, depth 80 m, 16 December 1964.

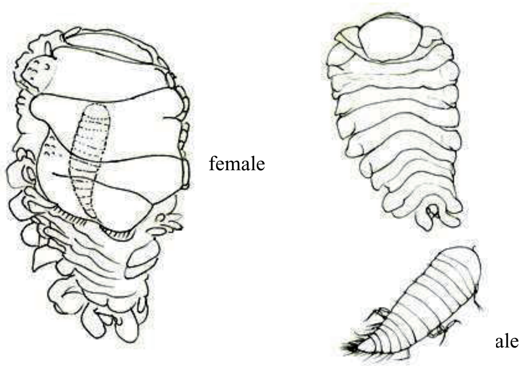


Fig. 304. Undetermined juvenile near *Pleurocryptella*.

Undetermined male (Fig. 305)

Material:one male**,**without data

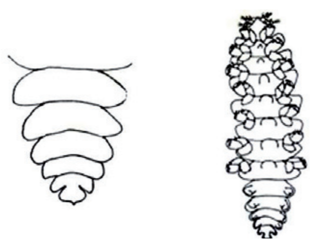


Fig. 305. Undetermined male.

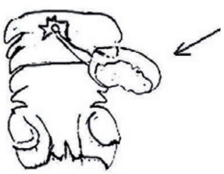
SUP.O. Rhizocephala Müller, 1862

F. Undetermined family

Material: One specimen attached to ventral side of first abdominal somite.

IIOE host: Unidentified galatheid, St. M3c.

Note: One specimen of IIOE galatheid was infested by an unidentified rhizocephalan, as the material is returned to the Smithsonian Institution so no further investigation could be made. There are probabilities that the rhizocephalan belongs to either Peltogastridae or Lernaeodiscidae which occur in the deep sea. The hosts involved in the two families belong to the anomurans including the Galatheidae. Tirmizi (1966) noted *Galacantha trachynotus* Anderson, taken by the John Murray Deep Sea Expedition in the northern Arabian Sea was infected with a large rhizocephalan emerging between abdominal somite 4 and 5.



retinaculum

Fig. 306. Undetermined rhizocephala on host abdomen indicated by an arrow

F. Peltogastridae Lilljeborg, 1859

G.? *Cyphosaccus* Reinhard, 1958 (Fig. 307)

Material: Two externae on second and third abdominal somite, St397 Cr8

Alternate names updated records.

Spermatophores Tirmizi and Javed, 1993

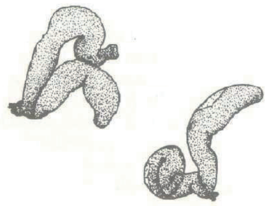


Fig. 307. ? *Cyphosaccus* (after Tirmizi and Javed, 1993).

IIOE host: *Munida andamanica*

Note: Tirmizi and Javeds' (1993) figure of spermatophoresmost probably are not spermatophores, since the spermatophores in anomuran crabs are said to consist of a stem and an ampulla composed of two halves joined along their lateral ridges and during copulation the spermatophores are randomly placed on the sternum of the female, near the genital opening, by the fifth pereiopods of the male. Figure given by Timizi and Javed (1993) as spermatophores does not mach this description. Here the body have the appearance of a 2-pronged fork; the posterior arm is almost as long as the anterior one is s lender at the point of origin, both arms gradually become broader towards the tip terminating in a nipple like protuberance as found in *Cyphosaccus*. One species *Cyphosaccus cornutus* Reinhard has been recorded from the Western Indian Ocean.

Epilogue:

The present review of associations between crustaceans and other organisms is admittedly incomplete. I guess of the existence of a number of other such associations. Many areas in the Indian Ocean and fresh water bodies around it have received no sustained taxonomic attention and remain very poorly known regarding the symbiotic crustaceans. Anyhow shallow depths i.e. intertidal to shelf of our region have received considerable attention but with several species remaining to be discovered. Out of nearly 425 crustaceans occurring here only 190 live as symbionts. Even rough estimates of the richness of most symbiotic groups in our ocean are premature for the following reasons: species numbers of host groups, in particular in the deep sea are not known; most host groups have been examined only insufficiently for symbionts or not at all; even in some of the best known groups, species richness is only poorly understood. Lack of symbiotic groups is likely a sampling artefact and it has been predicted that the Central Indian Ocean and East Asian Sea hold a wealth of undescribed species, reflecting our knowledge of host diversity patterns. Increasing knowledge of the biodiversity of symbiotic crustaceans will provide a baseline against which changes in marine biota can be detected.

The present collections of bopyrid no doubt represent only a portion of actual bopyrid fauna in the Arabian Sea. Several species of parasitic copepods are invasive and colonized various species of fish hosts in many parts of the world. Among them are species of *Lernaea* and *Lamproglena* of the Lernaeidae and *Caligus* of the Caligidae. Most of these exotic invaders are freshwater species and spread by anthropogenic translocation of fish stocks for aquaculture. They are expected here as already invasive *Caligus foiaceus* and *Lamproglena* have reached in Pakistan.

The present unidentified species may also be invasive ones although it is assumed that species are native, nevertheless there are extensive evidences in literature to the contrary (Carlton, 2009). This perception can lead to the underestimation of the scale of invasions by non-native species. There are few copepod taxonomists in Pakistan who mostly worked on Calanoide, the great gaps in our knowledge copepod diversity are in the orders Cyclopoida, Harpacticoida, Siphonostomatoida, and Poecilostomatoida, especially concerning copepods as symbionts and parasites, these can be filled only by sampling little-studied environments, namely phytal, freshwater, deep-water, damp-terrestrial groundwater, and offshore islands. Sampling of benthopelagic and deep-sea habitats will yield records of hitherto undiscovered families and orders. Because copepods are ecologically and economically so important, there is tremendous scope to understand their impact on the other organisms with which they live in association, some of which are directly exploited by humans.

It is hoped that this review provides a springboard for future studies on the multitude of questions regarding the natural history, ecology, and symbiotic relations of crustaceans and their associates. Thus far largely the domain of parasitologists and pathologists, the diseases of aquatic particularly the marine organisms must also become a focal point of ecological research.

Human related issues:

Parasitic crustaceans impact a variety of commercially important hosts, including fish, brachyuran crabs and shrimp or are prey for commercially important species. Although they do not pose a medical threat to humans, their presence in the hosts can negatively impact saleability of infected hosts such as fish, crab and shrimp. The parasites can shut down reproduction of hosts but most host populations do not appear to be strongly impacted, as the parasites are typically found in low prevalence. Parasitic isopods can also be found on shrimp sold in the aquarium trade and used as bait. Some parasitic species on mud shrimp have significant ecological and economic implications for humans because the host mud shrimp is an ecosystem engineer and has impacts on bivalve fisheries through its activities in influencing sedimentation. Parasitic isopods also have been used as biological indicators of disturbed habitats and may make hosts more susceptible to environmental toxins particularly the cymothoid infestation has a potential to be a useful marine ecosystem health indicator in a changing environment.

Biting cirolanid isopods are economically important as scavenging animals in warm waters which can sometimes swarm in vast numbers and are familiar as pests that attack damaged or dying fish, particularly at dusk or at night on fish trapped in fishing nets, and some are capable of stripping a fish to the bones in a matter of hours. At times they may become a problem to commercial fisheries. A single trap set overnight can yield as many as 30,000 individuals, which suggests that cirolanids must be of some ecological significance (Fig. 308).

Fig. 308. Cirolanid isopods (courtesy of Moazzam).

They occasionally attack divers working as jetty cleaners although generally this presents more a minor nuisance rather than a real danger? The isopods may eat away exposed skin. *Cirolana kokuru* was once involved in a police investigation of a tragic multiple murder–suicide. When the bodies were found, these isopods had chewed their way into the corpses.

The sphaeromatid isopods can cause loss of aquaculture/ commercial/ recreational harvest. They may be found in high densities up to 12, 521 per square meter heavily fouling mariculture cages (Molnar *et al*., 2008). They are threats to the wellbeing of mangroves. The continual loss of mangroves as a result of Sphaeromatids activity, erosion, and human interference, may well decrease the extent to which these vital channels can be used as nurseries by commercially important species. The limnorid isopods *Limnoria* causes destruction to marine timber structure such as jetties and piers (Fig. 309).

Fig. 309. Isopods *Limnoria* caused destruction to marine timber.

Wood is rather scarce in the sea except in harbours. But sea weeds of some kind are available practically everywhere in the littoral region. This practice of boring into sea-weeds obviously helped *Limnoria t*o enjoy a very wide distribution .Sea weed boring limnorids attack holdfasts and their activities can cause sea weeds to come adrift and enzyme produced by them my be a source of biofuel. They damage ship hulls, pilings and other wooden structures in contact with sea water. Damage is most pronounced near the low tide level and typically occurs at depths of 0–30 m sea water. The possibility of rapid population increase due to a high potential of dispersal, through rafting and shipping, ensure *L. lignorum* invasive success. *L. lignorum* attack occurs on the surface of the wood, which makes the wood highly porous and friable causing further deeper erosion. The deterioration is a matter of considerable economic importance in some parts of its range *L. lignorum* may be replaced by other species, such as *L. quadripunctata*. Its replacement may be related to significant warming of coastal waters either due to climate change or to local factors.

The Oniscid isopods (Woodlice) (Fig. 310) are terrestrial, they can also invade homes en masse in search of moisture and their presence can indicate dampness problems. However, they are not generally regarded as a serious household pest as they do not spread disease and do not damage sound wood or structures.

Fig. 310. *Periscyphis vittatus* (after Kazmi *et al.,* 2000).

REFERENCES

Abd El-Mohsen, H., Mohamed, M., Hassan, A. and Hussien, A.M. Osman, 2013. Protochondracanthus alatus infesting Gills of Some Marine Fish Species .Global Veterinaria 11 (4): 406-413.

ADB/NACA, 1991. Fish Health Management in Asia-Pacific.Report on a regional study and workshop on fish Diseases and Fish Health Management.ADB Agriculture Department Report Series No. 1. Network of Aquaculture Centres in Asia-Pacific. Bangkok, Thailand.

Adkison, DL, 1984. Probopyrinella heardi n. sp. (Isopoda: Bopyridae) a branchial parasite of the hippolytid shrimp Latreutes parvulus (Decapoda: Caridea). Proc.. Biol. Soc. Washington 97: 550-554, figs. 1-2.

Afzal, M, Akhtar, N, Qayyum, M, Khan, MN, Rab, A. and Naqvi, SMHM, 1995. Parasitic infestation in different fresh-water fishes of mini-dams of Potowar Region. Pakistan Journ. Biol. l Sci.. 6(13): 1092-1095.

Ahmed, J, 1976. On some amphipods of Karachi coast. Rec. Zool. survey of Pakistan. 8: 27-36.

Ahmed, M. and Mustaquim, J, 1974. Population structure of four species of porcellanid crabs (Decapoda: Anomura) occurring on the coast of Karachi. 26, 2: 173-182.

Ahmed, MF, Syed, SM, Karim, SI, Niazi, MS, Jawaid, T and Masihuzzaman, M, 1972. Arthropod (Marine Fauna Supplement). Rec. Zool. Surv. Pakistan 4(1/2): 51-60.

Ahmed, MS, Kausar, M, and Khan, WA, 2001. Prevalence of Lernaea cyprinacea (Crustacea: Copepoda) in freshwater major carps. Sci. Internat., Lahore 3(1): 83-86

Ahyong, ST, Lowry, JK, Alonso, Ml, Bamber, RN, Boxshall, GA, Castro, P, Gerken, S, Karaman, GS, Goy, JW, Jones, DS, Meland, K, Rogers, DC and Svavarsson, J, 2011. *Subphylum Crustacea* Brünnich, 1772. In Z.-Q. Zhang. "Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness"). Zootaxa, 3148: 165–191.

Ahyong, ST, and Ng, PKL, 2007. The pinnotherid type material of Semper (1880), Nauck (1880) and Bürger (1895)(Crustacea: Decapoda: Brachyura). Raffles Bull. Zool. supplement 16: 191–226.

Akhtar, N, M. Qayyum, MN. Khan, M. Afzal. A. Rab and SMHM. Naqvi. 2003. Seasonal distribution of *Lernaea cyprinacea* (Copepoda: Lernaeidae) in the populations of freshwater cultivable fishes from a mini-dam reservoir of Pakistan. Pakistan Journ. Biol.. Sci. 6 (1): 1-4.

Alaş, A, Öktener, A. and Solaki, K, 2010. A study on the morphology of Argulus foliaceus Lin., 1758 (Crustacea; Branchiura) procured from Çavuşcu Lake (Central natolia Turkey) with scanning electron microscopy. Turkish Jour. Biol.,34 : 147-151.

Al-Zubaidy, AB and Mhaisen, FT, 2013. The First Record of Three Cymothoid Isopods from Red Sea Fishes, Yemeni Coastal Waters. Intern. Jour. Mar. Sc., 3, No. 21.

Alcock, A, 1892 Appendix No. XII. A Report of the Surgeon Naturalist for the year ending 1st March 1892. *In*: *Administration Report of the Indian Marine for the Official Year 1891–92*. The Government Central Press.

Alcock, A, 1896. Materials for a carcinological fauna of India. No. 2. The Brachyura Oxystomata. Journ. Asiat. Soc. Bengal, 65, part 2(2): 134-296, pls 6-8, Bombay: 44–57.

Alcock, A, 1898. Materials for a carcinological fauna of India. No. 3. The Brachyura Cyclometopa. Part I. The family Xanthidae. Journ. Asiat. Soc. Bengal, 67 (part II, no. 1): 67–233.

Ali, QM, 1995. A new record of parasitic copepod Paralebion elongates Wilson, 1911. Pro. Paras.20: 91-93.

Amin, OM, 1981. On the Crustacean ectoparasites of fishes from southeast Wisconsin. Trans. American Micros. Soc. 100(2): 142-150.

An, J, 2009. A review of bopyrid isopods infesting crabs from China. Integ. Comp. Biol. 49(2): 95-105.

Anderson, G, 1990. Postinfection mortality of *Palaemonetes* spp. (Decapoda: Palaemonidae) following experimental exposure to the bopyrid isopod *Probopyrus pandalicola* (Packard) (Isopoda: Epicaridea). Jour. Crust. Biol. 10: 284–292.

Andersen, ML, Bohn, M, Høeg JT and Jensen, PG, 1990. Cyprid ultrastructure and adult morphology in *Ptychascus barnwelli* new species and *P. glaber* (Cirripedia Rhizocephala) parasites on semiterrestrial crabs. Jour. Crust. Biol., 10: 20-28.

