Chapter

# Crustacea: The Increasing Economic Importance of Crustaceans to Humans

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## Abstract

Crustaceans (subphylum Crustacea) are members of the phylum Arthropods, including crabs, lobsters, crayfish, prawn, shrimp, krill, barnacles, woodlice and beach fleas. The most common types of crustaceans are shrimp and crab. This subphylum is distinguished from other arthropods, including myriapods, insects, and chelicerates, by the presence of two-parted (biramous) appendages, and the hatchling's nauplius shape. In addition, these arthropods are majorly aquatic, often found in fresh, marine, or brackish water bodies, however, some crabs, hermit crabs, woodlice and other members of the subphylum, are found in terrestrial environments. Also, most crustaceans are free-living while numerous are parasitic (for instance, *Rhizocephala*, tongue worms, fish lice) and sessile (barnacles). Mostly lived nocturnal. Crustaceans have a great economic importance to humans. The group is of great value directly or indirectly for his health and economic progress, such as aesthetic, commercial, gastronomic, biomedical, bioindicator, biomonitor, geological values, and miscellaneous uses, biodeterioration and poisons.

**Keywords:** crustaceans, crustacea, arthropods, economic, humans

## 1. Introduction

Crustaceans (Crustacea) are a large group of arthropods, 4th largest diversity among the animal groups and are usually considered as a subphylum. This group comprise approximately 50,000 to 75,000 species and include many familiar animals such as crabs, lobsters, prawn, barnacle, woodlice and beach fleas, as well as a host of lesser-known species. Unlike the terrestrial Hexapoda and Myriapoda and mainly terrestrial Chelicerata, the main radiation of the Crustacea has been aquatic, with the bulk of species living in marine habitats. There is also a substansial number of freshwater species, but only 2–3% of species live on land. Crustaceans are the dominant arthropods in the oceans, where they occupy benthic, pelagic, planktonic and intertidal niches and lead motile, sedentary, sessile or parasitic life styles. In inland waters they are represented by a more limited range of taxa, but nevertheless have succeeded in virtually all types of water bodies, including freshwater, temporary pools, and even hypersaline lake [1]. On other hand, on land the diversity is low, with representatives from only three orders of malacostracans and poorly studied cryptozoic fauna of microcrustaceans. The crustaceans show an enormous diversity of form, and a great range of size from a minute planktonic and larval forms of

*Stygotantulus stocki* at 0.1 mm (0.004 in) to giant crab, the Japanese spider crab, a large benthic crabs with a leg span of up to 12.5 ft. (3.8 m) and a mass of 48 lb. (20 kg), and also lobsters which can weigh up to 60 kg. The largest terrestrial species is the robber crab, *Birgus latro*, which can reach 3 kg in weight [2, 3]. Decapod crustaceans are possibly the most widely known vertebrates, due to the greatly cherished edibility. In this regard, shrimps, crabs and lobsters are of the highest commercial value. A study by De Grave et al. [4] estimated a total of 14,756 species and 2,725 genera of extant decapods.

Meanwhile, there are about 3,047 species of shrimps and prawns worldwide, and these are grouped into Caridea (2,517 species), Sergestoidea (94 species), Penaeiodea (94 species), and Stenopodidae (60 species). The commercial shrimp species majorly belong to one of the 5 penaeidean families (Penaeidae, Aristeidae, Sicyoniidae, Sergestidae and Solenoseridae) or the 3 caridean families (Pandalidae, Palaemonidae, and Crangonidae) [4].

## 2. General description

Crustaceans have hard skin (shells) due to deposits calcium carbonate in the cuticle. All or some parts of the body contain the appendix biramous originals. Breathe with gills or the entire surface of the body. Antenna glands (green glands) or the maxilla gland are excretion tools. Except for certain types, crustaceans are generally dioecious, fertilization inside. Most incubating the egg. The initial type of crustacean larvae is basically the nauplius larvae that swim freely as plankton. However, a few peculiar biological features possessed by crustaceans are not documented. These include, anatomy and morphology (segmentation, extremities, cuticle), circulation, excretion, respiration, osmotic regulation, procreation and life history habits (precopula, breeding, hatchlings, moulting), abundance and distribution, as well as mode of life (in the benthos or as plankton).