Aneesh, PT, Sudha, K, Helna, AK, Arshad, K, Anilkumar Gand Trilles, JP, 2013. Simultaneous Multiple Parasitic Crustacean Infestation on Banded Needlefish, Strongylura leiura (Belonidae) from the Malabar Coast, India. Intern. Jour. Sci. Res. Pub., 3, Issue 7,

Angel, JE, 2000. Effects of shell fit on the biology of the hermit crab *Pagurus longicarpus* (Say). J. Exp. Mar. Biol. Ecol., 243: 169-184

Anker, A, 2010. On two snapping shrimps, Alpheus baccheti n. sp. and A. coetivensis Coutiere from the Tuamotu Islands, French Polynesia (Crustacea, Decapoda). Zootaxa, 2492: 49-62

Anker, A, Murina GV, Lira C, Vera Caripe JA, Palmer AR and Jeng MS, 2005. Macrofauna associated with echiuran burrows: a review with new observations of the innkeeper worm, Ochetostoma erythrogrammon Leuckart and Rüppel, in Venezuela. Zoo. Stud. 44: 157–190.

Annandale, N, 1909. An account of the Indian Cirripedia. (Pedunculata). Mem. Ind. Mus., 2. The Cirripedia of the Siboga Expedition, A. Pedunculata. Family Lepadidae (sensu stricto). Rec. Indian Mus., 2 (2), 61–137.

Appadoo, C and Steele, DH, 1998. Shallow-Water Marine Gammaridean Amphipods of Mauritius Island. Crustaceana 71,6: 633-645.

Appukuttan, KK, 1972. *Pseudopythina subsinuata* (Lischke) a commensal bivalve of *Squilla nepa* (Latrielle) and *Squilla raphidea* Fabricius. Jour. Mar. Biol. Assoc. India, 14 (1): 412-415.

Ayub, Z and Ahmed, M, 2004. Study of the host-parasite relationship of *Parapenaeopsis stylifera* (H. Milne Edwards) (Decapoda:Penaeidae) and Parapeneon japonica Theilmann) (Isopoda:Bopyridae). Hydrobiologia, 523: 225-228.

Bahrndorff, S and Løfstedt, M, 2004.Commensal amphipods in ascidians and sponges off Phuket Island, Phuket. Mar. Bio. Cen. Res. Bull. 65: 45–54.

Badillo, FJ, 2007. Epizoítos y parásitos de la tortuga boba (Caretta caretta) en el Mediterráneo Occidental. Phd Thesis. Universitat de València, Valencia, Espanha, 262.

Bacescu, M, 1981. Contribution to the knowledge of the Monokonophora (Crustacea, Tanaidacea) of the eastern Australia coral reefs. Rev. Roum. Biol. (Biologie animale), 26: 111-120.

Bach, CE and Hazlett BA, 2009. Shell shape affects movement patterns and microhabitat distribution in the hermit crabs *Calcinus elegans, C. laevimanus* and *C. latens*. Jour. Exp. Mar. Biol. Ecol. 382(1): 27-33.

Baer, JG, 1952. Ecology of animal parasites. University of Illinois Press, Urbana.

Baeza, JA, 2007. The origins of symbiosis as a lifestyle in marine crabs (genus Petrolisthes) from the eastern Pacific: Does interspecific competition play a role? Rev. Biol. Mar. Ocean., 42(1): 7-21.

Baeza, JA, 2008. Social monogamy in the shrimp *Pontonia margarita*, a symbiont of Pinctada mazatlanica, off the Pacific coast of Panama. Mar. Bio. 153: 387–39.

Baeza, JA and Thiel, M, 2007. The mating system of symbiotic crustaceans: a conceptual model based on optimality and ecological constraints. In: Duffy JE, Thiel M, editors. Evolutionary ecology of social and sexual systems. Crustaceans as model organisms. Oxford, England: Oxford University Press. pp. 249–267.

Baig, HS and Zehra, I, 2006. Seasonal variation in sessile and mobile epifauna associated with brown seaweed (*Sargassum* spp.) from two rocky shores of Pakistan. Pakistan Jour. Ocean. 2 (1): without pagination.

Bal, DV and Joshi, UN, 1959. Some new Isopod parasites on fishes. Journ. Bombay Nat. Hist. Soc. 56: 563-569.

Bamber, RN, 1990. A a new species of Zeuxo (Crustacea: Tanaidacea) from the French atlantic coast. Journ. Nat. Hist. 24: 1587–1596.

Bano, H and Kazmi, QB, 2004. *Laetmatophilus paradurbanensis*, new species (Crustacea: Amphipoda: Podoceridae) from Pakistan coast (northern Arabian Sea) Pakistan. Jr. Mar. Sc.13(1): 35-40.

Bano, H and Kazmi, QB, 2005. New record of *Phronima colletti* Bovallius, (1887) (Crustacea: Amphipoda: Phronimidae) from Pakistan territorial waters. Pak. J. Mar. Sci. 14: 65-67.

Barkati, S and Tirmizi, NM, 1990. The crustacean woodborer Sphaeroma terebrans Bate from Karachi mangroves Pakistani border of the northern Arabian Sea). Pakistan J. Sci. Mar. Res., 33: 335-338.

Barkati, S and Tirmizi, NM, 1991. The environmental impact of wood borers in mangrove swamps. Sym. Zool. Soc. London, No. 63: 251-263.

Barnard, KH, 1937. Amphipoda, John Murray Expedition, 1933-34. Sci. rep. British Mus. Nat. Hist. 4:131-201.

Barnard, JL, 1972. Gammaridean Amphipoda of Australia, Part I. Smiths. Contr. Zool. **103**:

Barnard, JL, and Karaman GS, 1991. The families and genera of marine Gammaridean Amphipoda (Except Marine Gammaroids) Part 1. Rec. Australian Mus. 13(1): 1- 417.

Barnes, DKA, 2003. Ecology of subtropical hermit crabs in SW Madagascar: short-range migrations. Marine Biology 3; 142: 549-557. 6. Beach, J. Crust. Biol., 21: 393-406.

Barnes, RD, 1982. *Invertebrate Zoology*. Philadelphia, PA: Holt-Saunders International. pp. 873–877.

Bauer, RT, 2004. Remarkable shrimps. Adaptations and natural history of the carideans. Animal Nat. Hist. Ser. 7: xvii + 282 pp.

Beg, MM, 1954. Species of stomatopoda of Karachi Coast. Proc. 6th Pakistan Sci. Conf. Karachi: 143-144.

Benvenuti, D and Messana, G, 2000. The sphaeromatid genus *Paracilicaea* Stebbing 1910 (Crustacea Isopoda) from the Western Indian Ocean with the description of five new species.Trop. Zoo. **13**: 181–217.

Benz, WG, Mohan, PJ and Crow, GL, 1992. Developmental Stages of Paralebion elongatus from Aquarium-Held Reef Whitetip Sharks (Triaenodon obesus) Captured in Hawaiian Waters. Jour. Para. 78, No. 6: 1027-1035.

Bernier, R, Klassen G and Locke, A, 2002. Occurrence of Cymbasoma rigidum Thompson, 1888 (Copepoda, Monstrilloida) in Estuaries of the Southern Gulf of St. Lawrence, Canada.Crustaceana. 75,. 5: 649-661.

Bhatti, MN and Minhas IK, 2000. *Machlion ki bimarian aur un ka ilaj* (in Urdu). Suffa Publishers, Lahore pp. 269.

Bierbaum, R and Ferson, S, 1986. Do symbiotic pea crabs decrease growth rate in mussels? Biol.l Bull. 170:51-61.

Bierbaum, R and Shumway, SE, 1988. Filtration and oxygen consumption in mussels, Mytilus edulis with and without pea crabs, Pinnotheres maculatus. Estuaries 11:264-271.

Bonnier, J, 1900. Contribution a l'étude des épicarides. Les Bopyridae. Trav. St. Zool. Wimereux 8: 1-475, pls.; 1-41.

Boschma, H, 1931. Die Rhizocephalen der Siboga-expedition.Supplement. Siboga-Expeditie, XXXI : 1 – 66.

Boschma, H, 1969. Notes on the Saccunidae from the Gulf of Iran. Proc K.ned. Akad. wet. 70C: 137-140.

Bourdon, R, 1968. Les Bopyridae des mers Européennes. Mém. Mus. Nat. Hist. Nat. Paris, Nouvel Série (A)50 (2): 77–4.

Bourdon, R and Bruce, AJ, 1983a. On Probynia, a new genus of bopyrid (Isopoda, Epicaridea) parasitic on pontoniine shrimps from the Great Barrier Reef, Australia. Crustaceana 44(3): 310–316.

Bourdon, R. and Bruce, AJ, 1983b. Six bopyrid shrimp parasites (Isopoda, Epicaridea) new to the Australian fauna. Crustaceana 45(1): 96–106.

Boxshall, G, 2001. Copepoda (excl. Harpacticoida), ***in***: Costello, M.J. *et al.* (Ed.) (2001). *European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification. Collection Patrimoines Naturels,* 50: 252-268.

Boxshall, GA and Defaye, D, 1993. Pathiogens of Wild and Farmed Fish: Sea Lice. Ellis Horwood Ltd., Chichester, West Sussex: 378 pp.

Boxshall, GA and El-Rashidy, HH, 2009. A review of the Caligus productus species group with a new species, new synonymies and supplementary descriptions. Zootaxa, 2271: 1-26.

Boxshall, GA and WT, Chad, 2014. In: Walter, T.C. and Boxshall, G. . World of Copepods database.

Boxshall, GA and Halsey, SH, 2004. An Introduction to Copepod Diversity. The Ray Society, London.

Boxshall, GA. and Huys, R, 2007. Copepoda of New Caledonia. *In*: Payri, C.E. and Richer de Forges, B. [Eds]. *Compendium of marine species of New Caledonia*. Doc. Sci. Tech. IRD, Nouméa. II7(2): 259-265.

Boxshall, GA and Montú, M, 1997. Copepods parasitic on Brazilian coastal fishes: a handbook. Nauplius, 5: 1-225.

Boyko, CB and Kazmi, QB, 2005. A new species of Argeiopsis Kensley, 1974 (Crustacea: Isopoda: Bopyridae: Argeiinae) from the northern Arabian Sea. Zootaxa 1002: 59-64.

Boyko, CB, Mossc, J, Williams JD and Shields, JD, 2013. Molecular phylogeny of Bopyroidea and Cryptoniscoidea (Crustacea: Isopoda**).** Syst. Bio., 11:4, 495-506.

Boyko, CB and Williams, JD, 2001. A review of Pseudionella Shiino, 1949 (Crustacea: Isopoda: Bopyridae), with the description of a new species parasitic on Calcinus hermit crabs from Easter Island. Pro. Bio. Soc. Washington.114:649--659

Bowman, TE and Abele, LG, 1982. Classification of the Recent Crustacea. In: Abele, L. G. (ed.), Systematics, the fossil record,and biogeography, vol. I of Bliss, D. E. (ed.), The Biology of Crusta.cea. New York, Academic Press. ; 1-27.

Bowman, TE and Inam, U Tareen, 1983. Cymothoidae from fishes of Kuwait (Arabian Gulf) (Crustacea, Isopoda). Smith. Contrib. Zoo. 382: 1–30.

Bresciani, J and Høeg, JT, 2001. Comparative ultrastructure of the root system in rhizocephalan barnacles (Crustacean: Cirripedia: Rhizocephala). Jour. Morph., 249: 9-42.

Brown, DW and Beckman, PA, 1992. Epizooic Foraminifera, tanaid, and polychaete species association on antarctic scallop shell. Antarctic Jour. U S 27: 134–135.

Bruce, AJ, 1976. Shrimps and prawns of coral reefs, with special reference to commensalism. Pp. 37-94. In O. A. Jones, and R. Endean, eds., Biology and geology of coral reefs, Volume III, Biology 2. New York: Academic Press

Bruce, LN, 1986. Revision of the Isopod crustacean genus Mothocya Costa, in Hope 1851 (Cymothoidae: Flabellifera), parasitic on marine fishes. Journ. Nat.l Hist. 20: 1089-1192

Bruce, NL, 1987a. Australian species of *Nerocila* Leach, 1818, and *Creniola* n. gen. (Isopoda: Cymothoidae), crustacean parasites of marine Fishes. Rec. Aus. Mus. 39: 355–412.

Bruce NL, 1987b. Australian *Pleopodias* Richardson, 1910 and *Anilocra* Leach, 1818 (Isopoda: Cymothoidae), crustacean parasites of marine fishes. Rec. Aus. Mus. 39: 85–130.

Bruce, NL, and Harrison-Nelson EB, 1988. New records of fish parasitic marine Isopod Crustaceans (Cymothoidae, subfamily Anilocrinae) from the Indo-West Pacific. Proc. Biol. Soc. Washington, 101, 585–602.

Brucen, L and Sidabalok, C, 2011. The genus *Lanocira* Hansen, 1890 (Corallanidae: Isopoda: Crustacea) in tropical Australian waters. Zootaxa 2793: 23–34.

Brusca, RC, 1981. A monograph on the Isopoda Cymothoidae (Crustacea) of the eastern Pacific. Zool. Journ. Linn. Soc., 73: 117-199. With 28 figures.

Bugoni, L, Krause, L, Almeida, AO and Bueno, AAP, 2001. Commensal barnacles of sea turtles in Brazil. Marine Turtle Newsletter 94: 7-9.

Bunkley-Williams, L and Williams, EH, 1998. Isopods associated with fishes: a synopsis and corrections. Jour. Para. 84: 893-896.

Caine, EA, 1986. Carapace epibionts of nesting loggerhead sea turtles: Atlantic coast of USA. J. Exp. Mar. Biol. Ecol. 95: 15-26.

Carlton, JT, 2009. Deep Invasion Ecology and the Assembly of Communities in Historical Time. Ecological Studies, 204 Biological Invasions in Marine Ecosystems Springer: 13-56.

Caruso, T, Falciai, L and Zupo,V, 2005. Do hermit crabs like living in sponges? Paguristes eremita and Suberites domuncula: biometric data from the southern Mediterranean Sea. J. Mar.. Biol. As. U K 85: 1353-1357.

Carrison-Stone, D, Syoc, RV, Williams, G, and Simison, WB, 2013. Two new species of the gorgonian inhabiting barnacle, *Conopea* (Crustacea, Cirripedia, Thoracica), from the Gulf of Guinea. Zookeys. (270): 1–20.

Cantor, M, SG, Leite Siqueira, Cruvinel GT, and Pedini Leite, FP, 2009. Occurrence of the amphipod Leucothoe spinicarpa (Abildgaard, 1789) (Amphipoda) in the ascidian Phallusia nigra (Urochordata, Ascidiacea) in Southeastern Brazil. Nauplius 17(1): 13‑17.

Castro, P, 1976. Brachyuran crabs symbiotic with scleractinian corals: a review of their biology. Proceedings of the International Symposium on Indo-Pacific Tropical Reef Biology, Micronesica, 12, 99–110.

Castro, P, Ng, PKL and Ahyong, ST, 2004. Phylogeny and systematic of the Trapeziidae Miers, 1886 (Crustacea: Brachyura), with the description of a new family. Zootaxa, Auckland, 643: 1-70.