A crustacean's body comprises of segments, arranged into three regions, the head or cephalon, the thorax, and the abdomen or pleon. In some organisms, the head and thorax are merged to form a cephalothorax, often secured an expansive carapace [5]. Furthermore, the hard exoskeleton in crustaceans offers protection, and ought to moulted for development to occur. Each somite is surrounded by a shell separated into dorsal tergum, ventral sternum and a lateral pleuron, and the different exoskeleton parts are often combined together.

In addition, every somite or body portion often carry a pair of jointed appendages, while the head bears two sets of antennae, as well as the maxillae mandibles and the thoracic regions carry the legs. These legs are often specialized as maxillipeds (*feeding legs*) and pereiopods (*walking legs*). Meanwhile, pleopods (*swimming legs*) are located on the abdomen, this in turn closes in a telson, bears the anus, and is often bordered by uropods, forming a tail fan [2, 6]. The subphylum's remarkable survival is partly due to the large number and assortment of appendages. These are ordinarily biramous (comprised of two parts), with the exception of the uniramous primary antennae. This biramous nature possibly originated in crustaceans or became lost by other arthropods because of evolution, however, the exact origin is unclear, as even trilobites have biramous limbs.

Crustaceans also possess an open circulatory system, and blood circulated to the haemocoel the heart, adjacent to the dorsum. The oxygen carrying pigment in Malacostraca is haemocyanin, while the counterpart in copepods, ostracods, barnacles and branchiopods, is haemoglobin. In addition, the alimentary canal comprises a straight tube, progressing into a spiral, and often contains a "gastric mill" similar to a gizzard, as well as two digestive glands for food absorption. Also,

there are some kidney-like structures as well as a ganglia-shaped brain close to the antennae, and a group of major ganglia, beneath the intestine.

Numerous male decapods have primary (and in some cases, secondary) pairs of pleopods for transfer of sperm. Meanwhile, several terrestrial crustaceans (for instance, the Christmas Island red crab) mate often and migrate to the ocean to lay eggs, while others, including woodlice, lay eggs in soggy earth. Female decapods mostly carry eggs and give birth to free-swimming hatchlings.

## 3. Classification

Based on body size Crustaceans are grouped into the smaller forms called Entomostraca and the larger members called Malacostraca. Entomostraca is not considered a valid taxonomic division because the members differ from each other in diverse ways. Malacostraca is more clearly defined because all members of this group have abdominal appendages, an 8-segmented thorax, a gastric mill, and an abdomen of 6 (sometimes 7 or 8) segments. Entomostraca, there are four orders called Branchiopoda, Ostracoda, Copecoda, and Cirripedia, while Malacostraca there are three orders, namely: Isopoda, Stomatopoda, and Decapoda Order.

1. Enormostraca (small crustaceans)

   Characteristic: small in size, and is a lot of zooplankton found in sea water or fresh water. Its members consist of the Copepoda Order, the Cladocera Order, the Ostracoda Order, and the Amphipoda Order.

2. Malacostraca (large crustaceans)

   Its members consist of Isopoda Order (legged uniform) that used to live at sea, fresh water or land. For example, grasshopper shrimp and Decapoda Order (ten-legged) which has 5 pairs of limbs in the chest segment as legs, kinds like shrimp, crabs.

The malacostracans are the largest class of Crustacea, with more than 21,000 species including most of the larger and familiar forms such as prawns, crabs and lobsters. The body and appendages are specialised into thoracic and abdominal regions and head bears sensory and feeding appendages. The anterior thoracic limbs are commonly modified as additional mouthparts and limbs for capturing food, and are often chelate; the more posterior thoracic limbs are locomotory *pereiopods*. The abdominal appendages or pleopods are less sturdy and typically are used in slow swimming, the production of respiratory currents and in females for carrying eggs. The telson and uropods form a tail fan which enables rapid backward swimming when the abdomen is flexed – a behavior used to escape predators [2].

Crustacean development can be direct, in which the egg hatches into a fully formed but miniature version of the adult (as in most of the superorder Peracarida), or entirely anamorphic, in which change between successive molts consists essentially of increasing body size, adding segments and limbs, and developing existing limbs. Usually there is some metamorphosis, and at times this can be striking [7]. Typically, crustacean larvae have been grouped broadly into three main types, which are identified by the appendages primarily responsible for swimming; a 'nauplius' swims with its cephalic appendages, a zoea with its thoracic appendages, and a 'megalopa' with its abdominal appendages. The nauplius — zoea — megalopa' series represents a generalized developmental sequence as well, although most

crustaceans do not pass through all three phases. Ecologically, the nauplius and zoea are usually dispersive phases and the megalopa is the transitional setlement phase.

## 4. The numerous economic benefits of Crustaceans to humans

Crustaceans have numerous direct and indirect benefits for the economy as well as human health. For instance, shrimps, crabs, lobsters and other large crustaceans are globally recognized as edible aquatic organisms. Furthermore, the Indonesian maritime has a yearly economic potential of 1.33 trillion USD. Shrimps are the most significant aquatic export commodity, and compose 45% of the country's total fishery export. The worldwide demand for Indonesian shrimp is approximately 560,000–570,000 tons per year, and about 57% of this figure is imported by the United States, the largest destination. Over 60% of the total aquatic produce exported to the US in 2016 was solely shrimp, and this was estimated to cost more than 1 billion USD, and to increase by 2017 in order to meet the increasing global demand. Indonesian shrimp is often exported while frozen or after removing the heads and shells [8]. Meanwhile, copepods, water insects, krill and other small zooplanktonic crustaceans, connect the food chain between photosynthetic phytoplanktons and larger carnivores, including whales and fishes. These petite crustaceans (zooplanktons) are therefore staple nourishment for large aquatic organisms, as several larger vertebrates consume spiders and insects.

### 4.1 Aesthetic value

The crustacean subphylum is considered unique, magnificent and delectable by humans of all ages. These arthropods exist in several shapes, sizes, colors and forms, and are astounding creations of nature. In addition, small crustaceans, including spider, ghost, fiddler (Ocypodidae), moon (Matutidae), rock, lightfooted, paddler (Graspidae), arrow, stone (Leusiidae), box (Calappidae), coconut, and hermit crabs, fairy, cherry, ghost, bamboo and, mantis banana shrimps, as well as freshwater, blue, and tiger crawfishes, as well as blue lobsters, are highly fascinating and invigorating, and therefore often used in aquatic exhibitions. Some prevalent interesting species include freshwater Atyid shrimps from the genus *Caridina, Palaemonetes*, *Atyopsis*, *Triops*, as well as *Neocaridina*, and crawfishes of the genus *Cambarellus* and *Procambarus.*

### 4.2 Commercial value

The cultivation of crustaceans is of great significance to the global aquaculture industry, as the arthropods are rich in protein, and possibly help to meet the food requirements for mankind's ever increasing population. Marine shrimps, crabs, prawns, and lobsters are valuable food sources, and therefore of substantial economic importance to aquatic industries around the world. Furthermore, crustacean aquaculture produce, particularly the true lobsters (*Panulirus versicolor, Homarus gammarus, and Homarus americanus*), are costlier compared to other sources of animal protein. The class of crustacean often cultivated for consumption by humans is Malacostraca, while crabs account for 20% of the marine crustacean species captured, reared and used worldwide. This amounts to about 1.5 million tons per year, and the specie *Portunus pelagicus* comprises one-fifth of this total. Lobster are a magnificent worldwide delicacy and lobster fishing, often referred to as *lobstering*, is the act of collecting marine or spiny lobsters, as well as crawfish, for commercial purposes. The commercial cultivation of shrimp was first practiced in the 1970's,

and production has now developed steeply. Currently, about 75% of the shrimp and prawn cultivated in the world are produced in Asia (particularly, Indonesia, China, and Thailand). These are majorly genus penaeid, and two species, the Giant tiger prawn (*Penaeus monodon*) and the Pacific white shrimp (*Litopenaeus vannamei*, formerly *Penaeus vannamei*) comprise about 80% of all cultivated shrimp [9].