Castriota, L, Falautano, M, Vivona, P and Andaloro, F, 2010. A new locality and host for Pseudione crenulata GO Sars, 1898 (Crustacea, Isopoda, Bopyridae) in the Mediterranean. Acta Para. 55(3): 291-295.

Chace, FA, 1951. The oceanic crabs of the genera *Planes* and *Pachygrapsus*. Proc. US Nat. Mus.101: 65–103.

Chace, JR, FA, 1997. The Caridean Shrimps (Crustacea: Decapoda) of the Albatross Philippine Expedition, 1907-1910, Part 7: Families Atyidae, Eugonatonotidae, Rhynchocinetidae, Bathypalaemonellidae, Processidae and Hippolytidae. Smith. Contrib. Zoo., 587: 89-90.

Chan, BKK, 2012. Epibiotic barnacles (Crustacea: Cirripedia: Thoracica) collected by the Kumejima 2009 Expedition, with descriptions of two new species. *Zootaxa* 3367: 21–48.

Chandra, KJ, 2006**.** Fish Parasitological Studies in Bangladesh: A Review. J. Agric. Ru. Dev. **4**(1&2), 9-18**.**

Chapman, JW, Dumbauld, BR, Itani G and John, C, 2011. An introduced Asian parasite threatens northeastern Pacific estuarine ecosystems. Bio. Invasions. Springer Science : 151-3.

Chavanich, S, Nimmanoradee, K, Voranopand, V, Somchai, B, 2007. Preliminary Surveys of the Commensal Amphipod, Leucothoe spinicarpa (Abildgaard, 1789), in the colonial tunicate, Herdman, 1891, in the Andaman Sea, Thailand. Publications of the Seto Marine Biological Laboratory. Special publ.ser, 8: 97-101.

Chia, DGB and Ng, PKL, 1998. A revision of Ceratocarcinus white, 1847, and Harrovia Adams and White, 1849 (Crustacea: Decapoda: Brachyura: Eumedonidae), two genera of crabs symbiotic with crinoids. Raffles Bull. Zool. 46(2): 493-563.

Chopra, B, 1923. Bopyrid isopods parasitic on Indian Decapoda Macrura.Rec. Indian Mus. 2511 textfigs. 1-32; plates XI-XXI.

Churchill, CKC, Emily, AE, Pique AE and Oakley, TH, 2014. Two new sympatric species of Eusarsiella (Ostracoda: Myodocopida:

Sarsiellidae) from the Florida Keys with a morphological phylogeny of Sarsiellinae. Zootaxa 3802 (4): 444–458.

Codreanu, R, 1961. Crustacei paraziţi cu afinităţi indo-pacifice în Marea Neagră. Hydrobiologia, Academia Republicii Populare Romîne 3: 133-146. Conover, MR, 1979. Effect of gastropod shell characteristics and hermit crabs on shell epifauna. Journ. Exp. Mar. Biol. Ecol. 40(1): 81-94.

Cooper, RT, 1997. Mangal-Associated Brachyura (Ocypodidae, Grapsidae, Portunidae, Majidae, Xanthidae and Leucosiidae) from the North-Eastern Coastal Islands of Abu Dhabi, United Arab Emirates.Crustaceana. 70, No. 2 : 155-179.

Crossley, SMG, George AL and Keller CJ**,** 2009. A method for eradicating amphipod parasites (Hyperiidae) from host jellyfish, Chrysaora fuscescens (Brandt, 1835), in a closed recirculating system. Jour. Zoo and Wildlife Med. 40, 174-180.

Crowe, SE and Thomas, JD, 2002. Abundance and Distribution of Commensal Amphipods from Common Marine Sponges of Southeast Florida**.** Modern Approaches to the Study of Crustacea: 105-110**.**

De Bary, A, 1879. Die Erscheinung der Symbiose. Verlag von Karl J. Trubner, Strassburg.

Davenport, J, 1994. A cleaning association between the oceanic crab Planes minutus and the loggerhead sea turtle Caretta caretta. Journ. Mar. Biol. Ass. UK, 74: 735-737.

Davie, PJF, and Ng, NK, 2007. Two new subfamilies of Varunidae (Crustacea: Brachyura), with description of two new genera. Raffles Bull. Zool**.** supplement (16): 257-272.

Debelius, H, 2001. *Crustacea Guide of the World: Atlantic Ocean, Indian Ocean, Pacific Ocean* IKAN-Unterwasserachiv, Frankfurt. 321 pp.

Delaney, PM, 1989. Phylogeny and biogeography of the marine isopod family Corallanidae (Crustacea, Isopoda,Flabellifera). Contrib. Sci. 409: 1–75.

Dellinger, T, Davenport JA and Wirtz P, 1997. Comparisons of social structure of Columbus crabs living on loggerhead sea turtles and inanimate flotsam. Journ. Mar. Biol. Ass. U K 77: 185-194.

Dias, C de Oliveira, 1996. Monstrilloida (Copepoda) off the Brazilian coast.Hydrobiologia 324,3: 253-256.

Diesel, R, 1986.Optimal mate searching strategy in the symbiotic spider crab Inachus phalangium (Decapoda). Ethology 72:311–328.

Dojiri, M, and Ho J-S, 2013. Systematics of the Caligidae, copepods parasitic on marine fishes. Crustaceana Monographs, 18, pp 1–448.

Dreanno, C, Kirby RR and Clare AS, 2007. Involvement of the barnacle settlement-inducing protein complex (SIPC) in species recognition at settlement. Jour. Exp. Mar. Biol. Eco. 351: 276-282.

d'Udekem d'Acoz, C, 1999. Redescription of Hippolyte ventricosa H. Milne Edwards, 1837 based on syntypes, with remarks on Hippolyte orientalis Heller, 1862 (Crustacea, Decapoda, Caridea). Zoosystema 21: 65-76.

Duffy, JE, 1990. Amphipods on seaweeds: partners or pests?. Oecologia, 83: 267-276.

Ďuriš, Z and Anker, A, 2014. *Athanas manticolus* sp. nov., a new stomatopod-associated alpheid shrimp from Vietnam (Crustacea, Decapoda) .Zootaxa 3784 (5): 550–558.

Edgar, GJ, 1983a. The ecology of south-eastern Tasmanian phytal animal communities. I. Spatial organisation on a local scale. Journ. Exp. Mar. Biol. Eco. **70**: 129-157.

Edgar, GJ, 1983b. The ecology of south-eastern Tasmanian phytal animal communities. IV. Factors affecting the distribution of amphithoid amphipods among algae .Journ. Exp. Mar. Biol. Eco. 70: 205-225

El-Rashidy HH and Boxshall GA, 2002. New species and new records of Ergasilus Nordmann (Copepoda: Ergasilidae) from the gills of grey mullet (Mugilidae). Syst. Paras., 54, 37-58.

Emmerson, WD, 1986. The ecology of Palaemon pacificus (Stimp-son) associated withZostera capensis. Trans. Royal Soc. South Africa, 46: 79–97.

Fatima, M, 2007. Shell utilization by the hermit crab,Diogenes planimanus (Anomura: Diogenidae) from Karachi Coast, Pakistan. Pakistan Jour. Zool. 39(4): 233-238.

Fautin, DG, Guo, CG and Hwang, JS, 1995. Costs and benefits of the symbiosis between *Periclimenes brevicarpalis* and its host *Entacmaea quadricolor*. Mar. Eco. Pro. Ser., 129, :77-84.

Feroze, A, Rafique M and Khan, N, 2008. First record of the isopod Alitropus typus, a fish parasite from Chashma barrage, Pakistan. (Abstract). 28th Pakistan congress of zoology FEWFM-38: 121-122.

Foster, BA, 1987. Barnacle ecology and adaptation. In: Southward AJ (ed) Crustacean issues 5, Barnacle biology. Balkema AA, Rotterdam.

Foster, JM, 2008. Review of the Genus Polycheria Haswell, a Symbiotic Group of Amphipods (Crustacea: Dexaminidae) with Descriptions of New Species from Florida, the Caribbean Sea, and the Indo-Pacific RegionPh.D. dissertation, The University of Southern Mississippi, 1-259 pp.

Frame, K, Gene, Æ Hunt and Roy, K Æ 2007. Intertidal meiofaunal biodiversity with respect to different algal habitats: a test using phytal ostracodes from Southern California.Hydrobiologia 586: 331–342.

Froese, R and Pauly, D (eds), 2000. *FishBase 2000: concepts, design and data sources.* ICLARM, Philippines.

Galil, BS, 1987. The adaptive functional structure of mucus-gathering setae in trapezid crabs symbiotic with corals. Symbiosis, 4: 75-86, figs 1-5.

Galil, BS, 1997. Crustacea Decapoda: A revision of the Indo-Pacific species of the genus *Calappa* Weber, 1795 (Calappidae). In: A. Crosnier (ed.), Résultats des Campagnes MUSORSTOM, Volume 19. Mém.Mus. nation.Hist. natur., Paris, 176: 271-335, figs 1-35.

Galil, BS and Vannini, M, 1990. Research on the coast of Somalia. Xanthidae, Trapeziidae, Carpiliidae, Menippidae (Crustacea Brachyura). Trop. Zool., 3: 21–56.

Gannon, AT and Wheatly, MG, 1992. Physiological effects of an ectocommensal gill barnacle, Octolasmis muelleri, on gas exchange in the blue crab Callinectes sapidus. Jour. Crust. Biol., 12: 11-18.

Garcia, RB and Mantelatto, FL, 2000 Variability of shell occupation by intertidal and infralitoral Calcinus tibicen (Anomura: Diogenidae) populations. Nauplius; 8(1): 99-105.

Garcia, RB and Mantelatto, FL, 2001 Shell selection by the tropical hermit crab Calcinus tibicen (Anomura, Diogenidae) from southern Brazil. Jour. Exp. Mar. Biol. Eco. 265: 1 - 14.

Gasca, R, Suárez-Morales E and Haddock, SHD, 2007. Symbiotic associations between crustaceans and gelatinous zooplankton in deep and surface waters off California. Mar. Biol. 151(1): 233-242.

Gascar, R and Steven HD, 2004. Haddock Associations between gelatinous zooplankton and hyperiid amphipods(Crustacea: Peracarida) in the Gulf of California. Hydrobiologia 530/531: 529–535.

Geiselman, J, 1983. The food web of the Sargassum community. Special Publication, Bermuda Biological Station, 22: 261-270.

Ghani, N, 1996. A note on two parasitic isopods from northern Arabian Sea. Proc. Para. 22: 71-72.

Ghani, N, 2003. Isopod parasites of marine fishes of Pakistan . Proc. Pakistan Cong. Zool. 23 : 217-221.

Ghani, N and Ali, QM, 1996. A parasitic copepod Lernaeenicus hemirhamphi Kirtisinghe, 1933 (Copepoda, Siphonostomatoida) on Polynemus sextilis from Arabian Sea. Sc. Khyber 90(1):69-72.

Ghani, N and Ali , QM, 2001. Sphaeroma walkeri Stebbing, 1905 in the coastal water of Karachi. Online Jour. Biol. Sci., 9, 871–872.

Ghani, N and Ali, QM, 2003. Crustacean parasites of Pampus argenteus Euphrasen from Karachi waters. Pakistan Jour. Biol. Sc. 6(6):626-628.

Ghani, N and Shireen, SB, 1995. Two new records of parasitic isopods from Karachi coast. Proc. Para. 20: 19-30.

Ghani, N and Tirmizi, NM, 1993. Occurrence of Bopyrella saronae Bourdon and Bruce, 1979 (Isopoda, Epicaridea) in Karachi waters, northern Arabian Sea. Crustaceana 65(1): 117.

Glenner, H, 2001. Cypris metamorphosis, injection and earliest internal development of the Rhizocephalan *Loxothylacus panopaei* (Gissler). Crustacea: Cirripedia: Rhizocephala: Sacculinidae. Jour. Morph. 249, 1: 43–75.

Glenner, H, Høeg, T, O'Brien, JJ and Sherman, TD, 2000. Invasive vermigon stage in the parasitic barnacles Loxothylacus texanus and L. panopaei (Sacculinidae): closing of the rhizocephalan life-cycle. Mar. Biol. 136: 249-257.

Goh, BPL, Chou, LM and Ng, PKL, 1990. Anomuran and brachyuran crab symbionts of Singapore hard corals of the families Acroporidae, Agariciidae and Pocilloporidae. Indo-Malayan Zool., 6, 25–44.

Gohar, HAF and Al-Kholy, AA, 1957. The larvae of some brachyuran Crustacea. Publ. Mar. Biol. Stat. Ghardaqa 9; 145-176.

Gopalakrishnan, A, Rajkumar, M, Sun Jun and Trilles JP, 2010. Occurrence of double parasitism on black-barred halfbeak fish from the southeast coast of India. Chinese Journ. Ocean. Limn.28 (4): 832-835.

Gotto, V, 1993. Commensal and parasitic copepods associated with marine invertebrates (and whales*). Synopses of the British Fauna* (New Series) No. 46. Published for the Linnaean Society and the Estuarine and Coastal Sciences Association by Universal Book Services/ Dr. W. Backhuys, 264 p.

Goy, JW and Martin, JW, 2013. Redescription of Microprosthema semilaeve (von Martens, 1872) (Decapoda: Stenopodidea: Spongicolidae) and description of a new species of Microprosthema from Dry Tortugas, Florida. Zootaxa 3630,3: 467-488.

Grave, S. De, Pentcheff, ND, Ahyong, ST, Tin-Yam Chan, Crandall, KA, Dworschak, PC, Felder, DL, Feldmann, RM, Fransen, CHJM, Goulding, LYD, Lemaitre, R, Low, MEY, Martin, JW, Ng, PKL , Schweitzer, CE, Tan, SH, Tshudy, D, and Wetzer, R, 2009. A classification of living and fossil genera of decapod crustaceans. Raffles Bull. Zoo. Supplement No. 21: 1–109.

Griffiths, CL, 1976. Some new and notable Amphipoda from southern Africa**.** Ann. S. Afr. Mus., 61: 11–35.

Grygier, MJ, 1995. Annotated chronological bibliography of Monstrilloida (Crustacea: Copepoda).Galaxea; 12: 1–82.

Guerra-García, JM, 2002. Littoral caprellids (Crustacea: Amphipoda: Caprellidea) from Philippines, with the description of a new species. Raffles Bul. Zool. 50: 395–406.

Guerra-García, JM, 2004. Littoral Caprellidea (Crustacea: Amphipoda) from Phuket, Thailand. Steenstrupia 28: 159–175.

Guerra-García, JM, 2006. Caprellids from the caribbean coast of Colombia, with description of three new species and key for species identification. Bol. Invest. Mar. Cost. 35:149–194.