Meanwhile, *Macrobrachium* is the only cultivated genus of freshwater prawns. The species *M. nipponense*, *M. rosenbergii*, and *M. malacolmsonii* are majorly cultivated within the aquaculture industry. In addition, ornamental shrimps and crawfishes are often reared in South East Asia. The commercial fishing of Krill, marine crustaceans of the order Euphausiacea, closely resembling shrimp, as food for people and domesticated animals was first practiced during 19th century, and probably even earlier in Japan. These small invertebrates are present in oceans all around world, including the Southern Ocean, as well as the water body surrounding Japan. About 15o,000 to 20o,000 tons (minimum of 150,000–200,000 and maximum of 170,000–220,000) of krill are captured each year, and this is mostly obtained from the Scotia Ocean. This capture is mainly utilized as feed for aquaculture and aquarium organisms, bait for sport fishing, or to produce pharmaceuticals. Krill is often consumed by people in Japan as well as Russia and is referred to as *okiami* in Japan. In addition, some copepods and branchiopods (fairy shrimp and clam shrimps) are reared commercially for use in fish-farms and aquariums. These organisms therefore provide employment opportunities and recreational interests, through stocking, picking, feeding, sorting, and other activities related to crustacean gathering or cultivation.

### 4.3 Gastronomic value

Archaeologists have shown shellfishes were first used as food over hundreds of thousands of years ago. Practically all the cuisines prepared around the world involve these organisms as a significant protein source, especially in countries around coastal regions. The term "shellfish" is both a fishery and culinary word for edible aquatic invertebrates with exoskeleton, including several species of crustaceans, molluscs and in some cases, echinoderms. Thus, crustaceans are significant in shellfish seafood. These organisms are mainly aquatic and often harvested from saltwater bodies, however, some live in freshwater. Meanwhile, *Cardisoma guanhumi* and some other terrestrial crabs are also consumed, especially in the Caribbeans. Numerous organisms, from smaller animals like penguins and fish to the larger seals and even baleen whales feed on krill. Krills convert nutrient from consumed prey into an appropriate form for consumption by larger animals unable to feed directly on the diminutive algae, and are therefore, a crucial aquatic food chain component. Some species including northern krill, possess a rather small filtering basket and usually prey on copepods as well as larger zooplankton. The most popular commercially relevant species of the Euphausiidae genus include the Antarctic (*Euphausia superba*), Pacific (*Euphausia pacifica*) and Northern krills (*Meganyctiphanes norvegica*). In addition, the most dominant zooplanktons, marine copepods and ostracods are the major food sources for whales, small fishes, seabirds and crustaceans, including krill, in marine, brackish or fresh water bodies [10]. Branchiopods (brine shrimp and fairy shrimp) are utilized as nourishment of fish fry/aquarium fish food. The 90 species of krill are marine, pelagic, shrimp-like animals with shallow carapace. e.g. *Euphausia, Meganyctiphanes*. Species frequently have wide longitudinal but confined latitudinal dispersions and may be exceedingly various, often forming dense feeding swarms. Euphasids range from 40 to 150 mm in length. They are major nourishment source, particularly in Southern Ocean, for predators such as fish and squid and large scale filter-feeders such as baleen whales, and they are of expanding financial significance to humans [2].

### 4.4 Biomedical value

The shells of crabs and other crustaceans are used in medicine to treat and prevent inflammatory diseases. Some researchers at Florida Atlantic University have developed an orally administered crustacean microparticle dietary supplement to prevent and treat IBD and other inflammatory diseases, using the shells of crabs and other crustaceans. These chitin or chitosan microparticles undergo anti-inflammatory mechanisms applicable in the development of novel preventive and therapeutic substances for treating *inflammatory bowel disease* (IBD). The shells are a major, readily available waste produced by the seafood industry, and therefore an appropriate alternative for expensive and ineffective pharmaceutics, while krill oil is used as a dietary supplement. Two articles have been published with regard to the clinical applications of this oil in lipid lowering, arthritis pain relief and function, as well as C-reactive protein. The three most active medicinal components of krill oil are, the fish oil-like omega-3 fatty acids, the omega-3 fatty acids joined with phospholipids through conjugation, majorly phosphatidylcholine (marine lecithin), and the antioxidant, astaxanthin. Meanwhile, a study by the McGill University juxtaposed the impacts of fish and krill oils on cholesterol levels. The results showed a krill oil dosage of 1–3 g per day results in a more optimal treatment for hyperlipidemia, compared to a similar dose of fish oil.