Hadfield, K.A, Bruce, NL and Smit, NJ, 2013. Review of the fish-parasitic genus Cymothoa Fabricius, 1793 (Isopoda, Cymothoidae, Crustacea) from the southwestern Indian Ocean, including a new species from South Africa**.** Zootaxa, 3640(2): 152–176.

Hameed, SS, Ahmed, M and Shameel, M, 2001. Community structure and species composition of macro-organisms at the rocky beach of Pacha near Karachi Pakistan. Pak. Jour. Mar. Biol. 7(1&2): 135-146.

Harris, VA, 2014. Porcellidiidae of Australia (Harpacticoida, Copepoda). I.A reassessment of the European species of Porcellidium. Rec. Aust. Mus. 66(2): 63–110.

Hashmi, SS, 1963. Carcinological fauna of Karachi. Agri. Pakistan. 14.2: 237-243.

Hashmi, SS and Zaidi, SSH, 1965. Incidence of Lepas infestation on the gills of Scylla serrata (ForskalI) in Karachi waters. Agric. Pakistan, 16 (I): 117-129.

Hayes, FE, 2007. Decapod crustaceans associating with the sea urchin *Diadema antillarum* in the Virgin Islands. Nauplius, 15(2): 81-85.

Hayes, P, Justine, JL and Boxshall, GA, 2012. The genus Caligus Müller, 1785 (Copepoda: Siphonostomatoida): two new species from reef associated fishes in New Caledonia, and some nomenclatural probelms resolved. Zootaxa, 3534: 21-39.

Hardy, A, 1936. Observation on the uneven distribution of oceanic plankton. 'Discovery' Rep.11: 51.

Harrison, A, Gault, N and Dick J, 2006. Seasonal and vertical patterns of egg-laying by the freshwater fish louse *Argulus foliaceus* (Crustacea: Branchiura). Dis. Aq. Org. 68: 167-173.

Hassan, AS, 1963. Studies on the biology of *Balanus Amphitrite* Darwin, and a note on the hindrance they cause in the culture of edible oysters of West Pakistan coast. Agric. Pakistan 24: 297-306.

Hassack, E and Holdich, DM, 1987. The tubicolous habit amongst the Tanaidacea (Crustacea,Peracarida) with particular reference to deep-sea species. Zool. Scripta, 16,: 223-23.

Henderson, JR, 1893. A contribution to Indian Carcinology. Trans. Linn. Soc. London, (series 2, Zoology) 5(1): 325-458, pls 36-40.

Hendrickx ME, and Fiers, F, 2010. Copépodos Harpacticoida asociados con crustáceos decápodos.Cienc. Mar. 14:3–30.

Hicks, GRF, 1985. Meiofauna associated with rocky shore algae. *In: Moore, P.G. and R. Seed (eds.). The Ecology of Rocky Coasts. Hodder and Stoughton, London, etc. 467pp.*

Hicks, GRF, 1988. Evolutionary implications of swimming behaviour in meiobenthic copepods.*In: Boxshall, G.A. and H.K. Schminke (eds.). Biology of Copepods. Proceedings of the Third International Conference on Copepoda. Dev. Hydrobiol., Kluwer Academic Publishers. Dordrecht, Boston, London.* 47 (= Hydrobiologia, 167-168):497-504, figs. 1-2, tabs. 1-3.

Hicks, GRF and Coull, BC, 1983. The ecology of marine meiobenthic harpacticoid copepods.Ann. Rev. Ocean. Mar. Biol. 21: 67-175, figs. 1-13, tabs. 1-13.

Hiller, A, Harkantra S and Werding, B, 2010. Porcellanid crabs from Goa, eastern Arabian sea (Crustacea: Decapoda: Porcellanidae). Jour. Bombay Nat. Hist. Soc., 107(3): 201-212.

Ho, JS, 2000a. Four species of unrecorded caligid copepods (Siphonostomatoida) parasitic on marine fishes of Taiwan Jour. Fish. Soc. Taiwan. 27, 3: 201-22.

Ho, JS, 2000b. The major problem of cage aquaculture in Asia relating to sea lice, pp.13-19. In I. Liao and C. Lin (eds.). Cage Aquaculture in

Asia, Proceeding of the First International Symposium on Cage Aquaculture in Asia. Asian Fisheries Society, Manila and World Aquaculture Society.

Ho, JS, Batool, A, and Kim, I-Hoi, 2009. Redescription of *Catlaphilla elongate* Tripathi, 1960 (Copepoda, Lernaeidae) Parasitic on *Catla Catla* (Hamilton, 1822) (Teleostei, Cyprinidae) in Pakistan. Crustaceana, 82 1: 467-473.

Ho, JS, Jayarajan, P and Radhakrishnan, S, 1992. Copepods of the family Ergasilidae (Poecilostomatoida) parasitic on coastal fishes of Kerala, India. J. Nat. Hist. 26(6):1227-1241.

Ho JS and Kim I-H, 2000. Copepods of the genus *Hermilius* (Caligidae) parasitic on marine catfish of Kuwait, with a key to the species of *Hermilius*. Pakistan Jour. Mar. *Sc.*, 9, 79–90.

Ho, JS, Kim, I-H and Kumar, AB, 2000. Chondracanthid copepods parasitic on flatfishes of Kerala**,** India. Jour. Nat. Hist. 34(5): 709-735.

Ho, JS and Lin, CL, 2007. Three species of Caligus Muller, 1785 (Copepoda: Caligidae) parasitic on Caranx spp. (Teleostei: Carangidae) off Taiwan. Syst. Para. 68(1): 33-43.

Høeg, JT and Lützen, J, 1995. Life cycle and reproduction in the Cirripedia Rhizocephala. Ocean. Mar. Biol. Ann.l Rev. **33**: 427-485.

Høeg, JT and Lützen, J, 1996. Super-order des Rhizocéphales (Rhizocephala F. Müller, 1862). pp. 541-568 *in* Forest, J. (ed.). *Traité de Zoologie. Anatomie, Systématique, Biologie. Publié sous la direction de Pierre-P. Grassé. Tome VII. Crustacés. Fascicule 2. Généralités (suite) et systématique (Céphalocarides à Syncarides)*. Paris : Masson éditeur 1002 pp.

Howard, AD, 1952. Molluscan shells occupied by tanaids. Nautilus, 65: 74-75.

Humes, AG, 1985. Cnidarians and copepods: a success story. Trans. American Microsc. Soc. 104(4): 313-320, tabs. 1-3.

Humes, AG**,** 1994. How many copepods? Hydrobiologia, 292-293 Issue 1**:** 1-7.

Hussain, SM, 2001. Brief report on biodiversity in the coastal areas of Pakistan. Draft publication for Regional Technical Assistance (RETA) of ADB in collaboration with IUCN. 113 pp.

Huys, R, 2001. Copepoda - Harpacticoida, *in*: Costello, M.J. *et al.* (Ed.) (2001). *European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification. Collection Patrimoines Naturels,* 50: pp. 268-280.

Iqbal, Z, Khan, MN, Sharif Z and Pervaiz, K, 2006. A further look into fish diseases problem and their solution in fish pond in Punjab. Int. Conf. Solving Problems of Freshwater Fish Farming in Pakistan. Nov. 27-28 2006, UVAS, Lahore : 41-48.

Iqbal, Z, Minhas, IK, and Khan N, 2000. Disease Prevalence In culturable fish species in Punjab. Pakistan Jour. Fish. 1(2): 103-112.

Iqbal, Z, Minhas, IK and Khan N, 2001. Seasonal occurrence of lernaeasis in pond aquaculture in Punjab. Proc. Pakistan Cong. Zool. 21: 159-168.

Iqbal, Z, Mumtaz, R and Sajjad, R, 2013. Argulosis, in some ornamental fishes imported to Lahore**,** Pakistan. Europ. Jour. Vet. Med., 2, 3: 171-178.

Iqbal, Z, Shafqat A and Haroon, F, 2012. Lernaea diversity and infection in Indian and Chinese carps under semi-intensive culture conditions in Lahore, Punjab. Jour. Anim. Plant Sc., 22(4): 923-926.

Itani, G, Davie PJF and Takeda, M, 2002**.** Taxonomic notes on *Acmaeopleura balssi* Shen, 1932 and *A. toriumii* Takeda, 1974 (Crustacea, Brachyura, Grapsidae) from Japanese waters. Bull. Nat. Sc. Mus. Ser. A, Zoology 28(1): 43-50.

Ivanenko, VN, Ferrari, FD and Dahms HU, 2008. Nauplii of *Tegastes falcatus* (Norman, 1869) (Harpacticoida, Tegastidae), a copepod with an unusual naupliar mouth and mandible. Jour. Crust. Biol.28(2): 270–280.

Jafri, SIH, 1993. The status of diseases and parasites in freshwater fish of Pakistan. Abstact, 13th Pakistan Congress of zoology: 108.

Jafri, SIH, 1995. A new copepod parasite, Ergasilus pakistanicus, New species (Poecilostomatoida: Ergasilidae) from a freshwater fish in Sindh, Pakistan. Pak. J. Zool. 27(2): 153–156.

Jafri, SIH and Ahmed, SS, 1991. A new record of ectoparasitic Crustacean (Branchiura: Argulidae) from major carps in Sindh, Pakistan .Pakistan Journ. Zool. 23 (1): 11-13.

Jafri, SIH and Ahmed, SS, 1994. Some observations on mortality in major carps due to fish lice and their chemical control. Pakistan Jour. Zool. 26 (3): 274-276.

Jafri, SIH and Mahar, MA, 2003. Parasitic copepod, Lernaea multilobosa sp. nov. (family: Lernaeidae) from a cyprinid fish of Manchar lake (Sindh) Pakistan. Pakistan. Journ. Zool. 35(1): 29 – 33.

Jafri, SIH and Mahar, MA, 2009. New record of two copepod parasites from fresh water fishes of Sindh, Pakistan Sindh Univ. Res. Jour. (sci. Ser.). 41 (1): 37-40.

Javed, M and Mustaquim, J, 1994. New records of an acorn barnacle, Chelonibia patula (Cirripedia: Thoracica) from Pakistan. Crustaceana 66: 124-126.

Javed, W and Yasmeen, R, 1999. A new parasitic isopod of the genus Norileca (Crustacea, Cymothoidae) from the Arabian Sea. Pakistan Jour. Ma. Sc. 8(1): 55-60.

Jeffries, WB and Voris, HK, 2005. Crustacean hosts of the pedunculate barnacle genus Octolasmis in the northern Gulf of Mexico. Gulf of Mexico Sc., 2004: 173-188.

Jeffries, WB, Voris, HK, and Yang, CM, 1982. Diversity and distribution of the pedunculate barnacle Octolasmis in the seas adjacent to Singapore. Journ. Crust. Biol., 2: 562-569.

Jeyabaskaran, R, Ajmalkhan, S and Ramaiyan, V, 2000. *Brachyuran crabs of Gulf of Mannar.* Annamalai University, Parangipettai; Tamil Nadu.

Johnson, DS, 1958. The Indo-West Pacific species of the genus Polyonyx (Crustacea, Decapoda, Porcellanidae). Ann. Zool., Agra, 2 (8): 95-118.

Jones, CM, Miller TL, Grutter AS, Cribb TH,2008. Pelagic stage cymothoid isopods: description, molecular identification, and evolution of attachment. Int. Journ. Paras. 38: 477 –491.

Jones, D and Özdikmen, H, 2008. *Fischeriella* nom. nov., a replacement name for the genus *Temnaspis* Fischer, 1884 (Crustacea: Cirripedia) non Lacordaire, 1845, Munis Entom. Zool., **3**(1), 539-540.

Jones, S and Sankarankutty, C, 1960. Notes on animal associations. 3. A parthenopid crab, Harrovia albolineata Adams and White on a mariametrid crinoid, Lamprometra sp. Journ. Mar. Bioi. Ass.,India, 2(2): 194-195, PI. 1.

Kabata, Z, 1970. Diseases of Fishes, Book I: Crustacea as Enemies of Fishes. TFH Neptune City, NJ. 171 p.

Kabata, Z, 1985. Parasites and Diseases of Fish Cultured in the Tropics. Taylor and Francis, London. 317 p.

Kanwal, N Siraj, Z, Tasawar, Z, Mushtaq F and Lashari, MH, 2012. The Lernaeid Parasites of *Catla catla*. Acta Paras. Glob. 3 (2): 16-19.

Karim, SI, 1973. An addition to the crab fauna of Pakistan. Rec. Zool. Sur. Pakistan, 5(1 & 2): 33-40, pls 1-2.

Karim, SI, 1975. Isopod parasites of fishes of Karachi coast. Rec. Zool. Surv. Pakistan, 5(1and2): 62-72.

Karim, SI and Rehman, H, 1974. One some carides of Karachi coast. Rec. Zool. Surv. Pakistan VI (1&2): 25-28.

Karplus, I, Szlep, R and Tsurnamal, M, 1981. Goby-Shrimp partner specificity I. Distribution in the northern Red-Sea and partner specificity. J. Exp. Mar. Biol. Ecol. 51: 1-19.

Kayış, S and Ceylan, Y, 2011. First report of Nerocila orbigyni (Crustacea, Isopoda, Cymothoidae) on Solea solea (Teleostei, Soleidae) from Turkish Sea .Turkish Jour. Fish. Aquat. Sc. 11: 167-169.

Kazmi MA and Kazmi, QB, 1979. A check list of Marine Caridean Prawns of Pakistan. Biologia. Pakistan 25(1&2):151-157.

Kazmi, MA and Quershi, WM, 1974. Occurrence of Periclimenes (Harpilius) elegans (Paulson, 1875) from northern Arabian Sea. Agri. Pakistan XXV (3): 197-244.

Kazmi, QB, 1994. MRC NEWS LETTER, 3, no 4: 3.

Kazmi, QB, 1995a. Aegism. MRC NEWS LETTER, 4, no 3: 4.

Kazmi, QB, 1995b. New additions in MRC. MRC NEWS LETTER, 4, no 3: 1.

Kazmi, QB, 1996. Note on parasitized hippolytid caridean Saron marmoratus (Crustacea: Decapoda). MRC NEWS LETTER, 5, no 4: 4.

Kazmi, QB, 2001. Report of *Conopea calceola* (Ellis, 1758) (Cirripedia, Balanomorpha, Archeobalanidae) from Karachi Waters.Pak. Journ. Mar. Sci. 10(1): 73-77.

Kazmi, QB, 2003a. A note on A. japonicus (Crustacea, Argulidae) parasitizing gold fish (Carassius). Journ. Nat. Hist. Wildl. 2 (2): 49-50.

Kazmi, QB, 2003b. *Taxonomic studies of Crustacea in Pakistan*. Pp 230-248 in J. Shimura (ed.). Global taxonomy initiative in Asia.

Kazmi, QB, 2004a. Invertebrates of Indus Delta Eco-region. Proceedings of consultative workshop on Indus Delta Eco-region (IDER), Pakistan: 87-101.

Kazmi, QB, 2004b. Copepods from shore and offshore waters of Pakistan. Jour. Mar. Sci. and Tech. Taiwan 12 (4): 223-238.

Kazmi, QB and Bourdon, R, 1997. A new Bopyrid isopod *Progebiophilus assisi* on the mud shrimp *Upogebia* (*U.*) *assisi* Barnard (Thalassinoidea) from Pakistan. Pakistan Jour. Mar. Sc. **6**(1and2): 59–67.

Kazmi, QB and Boykyo, C, 2005. A new locality and host for *Pseudione minimocrenulata* Nierstrasz and Brender à Brandis, 1931 (Crustacea: Isopoda: Bopyridae) in the Indian Ocean, with comments on the identity of the type specimens. Zootaxa New Zealand 925: 1-10.

Kazmi, QB and Kazmi, MA, 2012. Biodiversity and biogeography of caridean shrimps of pakistan, HEC Pakistan, 400 pages.

Kazmi, QB and Manning, RB, 2003. A new genus and species of pinnotherid crab from Karachi, northern Arabian Sea (Crustacea, Decapoda, Brachyura). Jour. Natur. Hist. , 37: 1085-1089.

Kazmi, QB and Markham, JC, 1999. *Allathelges pakistanensis*, new genus, new species, a bopyrid isopod from Karachi, Pakistan, with a review of the athelginae recorded from the Indian Ocean. Jour. Crust. Biol. 19(4): 879-885.

Kazmi,QB and Moazzam, M, 2012. Four New Records of Brachyurans from Pakistan. Pakistan Journ. Zool., vol. 44(6): 1499-1505,

Kazmi, QB and Naushaba, R, 2000. First record of a spindle cowry *Crenovolva* (Ovulidae, Gastropoda) from Bulleji, Karachi, on the gorgonian coral *Muricella* sp. and with a note on their association. Pakistan Jour. Mar. Sci. 9(1and 2): 107-111.

Kazmi, QB and Perveen, S, 2005. Range extension of the land crab *Cardisoma carnifex* (Herbst, 1796) to further north on the Pakistan coast (Arabian Sea). Rec. Zool. Surv. Pakistan. XVI: 81-85.

Kazmi, QB, Schotte, M and Yousuf, F, 2002. An illustrated key to the Malacostraca (Crustacea) of the northern Arabian Sea. Part – V: Isopoda. Pakistan Jour. Mar. Sc. 11(1and2): 47–116.

Kazmi, QB and Siddiqui, FA, 2001. Pagurapseudes setulosa, a new species of Apseudomorpha (Crustacea,Tanaidacea) from Pakistan OnLine Jour. Biol. Sc. 1 (3): 166-168.

Kazmi,QB and Tirmizi, NM, 1995. A new species of *Cyphocarcinus* and new record for *Macropodia formosa* Rathbun (Crustacea, Decapoda, Majidae) from Pakistan. Pakistan. Jour. Mar. Sci. 4(1): 59-65.

Kazmi, QB and Tirmzi, NM, 1996. Marine Invertebrates: Associations and Partnership (ED B. Morton). MRC NEWSLETTER, 5 no. 2: 2-3.

Kazmi, QB and Yousuf, F, 2003. A new species of *Joeropsis* (Isopoda, Asellota, Joeropsidae) from a Sabellid reef in Pakistani waters (northern Arabian Sea). Bull. Mar. Sc. Fish. Kochi University Japan 22: 81-87.

Kazmi, QB and Yousuf, F, 2007. First report of larval form of Paragnathia cf. formica (Hesse, 1864) (Crustcea: Isopoda: Gnathidae) from Pakistani waters (Makri Creek). (Abstract) 27th Zoological Congress of Pakistan.

Kazmi, QB and Yousuf, F, 2013. Checklist of Peracarida, Crustacea of Pakistan. A- Marine and Terrestrial Isopoda. B- Marine Tanaidacea. FAUUST Jour. Biol. 3 (2): 129-139.

Kearn, GC, 2004. Leeches, lice and lampreys: a natural history of skin and gill parasites of fishes. Netherlands: Springer.

Khan, MA, 1976. *Cymbasoma williamsoni* sp. nov. (Copepoda - Monstrilloida - Monstrillidae) from Manora channel (Northern Arabian Sea). Jour. Sci. 4(1and2): 47-51.

Khan, MA, 1977. New records of Conchyliurus maximus Reddiah (Cyclopoidea-clausidiidae) from Sanguinolaria (Soletellina) diphos (Gmelon) from Karachi coast, Pakistan. Biologia. l. 23(1): 95-97.

Khan, MA and Ahmad, MF, 1975. A checklist of Brachyura of Karachi coasts, Pakistan. Rec. Zool. Surv.Pakistan 7 (1-2): 71-85.

Khan, MA and Kamran, WM, 1975. Cymbasoma tirmiziae sp. nov. (Copepoda) from Manora Channel (Northern Arabian Sea). Jour. Sc. Univ. Karachi. 3(1and2): 55-59.

Khan, MA, Kamran, WM and Khan, MF, 1988. Occurrence of Cymbasoma rigidum Thompson (Copepoda, Monstrilloida, Monstrillidae) from Manora Channel (Northern Arabian Sea). Agri. Pakistan 26(1): 113-116.

Khan, MN, Aziz, F, Afzal, M, Rab, A, Sahar, L, Ali R and, Naqvi, SMHM, 2003. Parasitic infestation in different Fresh Water Fishes of Mini Dams of Region Potohar, Pakistan.Pakistan Journ. Boil. Sc. 6(13): 1092-1095.

Kitsos, MS, Christodoulou, M, Arvanitidis, MM, Kirmitzoglou I and Koukouras, A, 2005. Composition of the organismic assemblage associated with *Caretta caretta*. Jour. Mar. Biol. Ass. (UK) 85: 257-261.

Klicpera, A, Taylor, PD and Westphal, H, 2013. Bryoliths constructed by bryozoans in symbiotic associations with hermit crabs in a tropical heterozoan carbonate system, Golfe d’Arguin, Mauritania. Mar. Bio. 43: 429–444.

Knowlton, N, 1980. Natural selection and dimorphism in two demes of a symbiotic, pair bonding snapping shrimp. Evolution 34: 161-173.

Krapp-Schickel, G and Ruffo S, 1990. Marine amphipods of the Canary Islands with description of a new species of Elasmopus. Misc. Zool.. 14: 53-58.

Krishnaswamy, S, 1957. Studies on the Copepoda of Madras. *Thesis, University of Madras.*

Kruger, P. 1912. Uber ostrasiatische Rhizocephalen. Anhang: Uber eninige intersante Vertreter der Cirripedia thoracica. Abhandl. Mat.-phys. Kl. K. Bayerische Akad. Wiss. II. Suppl.-Bd. 8: 1-16.

Kuang, P, 1962. Studies on the life history of Lamproglena chinensis Yu. Act. Hydrobiol. Sin. 1: 114-123, 2 pic.

Kumaravel, K, Ravichandran, S and Rameshkumar, G, 2009. Distribution of Barnacle *Octolasmis* on the Gill Region of Some Edible Crabs. Acad. Jour. Entom. 2 (1): 36-39.

Kupferberg SJ, Catenazzi A, Lunde K, Lind AJ and Palen WJ, 2009. Parasitic copepod (Lernaea cyprinacea) outbreaks in foothill yellow-legged frogs (Rana boylii) linked to unusually warm summers and amphibian malformations in Northern California. Copeia :529–537.

Kuriyan, GK, 1952**.** A note on the parasitic Isopod Cymothoa eremita Bruennich. Journ. Bombay Natur. Hist. Soc. Mic. 51(1): 291-293.

Lang, K, 1948. Monographie der Harpacticiden. 1,2. Sweden: Håkan Ohlsson, Lund.

Larsen, K, 2005. *Deep-Sea Tanaidacea (Peracarida) from the Gulf of Mexico. Brill, Leiden.*

Laval, P, 1980. Hyperiid amphipods as crustacean parasitoids associated with -gelatinous zooplankton. Ocean. Mar. Biol. an Annual Review 18: 11-56.

Ledoyer, M, 1984. Les Gammariens (Crustacea, Amphipoda) des herbiers de Phanerogames marines de Nouvelle Caledonie (Region de Noumea). Mem. Mus Nat.l D'Hist. Natur., Serie A, Zoologie, 129: 1-113.

Leonard, M, Gainess, KH and Sandoval, CM, 2001. Gastropod shell distribution and factors affecting their utilization by marine hermit crabs in Bahia Kino, Sonora, Mexico, Aquatic Sciences Meeting, Albuquerque.

Leong, TS, 1985. Copepoda of the genera of *Parapetalus, Synestius* and *Hermilius* (Caligidae) parasitic on Malaysian fishes. Malay. Nat. Jour., 19: 41–56.

Lewinsohn, C, 1984. Dromiidae (Crustacea, Decapoda, Brachyura) from Madagascar and the Seychelles. Bull. Mus. Nat. d'Hist. natur., Paris, (4) 6, sect. A. (1): 89-129, 4 figs, 4 pls.

Liu, RY, and Ren XQ, 2007. Fauna Sinica. Invertebrata. 42 Crustacea Cirripedia Thoracica. 633 pp. (in Chinese).

Lopez, NC, 2001. Parasitic crustaceans in fishes from some Philippine Lakes. SEAFDEC/AQD Institutional Repository (SAIR).

Lowry, JK and Springthorp, RT, 2001. Onwards. Amphipoda: Families and Subfamilies. Version 1: 1.

Lowry, JK and Myers, AA, 2013. Phylogeny and Classification of the Senticaudata subord. nov. (Crustacea: Amphipoda). Zootaxa 3610 (1): 001–080.

Lowry, JK and Stoddart, HE, 2003. Zoological Catalogue of Australia Volume 19. 2B: Crustacea: Malacostraca: Peracarida: Amphipoda, Cumacea, Mysidacea (Zoological Catalogue of Australia Series) CSIRO.

Madin, LP and Harbison, GR, 1977. The associations of Amphipoda Hyperiidea with gelatinous zooplankton. I. Associations with Salpidae. Deep-Sea Res. 24: 449–463.

Mahar, MA and Jafri, SIH, 2011. A new ectoparasitic crustacean, Argulus sindhensis sp. Nov. (Branchiura: Argulidae) from Pakistan. Sindh Univ. Res. Jour. (Sci. Ser.) 43 (2): 199-202.

Manship, BMA, Walker, J and Davies, AJ, 2011. Brooding and embryonic development in the crustacean *Paragnathia formica* (Hesse, 1864) (Peracarida: Isopoda: Gnathiidae). Arthr. Struc and Devel. 40, 2: 135–145.

Maran, Venmathi, BA, Seng, LT, Ohtsuka, S and Nagasa, K, 2009. Records of Caligus (Crustacea: Copepoda: Caligidae) from Marine Fish Cultured in Floating Cages in Malaysia with a Redescription of the Male of Caligus longipedis Bassett-Smith, 1898. Zool. St. 48(6): 797-807.

Marin, IN, Korn, OM and Kornienko, ES, 2011. Symbiotic crab Sestrostoma balssi (Shen, 1932) (Varunidae: Gaeticinae) from Vostok Bay, Sea of Japan: a new species for the fauna of Russia.Russian Jour. Mar. Biol. 37,6: 509-511.

Markham, JC, 1980. A new species of Dicropleon and new records of three other species of bopyrid isopods from the Indian Ocean. Bull. Mar. Sc. 30 (3): 623-633.

Markham, JC, 1985. Additions to the bopyrid isopod fauna of Thailand. Zool. Verh. Leiden 224, 31-xii: 1-63, figs. 1-29.

Markham, JC, 1986. Evolution and zoogeography of the Isopoda Bopyridae, parasites of Crustacea Decapoda. In: Gore RH, Heck KL (eds) Crustacean biogeography. Balkema, Rotterdam, pp 143–164.

Markham, JC, 2003. A worldwide list of hermit crabs and their relatives (Anomura: Paguroidea) reported as hosts of Isopoda Bopyridae. Mem. Mus. Vic. 60: 71–77.

Markham, JC, 2010. The isopod parasites (Crustacea: Isopoda: Bopyridae) of decapods Crustacea of Queensland, Australia, with descriptions of three new species. Paper presented at: Proceedings of the Thirteenth International Marine Biological Workshop, The MarineFauna and Flora of Moreton Bay, Queensland. Mem. Qld. Mus. Nature. 54:151–197.

Markham, JC and Kazmi ,QB, 1998. Extension of range and description of male of the bopyrid isopod *Parathelges neotenuicaudis* (Shyamasundari *et al.,* 1993) from Karachi, Pakistan. Pak. Jr. Mar. Sci. 7(2): 147-152.

Martin, JW and Davis, GE, 2001. An updated classification of the recent Crustacea. Natural History Museum of Los Angeles. County Science Series 39, 124 pp.

McLaughlin, PA, Camp, DK, Eldredge, LG, Felder, DL, Goy, JW, Hobbs III, HH., Kensley, B, Lemaitre, R and Martin, JW, 2005. Common and scientific names of Aquatic Invertebrates from the United States and Canada: Crustaceans. Order Decapoda. American Fisheries Society Special Publication 31, Maryland, 545 pp.

McLaughlin, PA, Rahayu, DL, Komai T and Chan, TY, 2001. A catalog of the hermit crabs (Paguroidea) of Taiwan National Taiwan Ocean University.

McLay, CL, 1993. Crustacea Decapoda: the sponge crabs (Dromiidae) of New Caledonia and the Philippines with a review of the genera. (Crosnier, A., Ed.). Résultats des Campagnes MUSORSTOM, 10. 156, 111–251.

Mikheev, VN, Valtonen ET and Rintamäki-Kinnunen P, 1998. Host searching in Argulus foliaceus L. (Crustacea:Branchiura): the role of vision and selectivity. Parasitology, 116: 425–430.

Mikheev, VN, Mikheev, AV, Pasternak, AF and Valtonen ET, 2000. Light-mediated host searcing strategies in a fish ectoparasite, Agulus foliaceus L. (Crustacea: Branchiura). Parasitology, 120: 409-416.

Minhas, IK, Iqbal, Z, and Khan N, 2001. Occurrence of Abdominal dropsy in culturable fish species in Punjab. Proceedings of the 21st Pakistan Congress of Zoology (International), (21): 169-174.

Mitra, S and Dev Roy, MK, 2011. On a new host record of Alitropus typus (Crustacea: Isopoda: Aegidae) and a new record from freshwater river system of West Bengal. Jour. Enviro. and Sociobio. 8(2): 269-271.

Moazzam, M, and Rizvi, SHN, 1978. Pedunculate cirripedes from Pakistan coast. Pakistan Jour. Zool. 10(2): 161-178.

Moazzam, M, and Rizvi, SHN, 1982. Addition to pedunculate cirripede fauna of Pakistan coast. Pakistan Jour. Zool. 14(2): 234-237.