### 4.5 Bioindicator and biomonitor

Crustaceans usually serve as bioindicators or biomonitors in various aquatic environment settings. This is because the arthropods are rather successful, and found in numerous environments including terrestrial, brackish, marine and freshwater habitats. The creatures are therefore, the perfect subjects for comparative analyses. Furthermore, some characteristics peculiar to crustaceans, particularly reproduction schemes, are possibly significant for interpreting data obtained from bio-indication studies based on these organisms, as well as in advancing focus on ecotoxicology. Thus, this presentation aims to highlight the use crustaceans, as biomonitors or bioindicators, especially in freshwater bodies. These two terms have currently not been distinguished. The term "bioindicator" refers to the characterization of a group of organisms in a particular field (in terms of statistics), in order to obtain information regarding the habitat, using the organisms' presence or absence, life history, or population (based on abundance, age distribution age, genetic composition or conditional index), as the study variables. Meanwhile, bio-monitoring involves characterizing living things in a bid to determine the bioavailability and geographical distribution of pollutants by measuring the concentration of accumulated chemicals within specific tissues or in the organism's entire body [11]. Planktonic copepods are crucial in global ecology and to the carbon cycle. Several scientists regard these organisms as the world's largest animal biomass, while others consider this to be the Antarctic krill (*Euphausia superba*). The *Calanus glacialis* inhabit the Arctic region's edge, and comprise up to 80% of the world's zooplankton biomass. In addition, some native species of crustaceans serve as bioindicators of pollution in freshwater bodies. *Palaemonetes argentinus* are able to function as proof of *environmental degradation* caused by pollutants in freshwater *ecosystems* [12]. Therefore, knowledge of pollutant bioaccumulation is required to completely comprehend the effect of pollution on aquatic ecology. Also, feeding and growth patterns, as well as migration and other animal behavior (for instance, precopula) are significant bio-indicators (or biomarkers).

### 4.6 Geological value

The most common arthropods in fossil records are Ostracods (seed shrimp). These fossils were first discovered around the Cambrian era, and continue to be found by archeologists, even in present day. M. B. Hart compiled a microfaunal zone layout base on Ostracoda and Foraminifera arthropods. Freshwater ostracods from the Baltic amber of Eocene era assumed to have been washed onto trees during surges, have also been discovered. These organisms are therefore of geological significance, particularly with respect to local or regional marine strata biozonation. The arthropods are also useful paleo-habitat indicators due to the prevalence, minute size, and the easily preserved generally-moulted and calcified bivalve carapaces, a commonly discovered microfossil [4].

### 4.7 Miscellaneous uses

Living copepods are used as feed in saltwater aquariums, and are generally useful for breeding marine species in captivity, particularly in reef tanks containing the notorious scooter blenny or the mandarin dragonet. Copepods are generally scavengers and in some cases, feed on coralline and other algae. These organisms, and other crustaceans, are popularly supplied as bait within the refugium, in saltwater aquariums. The mole crab or sand flea (*Emerita talpoida*), is a popular bait for game-fishing in oceans. Woodlice are terrestrial crustaceans having segmented, rigid, and long exoskeleton with fourteen jointed appendages, belonging to sub-order Oniscidea, and the order Isopoda. Over 3,000 known species belong to this order, and these organisms are mainly used in gardens for compost production and soil overturning.

### 4.8 Demerits or biodeterioration

#### *4.8.1 Pests*

Numerous water insects, especially spiny water fleas, *Bythotrephes & Cercopagis* species, are regarded as pests within fish farms. These fleas compete with juvenile fish for smaller zooplanktons, and because of quick reproduction rate, monopolize the food source, leaving the fish with lesser nourishment.