Moazzam, M and Rizvi, SHN, 1985. Pinnotheres tivelae Gordon, 1986, a new addition to the crab fauna of Pakistan. Pakistan Jour. Zool. 17(4): 441-442.

Moazzam, N and Moazzam, M, 2004. Rhizocephalan cirripedes from Pakistan coast. Pakistan Jour. Zool. 36: 253-254.

Moller, O, Olesen, J, Avenant-Oldewage, A, Thomsen, P, and Glenner, H, 2008. First maxillae suction discs in Branchiura (Crustacea): development and evolution in light of the first molecular phylogeny of Branchiura, Pentastomida, and other Maxillopoda". *Arthropod Structure and Development*, 37: 333-346.

Molnar, JL, Gamboa, RL, Revenga C and Spalding, MD, 2008. Assessing the global threat of invasive species to marine biodiversity. Front. Eco. Environ. 6 (9): 485-492.

Monod, T, 1933. Tanaidacea et Isopoda. Mission Robert Ph. Dollfus en Egypte. Mem. Instit. Egypte 21: 161-264.

Monteforte, M, 1987. The decapod Reptantia and stomatopod crustaceans of a typical high island coral reef complex in French Polynesia (Tiahura, Moorea Island): zonation, community composition and trophic structure**.** Atoll Res. Bull., 309: 1–37.

Moore, PG, 1981. Marine Amphipoda (Crustacea) new to Science from the Tasmanian phytal fauna. Jour. Natur. Hist*.* 15: 939-964.

Moore, PG, 1983. Pagurisaea schembrii gen. and sp. n. (Crustacea: Amphipoda) associated with New Zealand hermit crabs, with notes on Isaea elmhirsti Patience. Zool. Scripta, 12, 1, pp. 47-56; 7 figs.

Morgado, EH and Tanaka, MO, 2001. The macrofauna associated with the bryozoan Schizoporella errata (Walters) in southeastern Brazil. Sci. Mar. 65(3): 173-181.

Morton, B, 1989. Partnerships in the Sea**:** Hong Kong's Marine Symbioses. Kent State University Press, 124 pages.

Morton, B and Morton, J, 1983. The seashore ecology of Hong Kong: i-xiv, 1-350, many figs, pis. 1-28.Hongkong University Press, Hong Kong.

Murty, KPVM, 1983. Distribution of phytal harpacticoid copepods along Visakhapatnam coast. Mahasagar 16(1): 47-54.

Mushtaq, S, and Mustaquim, J, 2009. The occurrence and distribution of stalked barnacles of the genus O*ctolasmis* on the gills of mud or mangrove crab, genus S*cylla.* Crustaceana, 82 (1): 53-61.

Mustaquim, J and Javed M, 1993. Occurrence of Chelonibia testudinaria (Linnaeus) (Crustacea: Cirripedia) in coastal waters of Pakistan. Pakistan Jour. Mar. Sc. 2: 73-75.

Mustaquim, J and Rabbani, MM, 1976. Species of portunid crabs (Decapoda, Brachyura) from Karachi. Pakistan Journ. Sc. Indust. Res. 19: 161-164.

Naik, IU, 1977. A study of diseases of Cyprinus carpio in fish seed hatchery,Chhenawan.Punjab, Pakistan. Pakistan Jour. Sc. 29(1) .

Nalesso, RC, Duarte, LFL, Pierozzi, JRI and Enumo, EF, 1995. Tube epifauna of the polychaete Phyllochaetopterus socialis Claparède. Est Coast Shelf Sci 41: 91-100.

Nascimento, EE and Torres, MFA, 2006. Macroinvertebrados associados a agregados de tubos de Nicolea uspiana Nogueira, 2003

(Polychaeta, Terebellidae) nos recifes da Praia de Boa Viagem, Recife – Pernambuco. Bol. Tec. Cient. CEPENE 14(2): 9-15.

Narvarte, MA and Saiz, MN, 2004. Effects of the pinnotherid crab Tumidotheres maculatus on the Tehuelche scallop Aequipecten tehuelchus in the San Matías Gulf, Argentina. Fish. Res., 67: 207-214.

Nayar, KN, 1966. On the gammaridean Amphipoda of the Gulf of Mannar, with special reference to those of the Pearland chank beds. Proceedings of the Symposium on Crustacea held at Ernakulam from January 12 to 15, 1965. Mar. Biol. Asso. India, 1: 133–168.

Nayeem, I, Kazmi, QB and Tirmizi, NM,1993. Records of Oxycephalid amphipods (Crustacea) from Pakistan. Pakistan. Jour. Mar. Sci. 2(2): 137-151.

Nazli, S, 1999. Seasonal variation in the copepod parasites of hybrid *Labeox catla*from fish hatchery, Pirowal, Punjab. *M.Sc. Thesis, Institute of Pure and Applied Biology, B.Z. University, Multan, Pakistan.*

Neeraja, T, TripathI, G and Ummey Shameem, 2014. Occurrence of the isopod, Norileca indica (Isopoda: Cymothoidae) on bigeye scad, Selar crumenophthalmus (Bloch) off Mumbai coast, India. Indian Jour. Fish., 61(1) : 49-56.

Nelson, WG, 1979. An analysis of structural pattern in an eelgrass (*Zostera marina* L.) amphipod community. Journ. Exp. Mar. Biol. Ecol. **39**: 231-264.

Ng, PKL, 1998. FAO Species identification guide for fishery purposes vol. 2, pp. 1045-1155.

Ng, PKL, and Tan, LWH, 1986. The leaf-carrying behaviour of Neodorippe (Neodorippe) callida (Fabricius, 1798) with a note on carrying behavior of dorripids crabs (Crustacea, Decapoda, Brachyura) Jour.Singapore Acad. Sc. 15: 45-47.

Ng, PKL, Chan, TY and Wang, CH, 2000. The Dromiidae, Raninidae and Corystidae (Crustacea: Decapoda: Brachyura) of Taiwan. In: J.-S. Hwang *et al.*, (eds.), Proceedings of the International Symposium on Marine Biology in Taiwan - Crustacea and Zooplankton Taxonomy, Ecology and Living Resources. Taiwan Museum Special Publication Series, No. 10.

Ng, PKL, Wang, C-H, Ho, P-Ho and Shih, H-T, 2001. An annotated checklist of Brachyuran Crabs from Taiwan (Crustacea: Decapoda). National Taiwan Museum Special Publication Series, Number 11. Published by National Taiwan Museum, Taipei, Taiwan Republic of China. Pp. 1-87.

Niazi, MS and Ahmed, MA, 1973. Parasitic copepods of marine fishes of Karachi coast. Fam: Caligidae. Rec. Zool. Surv. Pakistan, 5(1/2): 79-94.

Niazi, MS, Sadiq, M and Ahmed, MA, 1973. Lernaeenicus hemirhamphi Kirt (Lernaeidae: Caligidea), a copepod parasite in Hemirhamphus xanthopterus (Val) from Karachi coast. Rec. Zool. Surv. Pakistan 5(1 and 2): 7-9.

Nilsson-Cantell, CA, 1934a. Indo-Malayan cirripeds in the Raffles Museum, Singapore. Bull. Raff. Mus. 9: 42-73.

Nilsson-Cantell, CA, 1934b. Cirripeds from the Malay Archipelago in the Zoological Museum of Amsterdam. Zool. Med. 17: 31-63, figs. 1-12.

Nogata, Y and Matsumura, K, 2005. Larval development and settlement of a whale barnacle. Biology Letters 2(1): 92-93.

Nomura, K, 2000. Host and colour variation of Alpheus barbatus Coutière (Crustacea,Alpheidae) in Japan. Biol. Mag.Okinawa 38:59-64.

Noodt, W, 1971. Ecology of the Copepoda. *In: Hulings, N.C. (ed.). Proceedings of the First International Conference on Meiofauna.* Smithsonian Contrib. Zool. 76:97-102, fig. 1. (30-xii-1971).

Nooruddin, 1960. On some isopods of the families Idoteidae and Sphaeromidae collected from Manora Island. Proc.4thPan Indian Ocean Cong.: 161-169.

Ohtsuka, S, Koike, K, Lindsay, D, Nishikawa, J, Miyake, H, Kawahara, M, Mulyadi, Mujiono N, Hiromi J,and Komatsu H, 2009. Symbionts of marine medusae and ctenophores. Plank. Benth. Res 4:1–13.

Oktener, A, Trilles J and Leonardos, L, 2007. Five ectoparasites from Turkish fish. Parasitology. 31: 154-157.

Ortiz, M, Lalana, R and Sanchez-Diaz, A, 2000. Una nueva especie de anfípodo espongícola del género *Hoplopheonoides* Shoemaker, 1956 (Gammaridea:Cyproideidae), de Cuba. Avicennia, 12–13: 63–6.

Ortiz, M, Winfield I and Cházaro-Olvera, S, 2012. A new species of isopod (Isopoda: Flabellifera: Sphaeromatidae) from Cuba, with an identification key for the species of Paraimene. Rev. Mexicana Biod. 83: 976-982.

Ostergaard, P, 2003. Catalogue of genera and species of the family Chondracanthidae Milne Edwards, 1840 (Copepoda: Poecilostomatoida) with notes on morphology. Syst. Parasit. 55(2): 135-150.

Östlund-Nilsson, S, Curtis, L, Nilsson, GE and Grutter, AS, 2005. Parasitic isopod Anilocra apogonae, a drag for the cardinal fish Cheilodipterus quinquelineatus. Marine Ecology. Progress Series 287:209-216.

Overstreet, RM, 1983. Metazoan symbionts of crustaceans. Pages 156-250 in A.J. Provenzano Jr (ed) *The biology of the Crustacea* 6, Pathobiology. Academic Press, New York.

Ozcan, T, 2012. The swimming crab Portunus segnis (Forskal, 1775): host for the barnacle Chelonibia platula (Ranzani, 1818) from the Turkish coast. Jour. Black Sea/Mediterranean Env., 18(3): 271-278.

Parker, JD, Duffy, JE, Orth, RJ, 2001. Plant species diversity and composition: experimental effects on marine epifaunal assemblages. Mar. Eco. Prog. Se., 224: 55-67.

Pasternak, A, Mikheev V, and E Valtonen, 2000. Life history characteristics of *Argulus foliaceus* L. (Crustacea: Branchiura) populations in Central Finland. Ann. Zool. Fennici, 37: 25-35.

Pasternak, Z, Blasius, B, Achituv, Y, and Abelson, A, 2004. Host location in flow by larvae of the symbiotic barnacle *Trevathana dentate* using odour-gated rheotaxis. Proc. Roy. Soc. London. Series B, Biol. Sc. 271(1549): 1745-1750.

Patton, WK, 1968. Feeding habits. behavior and host specificity of Caprella grahnmi, an amphipod commensal with the starfish Asterins forbes. Biol. Bull. (Woods Mole) 134: 148-1 53.

Peart, RA, 2004. A revision of the *Cymadusa filose* complex (Crustacea: Amphipoda: Corophioidea: Ampithoidae). Journ Natur. Hist., 38,3: 301-336.

Peart, RA, 2007a. A review of Australian *Cymadusa* (Crustacea: Amphipoda: Ampithoidae) with descriptions of eight new species. Zootaxa, 1540: 1-53

Peart, RA, 2007b. A review of the Australian species of *Ampithoe* Leach, 1814 (Crustacea: Amphipoda: Ampithoidae) with descriptions of seventeen new species. Zootaxa, 1566: 1-95

Peirano, A, Lombardi, C, Ponzè N., and Cocito, S, 2013. Verrucae on sea-fans: unexpected abundance of the barnacle Conopea calceola (ellis) on the gorgonian Eunicella singularis (Esper) in the Mediterranean sea . 6505, 40th CIESM Congress Marseille, France.

Pereira, SP, Lima, EHSM, Ernesto, L, Mathews H and Ventura, A, 2006. Epibionts associated with *Chelonia mydas* from northern Brazil. Mar. Turtle News. 111:17-18.

Piasecki, W, Goodwin, AE, Eiras JC and Nowak, BF. 2004. Importance of copepoda in freshwater aquaculture. Zool. Studies, 43, 193-205.

Pike, AW. and Wadsworth, SL, 1999. Sealice on salmonids: their biology and control. Adv. Parasitol. 44:233–337

Pilla, S, Prasanna Vankara A and Chikkam, V, 2012. Copepod parasites of snappers, Lutjanus spp (Pisces, Lutjanidae) with description of a new caligid copepod, Caligus rivulatus sp nov (Copepoda, Caligidae) from Visakhapatnam coast, India. Cibtech Journ. Zool. 1(2): 16-24.

Pillai, K, 1965a. Copepods parasitic on South Indian fishes. Family Bomolochidae. Journ. Bombay nat. Hist. Soc. 62 : 38-55.

Pillai, K, 1965b. Copepods parasitic on Indian Marine fishes—A review. Proc. Symp. Crust. : 1556-168

Pillai, K, 1969. Notes on some copepod parasites in the collection of the British Museum (N.H.), London Journ. Mar. biol. Ass. India, 11 (1 & 2): 149-174.

Pons, M, Verdi A and Domingo, A, 2011. The pelagic crab Planes cyaneus (Dana, 1851) (Decapoda,Brachyura, Grapsidae) in the southwestern atlantic ocean in association with loggerhead sea turtles and buoys. Crustaceana, 84 (4): 425-434.

Por, FD, 1964, A study of Levantine and Pontic Harpacticoida (Crustacea, Copepoda). Zoo. Verhand. Leiden, 64, 1–128.

Porras, R, Bataller, JV, Murgui, E and Torregrosa, MT, 1996. Trophic-structure and community composition of polychaetes inhabiting some Sabellaria alveolata (L.) reefs along the Valencia Gulf Coast, Western Mediterranean. Mar. Ecol. 17: 583-602.

Prakash, S, Thangappan, T, Kumar A and Khan, SA, 2013. Checklist of the Porcellanidae (Crustacea: Decapoda: Anomura) of India .Check List 9(6): 1514–1518,

Purivirojkul, W and Areechon, N, 2008. Survey of parasitic copepods in marine fishes from the Gulf of Thailand, Chon Buri province. *Proceedings of the 46th Kasetsart University Annual Conference, Bangkok, Thailand, 29 Jan - 1 Feb 2008.:* 71-80. [In Thai; abstract in English.]

Qazi, MH, 1959. Some bopyrid isopods of west Pakistan. The Scientist (Scientific Society of Pakistan, Karachi) 3(1): 55-62, 62A, 62B; figs. 1-8.

Rahayu, DL, 2000. Hermit crabs from the South China Sea (Crustacea: Decapoda: Anomura: Diogenidae, Paguridae, Parapaguridae). Raffles Bull. Zool. 8:377-404.

Raissy, M, Ansari, M and Jalali, B, 2009.Identification of parasites of three copepoda spp. in Kyar and Beheshtabad rivers, Chaharmahal and Bakhtyari province and first report of Lamproglena chinensis yu, 1937 in IranianJour. vet. Path. 1(1):22-18.