#### *4.8.2 Spiny water-flea*

These organisms are possible prey for fish, however, the presence of spine makes small fishes unable to swallow spiny water fleas. Studies have shown these organisms influence the survival and growth of young fish unfavorably, because of competition for food. Experts also assume the fishhook water flea to have similar impact. In addition, lake anglers most probably discover several hundred water fleas, resembling damp cotton, on fishing lines, as the long and spiny tails are easily entangled, and this poses a problem for anglers due to the clogging of the fishing rod's first line guide. Consequently, these fishermen are forced to resort to cutting the lines. Furthermore, woodlice feed on cultivated plants, including delicate seedlings and maturing strawberries, and also attack homes in groups looking for moisture, and therefore serve as an indicator for inadequate or excessive moisture. However, these organisms are not regarded as a serious household vermin, because woodlice are not disease vectors or destructive creatures. Conversely, Isopods, commonly referred to as gribble worms, belong to the

Limnoridae and Cheluridae families, and are productive borers, responsible for devastation of submerged timbers.

### 4.9 Poisonous Crustaceans

The species *Speleonectes atlantida*, an eyeless crustacean, of the Nectiopoda order was first discovered in August 2009 inside the Tunnel de la Atlantida, the longest submarine magma tube on Lanzarote, within in the west coast of the North African Canary Islands. This species possesses prehensile appendages, as well as venomous teeth serving as hypodermic needles. Meanwhile, the Coconut crab is consumed by indigenes of the Tuamotu Archipelago, and several cases of acute and lethal poisoning have been recorded within the region. Also, paralytic shellfish cause (saxitoxin) or tetrodotoxin poisoning, depending on the quantity of poison ingested.

#### *4.9.1 Parasitism*

Crustaceans are externally or internally parasitic to some organisms, especially as external parasites in fish. Furthermore, these arthropods are intermediate host for various pathogens, and first intermediate hosts for proceroid phase in several cestodes. *Argulus,* often referred to as "fish lice", and several other copepods, are particularly common parasitic crustaceans prevailing. These vampiric fish lice with dome-shells and beady-eyes, attach to scales using antennae in the shape of huge, spiked suckers.

Meanwhile, isopods, including woodlice and pillbugs belong to the family Gnathiidae, and are extremely similar to ticks, but lie in wait for fish. Prior to moulting into a non-parasitic phase, the fish-chigger feeds on blood for some days, and this cycle is repeated a few times during the organism's life cycle, while the *Cymothoa exigua*, known as tongue-eating lice, are possible parasitic crustaceans, belonging to the Cymothoidae family. These parasites invade fish from the gills, and subsequently, attach to the base of the tongue. In addition, the soft, tiny and globular pea-crabs (Pinnotherid) invade hosts durings as hatchlings, and subsequently feed and grow. The main hosts of parasitic crustaceans include oysters and other mussels, as well as echinoderm body cavities (sea cucumbers and urchins), snail shells, certain worms or and even sea squirts (within the gills).

#### *4.9.2 Pea-crab in bivalve molluscs*

*Sacculina*, and other rhizocephalans ("root heads") are born as "cyprid", as observed in several barnacles, then swim freely in search of host, unlike other barnacles. These hosts include other crustaceans, including live crabs, and in some cases, about half of the entire crab population is infested. Some other parasitic crustaceans include sarcotacids (skin-bags), pentastomids (five-mouths/tongue-worm), and siphonostomatoids (flesh-Anchors).

## 5. Conclusions

Crustaceans are a major group belonging to the Arthropoda subphylum, often used as food for animals and humans. Furthermore, at least 50,000 to 75,000 species of crustaceans have been recorded worldwide. These creatures, particularly crabs, shrimps, prawns, lobsters, and other decapods, are also the most significant source of animal protein for the human population, and are a significant sustainable

part of modern culture and commerce, bio-medicine and economic development, aesthetics, gastronomy, geology, and many other fields.

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## Conflict of interest

Authors declare no conflict of interest.

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