Raissy, M, Sohrabi, HR, Rashedi, M and Ansari, M, 2013. Investigation of a parasitic outbreak of *Lernaea cyprinacea* Linnaeus (Crustacea: Copepoda) in Cyprinid fish from Choghakhor lagoon. Iranian Journ. Fish. Sc. 12(3): 680- 688.

Ramakrishna, G, 1951. Notes on the Indian species of the genus Argulus (Muller) (Crustacea: Copepoda) parasitic on fishes. Rec. Ind. Mus. (49): 207-215.

Ramdane, Z, Bensouilah MA, and Trilles, JP, 2007. The Cymothoidae (Crustacea, Isopoda),parasites on marine fishes, from Algerian fauna. Belg. J. Zool., 137 (1) : 67-74.

Rameshkumar, G and Ravichandran, S, 2010a. New host Record, Rastrelliger kanagurta, for *Nerocila phaeopleura*. Middle-East Jour. Sc. Res. 5 (1): 54-56.

Rameshkumar, G and Ravichandran S, 2010b. Cymothoa indica (Isopoda; Cymothoidae) and Alitropus typus (Isopoda; Aegidae) on freshwater fish Tilapia ossambica(Cichlidae) in Vellar estuary, Southeast coast of India. Biotemas, 23 (3): 67-70.

Rameshkumar, G, Ravichandran, S, and Trilles, JP, 2011. Cymothoidae (Crustacea, Isopoda) from Indian fishes. Acta Parasit. 56,1: 78-91.

Rameshkumar, G, Ravichandran S and Trilles, JP, 2012. Observation on an isopod parasitizing the edible fish Parastromateus niger in the Parangipettai coast of India. Journ. Environ. Biol. 33: 191-193.

Randi, DR, Jeffrey, RC and Sara, ML, 2010. Social context of shell acquisition in Coenobita clypeatus hermit crabs. Behavioral Ecology 21 (3): 639–646.

Rasmussen, HW, Jakobsen, SL, Collins, JSH, 2008. Raninidae infested by parasitic Isopoda (Epicaridea). Bull. Miz. Fossil. Mus. 34:31–49.

Ravichandran, S and Kumar, TR, 2004. Infestation of isopod parasite Nerocila phaeopleura on Chirocentus dorab .Proc. Nat. Sem. Mar. Res. ST. Hindu College, Nagercoil: 45–48.

Razaq, A, 1999. Observations on the occurrence of copepod ectoparasites of Theila (*Catla catla)*(Hamilton) from fish hatchery, Pirowal, (Punjab, Pakistan).*M.Sc. Thesis, Institute of Pure and Applied Biology, B.Z. University, Multan, Pakistan.*

Reimer, A, 1975. Description of a Tetraclita stalactifera panamensis community on a rock intertidal Pacific shore of Panama. Mar. Biol. 35: 225–238.

Ren, X, 1980, Turtle barnacles of the Xisha Islands, Guangdong Province, China. Stud. Mar. Sin. 17: 187-197.

Reshmi, R and Bijukumar A, 2011. New records of hermit crabs, Calcinus morgani Rahayu and Forest, 1999 and Diogenes klaasi Rahayu and Forest, 1995 (Crustacea: Anomura: Diogenidae) from India. Journ. Threatened Taxa 3(5): 1771–1774.

Ross, DM, 1983. Symbiotic relations. In: Vernberg, S. J., Vernberg, W. B. (eds.) The biology of Crustacea,Vol. 7, Behavior and ecology. Academic Press, New York, : 163-212.

Ross, A and Neman, WA, 1967. Eocene Balanidae of Florida, including a new genus and species with a unique plan of "turtle-barnacle" organization. Am. Mus. Novit., 2288:1-21.

Ross, A and Newman, WA, 1973. Revision of the coral-inhabiting barnacles (Cirripedia. Balanidae). Trans. San Diego Soc. Natur. Hist., 17,: 137–174.

Sadiq, S, 1993. Study of algae inhabited crustaceans of Karachi coast. M. Phil. Thesis unpublished.

Sadiq, S, 1996. Female of Metmphiascopsis hirsutus(Thompson and Sott, 1909) a rare record. MRC Newsletter, 5(1):1.

Sakai, T, 1976. Crabs of Japan and the Adjacent Seas. Kodansha, Tokyo. English text, xxix+773 pp.; Japanese text, 461 pp.; Plate volume, 251 pp.

Sarusic G, 1999. Preliminary report of infestation by isopod *Ceratothoa oestroides* (Risso, 1826), in marine cultured fish. Bull. Eur. Ass. Fish Pathol. 19:110–112.

Saravanakumar A, Balasubramanian, T, Raja, Kand Trilles, JP, 2012. A massive infestation of sea snakes by cymothoid isopods. Parasit. Res. 110(6): 2529-31.

Schmitt, WL, 1973. Crustaceans. David and Charles pp 204.

Stephensen, K, 1945. The Brachyura of the Iranian Gulf with an Appendix: The male pleopod of the Brachyura. In: Danish Scientific

Investigations in Iran, Part 4. Copenhagen, E. Munksgaard: 57-237, figs 1-60.

Serène, R, 1984. Crustacés Décapodes Brachyoures de l'Ocèan Indien Occidental et de la Mer Rouge, Xanthoidea: Xanthidae et Trapeziidae. Avec un addendum par Crosnier, A.: Carpiliidae et Menippidae. Faune Tropic., 24, 1–349, 48 pls.

Serène, R and Romimohtarto, K, 1969. Observations on the species of *Dorippe* from the Indo-Malayan Region. Mar. Res. Indonesia (Penelitian Laut di Indonesia), 9: 1-35, figs 1-29, pls 1-6.

Sethi, S, 2012. Occurrence of isopod parasites in clupeids off Chennai coast, India.Indian Journ.fish 59,3: 153-155.

Shafiq, MA, Mehnaz K, and Khan, WA, 2001. Prevalence of Lernaea cyprinacea (Crustacea Copepoda) in freshwater major carps. Sci. Inter, 13(1): 83-86.

Shahzad, MF, 1999. Studies on the seasonal dynamics of copepod ectoparasites of silver carp (*Hypophthalmichthys molitrix*). *M.Sc. Thesis, Institute of Pure and Applied Biology, B.Z. University, Multan,* Pakistan.

Shariff, M and Sommerville, C, 1990. Comparative morphology of adult Lernaea polymorpha Yu and Lernaea cyprinacea Linnaeus. In Hirano R and Hanyu I (eds) Second Asian Fisheries Forum Asian Fish. Soc. Manila, pp. 717-720.

Shazia, I, Ayub, Z, Moazzam, M and Siddiqui, G, 2012. Commensal invertebrates found with hermit crab Diogenes custos from Clifton, Karachi. Abstract FEWFM-36, 32nd Pakistan Congress of zoology.

Shazia, I, Ayub Z, and Moazzam, M, 2013. Observations on the reproductive pattern of the hermit crab Diogenes custos on the sandy shore of Clifton. Abstract FEWFM-91, 33rd Pakistan Congress of zoology.

Shih, CT and Dunbar, MJ, 1963. Amphipoda, Sub-order: Hyperiidea, Family: Phronimidae. Conseil International pour l'Exploration de la Mer. Zooplankton Sheet 104, pp. 1-6.

Shick, JM, 1991. *A Functional Biology of Sea Anemones*. London: Chapman and Hall.

Shimomura, M, Ohtsuka, S and Sakakihara, T, 2006. Two bopyrid isopods infesting caridean shrimp Hippolyte sp.n the Seto Inland Sea, western Japan(Crustacea: Peracarida) Bull. Kitakyushu Mus. Nat. Hist. Hum. Hist., Ser. A, 4:1-7.

Shimomura, M and Bruce, NL, 2012. A new species of Halacarsantia Wolff, 1989 (Crustacea, Isopoda, Asellota, Santiidae) from Wistari Reef, southern Great Barrier Reef, Australia. Zoo. Keys 173: 1–9.

Shireen, SB, 1997. Taxanomic studies of Isopod parasites of marine prawn and bony fishes of Karachi coast. unpublished M.Phil thesis pp100.

Shireen, SB, 2001. Description of four parasitic isopods belonging to the genera Elthusa, Anilocra and Nerocila from Karachi coast, Pakistan. Pakistan Journ. Mar. Biol. 7 (1and2): 81-104.

Shiino, SM, 1942. On the parasitic isopods of the family Entoniscidae, especially those found in the vicinity of Seto. Mem. Coll. Sc., Kyoto Imperial University, ser. B, 18(1)(2): 37-76.

Siddiqui, FA and Kazmi, QB, 2003. A checklist of marine anomurans (Crustacea: Decapoda) of Pakistan, northern Arabian Sea. Mem. Mus. Victoria, 60: 87- 89.

Siddiqui, FA, Kazmi, QB and McLaughiln, PA, 2004. Review of the Pakistani species of Diogenes Dana 1851 (Decapoda: Anomura: Paguroidea: Diogenidae). Trop. Zool., 17: 155-200.

Siddiqui, G, 2012. Infestation of pea crab, Nepinnotheres villosulus and their associated bopyrids Hypocepon enoencis in clams and cockles from Sonmiani (BALOCHISTAN). 1st Congress of Applies Chemical Sciences, Malaysia.

Siddiqui, G and Ahmed, M, 1993. Population structure of the xanthid crab Leptodius exaratus and its rhizocephalan parasite Sacculina from two rocky ledges near Karachi(Arabian Sea). Mar. Research 2:61-72.

Siddiqui, NA and Bilqees, FM, 1995. Studies on ecto parasites of the fish *Thunnus allbacares* of Arabian sea. Proc. Para. 19: 77-81.

Sieg, J, and Zibrowius, H, 1988. Association of the tube inhabiting tanaidacean, *Bifida scleractinicola* gen. nov., sp. nov., with bathyal scleractinians off New Caledonia (Crustacea Tanaidacea) - Cnid. Scleract. Mesog.. 48: 189-199.

Silliman, BR, Layman CA and Altieri, AH, 2003. Symbiosis between an alpheid shrimp and a xanthid crab in salt marshes of the Mid-Atlantic States, USA. Journ. Crust. Biol. 23:876-879.

Smit, NJ, N L. Bruce and Hadfield, KA, 2014. Global diversity of fish parasitic isopod crustaceans of the family Cymothoidae. Intern. Jour. Parasit.: Parasites and Wildlife 3 (2): 188–197.

Smit, NJ and Davies AJ, 1999. New host records for Haemogregarina bigemina from the coast of Southern Africa. J. Mar. Biol. Assoc. U.K. 79: 933-935.

Smith, WL, 1977. Beneficial behaviour of a symbiotic shrimp to its host anemone, Bull. Mar. sc. 27, 2: 343-346.

Song, L, Zhou ZC and Wang, NB, 2010. Zooplankton diversity of Liaodong Bay and relationship with oceanic environmental factors.Mar. Sc., Qing. 34(3):39-45. [In Chinese.]

Spiridonov, VA and Neumann, V, 2008. Coral-inhabiting swimming crabs (Crustacea, Decapoda, Portunidae) of the Sudanese Red Sea. Organ. Divers. and Evol. 8, 3: 170. e1–170.

Stimpson, W, 1907. Report on the Crustacea (Brachyura and Anomura) collected by the North Pacific Exploring Expedition, 1853-1856.Smithsonian Misc. Collec., Washington, 49(1717): 1-240, pls 1-26.

Stubbings, HG, 1936. Cirripedia. John Murray Expeditions, 1933-1934. Sci. Rep. Murray Exped. 4: 1-70.

Stubbings, HG, 1961. Cirripedia Thoracica from Tropical West Africa. - Atlantide Rep. 6: 7-41, 11 text-figs.

Suárez-Morales, E, 2001. Redescription of two *Cymbasoma* (Copepoda: Monstrilloida) collected during the Siboga Expedition (1899–1900). Bull.' Inst. Roy. Sc. Natur. Belgique, Biol. 71: 53–64.

Suárez-Morales, E, 2006. Validation and redescription of Cymbasoma germanicum (Timm) (Crustacea: Copepoda: Monstrilloida) from Helgoland with comments on Cymbasoma rigidum Thompson HELGOLAND MAR. RES. 60, 3: 171-179.

Suárez-Morales, E, 2011. Diversity of the Monstrilloida (Crustacea: Copepoda) Jour.l: PLOS One, vol. 6, no. 8.

Suárez-Morales, E and Iivanenko, VN, 2004. Two New Species of Monstrillopsis Sars (Crustacea: Copepoda: Monstrilloida) from the White Sea and Norway, with Comments on M. dubia Scott . ARCTIC 57, 1:37–46.

Suárez-Morales, E, Scardua, MP and da Silva, PM, 2010. Occurrence and histopathological effects of Monstrilla sp. (Copepoda: Monstrilloida) and other parasites in the brown mussel Perna perna from Brazil . J Mar Bio. Ass. UK. 90, no. 05: 953-958.

Takeda, M and Shikatani, N, 1990. Crabs of the genus *Calappa* from the Ryukyu Islands, with description of a new species. Zool. Sci., Tokyo, 7(3): 477-484, figs 1-4.

Tasawar, Z, Arshad M and Hayat, CS, 2001. Copepod Ectoparasites of Labeo rohita. Jour. Biol. Sc., 1: 676-677.

Tasawar, Z, Hanif, M, Lashari, MH and. Hayat, CS, 2007. The prevalence of Lernaeid ectoparasites in Mori (Cirrhinus mrigala) fish. Pakistan Vet. J., 27: 176-178.

Tasawar, Z, Hussain, L and Akhtar, M, 1999. Prevalence of copepod ectoparasites of Labeo rohita from Mian Channu Hatchery Punjab (Pakistan). Pakistan Vet. J., 19: 210-212.

Tasawar, Z, Khurshid S and Akhtar, M, 1999. Prevalence of copepod ectoparasites of mori fish (Cirrhinus mrigala). Pakistan Jour. Biol. Sci., 2: 1060-1061.

Tasawar, Z, Naseem R, and Akhtar M, 1999. Prevalence of Copepod Ectoparasites of Grass Carp Ctenopharyngodon idella .Pakistan Journ. Biol. Sc. 2: 1053-1054.

Tasawar, Z, Naz, F, Lashari, MH, Hayat, CS, Ali, SHB, Naeem, M and Shaheen, R, 2009. Incidence of lernaeid parasite in Catla catla on a fish farm. Sarhad Jour. Agr., 25: 285-289.

Tasawar, Z, Riaz, S, Lashari MH and Aziz, F, 2011. The incidence of lernaeid ectoparasites of Labeo rohita at local fish farms of Tehsil Kot Addu .Pakistan Journ. Agri., Agril. Engg., Vet. Sci., 27 (2): 185-191.

Tasawar, Z, Razaq A and M Ashraf, 1999. Investigations of Lernaeid parasites of Catla catla.Bull.Dep. Zool.,Uni. Punjab 14: 17-23.

Tasawar, Z and Shazad, MF, 2001. Seasonal prevalence of copepod ectoparasites of silver carp (Hypophthalmichthys molitrix). Punjab Univ. Jour. Zoo., 16: 49-54.

Tasawar, Z, Shahzad, MF and Hayat, CS, 2000. Copepod ectoparasites of *Hypophthalmichthys molitrix* from Fish Hatchery Pirowa (Khanewal, Punjab). Pakistan Vet. Jour. 20, 4: 193-196.

Tasawar, Z, Umer, K and Hayat, CS, 2007. Observations on lernaeid parasites of Catla catla from a fish hatchery, Muzaffargarh, Pakistan. Pakistan Vet. Journ., 27: 17-19.

Tasawar, Z, Zafar, S, Lashari MH and Hayat, CS, 2009. The prevalence of lernaeid ectoparasites in grass carp (Ctenopharyngodon idella). Pakistan Vet. Journ., 29: 95-96.

Taylor, N, Sommerville C and Wootten R, 2006. The epidemiology of *Argulus* spp. (Crustacea: Branchiura) infections in stillwater trout fisheries. Journ. Fish Dis., 29: 193-200.

Thatcher, VE, De Oliveiraand AAN and Garcia, AM, 2009. *Braga cigarra* comb. nov. for *Philostomella cigarra* (Crustacea: Isopoda: Cymothoidae) with a redescription of the species based on specimens from *Galeocharax kneri*, a freshwater fish of Minas Gerais State, Brazil**.**Zoologia (Curitiba), 26: 155–160.

Thomsen, MS, 2010. Experimental evidence for positive effects of invasive seaweed on native invertebrates via habitat-formation in a seagrass bed .Aq. Inv. 5, 4: 341–346.

Thomsen, MS, Wernberg T, Olden JD, Griffin JN and Silliman BR, 2011. A framework to study the context–dependent impacts of marine invasions. Journ.Exp. Mar. Biol. Ec. 400:322–327.

Threlkeld, ST, 1977. The distribution of five species of Monstrillidae (Copepods, Monstrilloid.a) near Kodiak Island, Alaska. Crustaceana 32: 225–228.

Tirmizi, NM, 1966. Crustacea: Galatheidae. The John Murray Expedition 1933-23, Scientific Reports, 11 (2), 167–234.

Tirmizi, NM, 1966. The occurrence of Protosquilla lenzi (Crustacea: Stomatopoda) from Karachi coast with notes on other species. Univ. Stud., Sc. and Tech. numb. Karachi, IV(3): 44-53.

Tirmizi, NM, and Bashir, Q, 1973. Shore and offshore Penaeid prawns of northern Arabian Sea, 46 figures: 1-71. Publication of University of Karachi. Pakistan.

Tirmizi, NM and Ghani, N, 1996, Marine Fauna of Pakistan: 5, Crustacea: Brachyura, Brachyrhyncha, Part I (Xanthidae, Goneplacidae, Pinnotheridae, Ocypodidae, Grapsidae). Publication of Centre Excel. Mar. Biol., University of Karachi, 188 p.

Tirmizi, NM and Javed, W, 1993. Indian Ocean galatheids (Crustacea; Anomura). University Grants Commission, Islamabad pp. 147.

Tirmizi, NM and Kazmi, QB, 1980. A new species of *Mesacturoides* from Karachi waters with notes on its first larva, (Stomatopoda, Gonodactylidae).Crustaceana 38(1): 61-66.

Tirmizi, NM and Kazmi, QB, 1982. Report of *Anchistus custos* (Forskal, 1775) (Decapoda, Caridea) in Pakistan waters (Arabian Sea). Pakistan Jour. Zool. Pakistan 14(1): 115-117.

Tirmizi, NM and Kazmi, QB, 1983. Carcinological studies in Pakistan with remarks on species to the Red Sea and the Mediterranean. The International Conference on Marine Sciences in the Red Sea, Egypt. Publication incorporation with AIBS. Bull. Inst. Ocean. and Fish. Egypt 9: 347-380.

Tirmizi, NM and Kazmi, QB, 1984. A hand book on a Pakistani mantis shrimp "*Oratosquilla*" Ed. R.B. Manning. Cent. Excel. Mar. Biol. Publication: 1-101.

Tirmizi, NM and Kazmi, QB, 1988. Marine Fauna of Pakistan: 4. Crustacea: Brachyura (Dromiacea, Archaeobrachyura, Oxystomata, Oxyrhyncha). BCCI Publication: 1-244.

Tirmizi, NM and Kazmi, QB, 1994. A northern Indian Ocean record of bopyrid *Parapenaeon japonica* parasitic on species of penaeid prawns (*Penaeus*). Pakistan Journ. Mar. Sci. 3(2): 171-175.

Tirmizi, NM and Kazmi, QB, 1996. New Additions in MRC. MRC NEWS LETTER, 4, 4: 1.

Tirmizi, NM, Kazmi, QB and Ghani, N, 1982. *Planes cyaneus* Dana, a grapsid crab new to the Arabian Sea with notes on *Metaplax indica* Milne-Edwards (Decapoda: Brachyura, Grapsidae). Pakistan Jour. Zool. Pakistan 14(2): 169-173.

Tirmizi, NM, Kazmi, QB and Ghani, N, 1985. Crustacean fauna of mangrove of Karachi Coast. National Workshop on Mangroves 1983. Proc. PARC Pakistan, 38-39.

Tirmizi, NM and Sadiq, S, 1996. New Additions in MRC. MRC NEWS LETTER l.4, 4:1.

Tirmizi, NM and Serène, R, 1971. The rediscovery of two species of crabs (Decapoda, Brachyura) with observations on three other species from Pakistan. Crustaceana, 21(1): 21-32, figs 1-4, pls 1-2.

Tirmizi, NM and Siddiqui, FA, 1981. An Illustrated key to the Identification of Northern Arabian Sea Pagurids. Institute of Marine Biology, Centre of Excellence, University of Karachi, Pakistan: 31 pp.

Tirmizi, NM and Siddiqui, FA, 1982. The marine Fauna of Pakistan: 1. Hermit crabs (Crustacea, Anomura). Saad Publications, Karachi: 103 pp.

Towanda, T and Thuesen, EV, 2006. Ectosymbiotic behavior of Cancer gracilis and its trophic relationships with its host Phacellophora camtschatica and the parasitoid Hyperia medusarum. Mar. Ecol. Prog. Se., 315:221-236.

Trilles, JP and Öktener, A, 2004. *Livoneca sinuata* (Crustacea; Isopoda; Cymothoidae) on *Loligo vulgaris* from Turkey, and unusual cymothoid associations. Dis. Aquat. Org. 61(3):235–240.

Trilles, JP, Rameshkumar G, and Ravichandran S, 2013. Nerocila species (Crustacea, Isopoda, Cymothoidae) from Indian marine fishes. Parasit. Res. 112(3): 1273–1286.

Tsai ML, Li JJ and Dai CF, 1999. Why selection favors protandrous sex change for the parasitic isopod, Ichthyoxenus fushanensis (Isopoda: Cymothoidae). Evol. Ecol. 13:327–338.

Utinomi, H, 1970. Studies on the cirripedian fauna of Japan. IX. Distributional survey of thoracic cirripe ds in the southeastern part of the Japan Sea. Publ. Seto Mar. Bioi. Lab., 17 (5): 339-3.

Vader, W, 1978. Associations between amphipods and echinoderms. Astarte, 11, 123–134.

Vader, W, 1983. Associations between amphipods (Crustacea: Amphipoda) and sea anemones (Anthozoa: Actinaria). Mem. Australian Mus. 18: 141-153.

Vader, W, and Beehler, CL, 1983. *Metopa glacialis* (Amphipoda, Stenothoidae) in the Barents and Beaufort Seas, and its association with the lamellibranchs *Musculus niger* and *M. discors* s.l. Astarte 12 (1979), :57-61.

Vader, W and Krapp-Schickel, T, 1996. Redescription and biology of *Stenothoe brevicornis* Sars (Amphipoda, Crustacea), an obligate associate of the sea anemone *Actinostola callosa* (Verrill). Jour. Nat. Hist. 30, 51-66.

Van Baal, 1937. Rhizocephala of the families Peltogastridae and Lernaeodiscidae. Temminckia 2**:** 1-96.

Vannini, M and Innocenti G, 2000. Research on the coast of Somalia. Portunidae (Crustacea Brachyura).Trop. Zool., 13: 251–298.

Valtonen, ET, Holmes, JC, Koskivaara, M, 1997. Eutrophication, pollution, and fragmentation: effects on parasite communities in roach (*Rutilus rutilus*) and perch (*Perca fluviatilis*) in four lakes in central Finland. Canadian Jour. Fish. Aqua. Sci. 54: 572–585.

Veerappan, N, and Selvamathi, A, 2003. Parasitic fauna of fishes: Isopods and Acanthocephalans, Biodiversity in mangrove ecosystems: UNU- UNESCO International training course on 10 th to 20th March 2003 at CAS in Marine Biology, Annamalai University: 225-233.

Vinuesa, J and Balzi P, 2010. Infestation of *Lithodes santolla* (Decapoda: Lithodidae) by *Pseudione tuberculata* (Isopoda: Bopyridae) in San Jorge Gulf, Southwestern Atlantic Ocean. Mar. Biol. Res. 6: 608-612.

Voris, HK, Jeffries, WB and Poovachiranon, S, 2000. Size and location relationships of stalked barnacles of the genus Octolasmis on the mangrove crab, Scylla serrata. Journ. Crust. Biol., 20: 485-496.

Wagele, JW, 1988. Aspects of the life-cycle of the Antarctic fish parasite Gnathia calva Vanhoffen (Crustacea:Isopoda). Polar Biol. 8: 287–291.

Wahl, M, 1989. Marine epibiosis. I. Fouling and antifouling: some basic aspects. Mar Ecol Prog Ser 58. 175-189.

Wait, M and Schoeman, DS, 2012. Shell use, population structure, and reproduction of the hermit crab, Clibanarius virescens (Kraus, 1843) at Cape Recife, South Africa. Jour.Crust. Bio. 32, 2, p203.

Walker,G, 2001. Introduction to the Rhizocephala (Crustacea: Cirripedia). Journ. Morph. 249, 1: 1–8.

Walker, PD, Flik G and Wendelaar Bonga, SE, 2004. The biology of parasites from the genus Argulus and a review of the interactions with its host. Sympos. Soc. Exp. Biol., 55: 107-129.

Walker, PD, Harris JE, van der Velde G, and Wendelaar Bonga SE, 2008. Effect of host weight on the distribution of *Argulus foliaceus* (L.) (Crustacea, Branchiura) within a fish community. Acta Parasit. 53(2): 165–72.

Werding, B, 2001. Description of two new species of Polyonyx Stimpson, 1858 from the Indo-West Pacific, with a key to the species of the Polyonyx sinensis group (Crustacea: Decapoda: Porcellanidae). Proc. Biol. Soc. Washington. 114: 109-119.

White, KN, 2011. A taxonomic review of the Leucothoidae (Crustacea: Amphipoda). Zootaxa 3078: 1–113.

White, KN and Reime, JD, 2012. Commensal Leucothoidae (Crustacea, Amphipoda) of the Ryukyu Archipelago, Japan.Part III: coral rubble-dwellers. Zoo Keys 173: 11–50.

Williams, JD and McDermot, JJ, 2004. Hermit crab biocoenoses: a worldwide review of the diversity and natural history of hermit crab associates. Journ. Exp. Mar. Biol. Ec. 305: 1– 128.

Williams, EH, Bunkley-Williams, L, Boulon, RH Jr., Eckert, KL and Bruce, NL, 1996. Excorallana acuticauda (Isopoda, Corallanidae) an associate of leatherback turtles in the northeastern Caribbean, with a summary on isopods recorded from sea turtles. Crustaceana 69: 1014-1017.

Wilson, GDF, Sims, CA and Grutter, AS, 2011. Toward a taxonomy of the Gnathiidae (Isopoda) using juveniles: the external anatomy of Gnathia aureamaculosa zuphea stages using scanning electron microscopy. Journ. Crust. Biol., 31:509–522.

Wirtz, P, 1997. Crustacean symbionts of the sea anemone Telmatactis cricoides at Madeira and the Canary Islands. Journ. Zool. 242: 799–811.

Wirtz, P and d'Udekem d'Acoz, 2001. Decapoda from Antipatharia, Gorgonaria and Bivalvia at the Cape Verde Islands. Helgoland Mar. Res. 55: 112–115.

Wirtz, P, Gustavo de Melo and S. de Grave, 2009. Symbioses of decapod crustaceans along the coast of Espı´rito Santo, Brazil .Mar. Biod. Rec., 2; e162 page 1 of 9.

Wolff, T, 1989. The genera of Santiidae Kussakin, 1988, with the description of a new genus and species (Crustacea, Isopoda, Asellota). Steenstrupia 15(7): 177–191.

Wunderlich, AC, Hattori, GY and Trilles, JP, 2011. A new host record, *Palaemonetes carteri* (Gordon, 1935) (Decapoda, Palaemonidae), for *Telotha henselii* (Von Martens, 1869) (Isopoda, Cymothoidae). Crustaceana, 84: 1403–1409.

Yamashita, H, Haga, T and Lützen, J, 2011. The bivalve *Divariscintilla toyohiwakensis* n. sp. (Heterodonta: Galeommatidae) from Japan, a commensal with a mantis shrimp. Venus, 69: 123-133

Yamauchi, T and Shimizu, M, 2013 .New Host and Distribution Records for the Freshwater Fish Ectoparasite Argulus japonicus (Crustacea: Branchiura: Argulidae). Compa. Paras. 80, 1: 136–137.

Yamauchi, T, Ohtsuka, S and Nagasawa, K, 2005. Ectoparasitic Isopod, Norileca indica (Crustacea, Isopoda, Cymothoidae), obtained from the Stomach of Coryphaena hippurus (Perciformes, Coryphaeniadae) in the Philippines. Biogeography, 7: 25-27.

Yamaguti, S, 1963. Parasitic copepoda and Branchiura of fishes. Part I and II (Reprinted, 1985). Intern. Books and Period. Suppl. Service. New Delhi, India, 164 –166.

Yu, HY and Li, XZ, 2003. Study on the Cymothoidae from Chinese waters. Stud. Mar. Sci., 45: 223-238.

Zeina, AF and Abou Zaid, M M, 2013. The re-description and distribution of two new records (Amphipoda: Caprellidae) from the Egyptian Red Sea coast. Egyptian Journ. Aquat. Res. 39, 4: 225–231.

Zeng, Y and Jaafar Z, 2012. Repetitive-motion display: a new behaviour in a burrowing alpheid shrimp. J. Crust. Biol. 32(5): 693–697.