

= Crustacean =

Crustaceans ( Crustacea / kr??ste??? / ) form a very large group of arthropods , usually treated as a subphylum , which includes such familiar animals as crabs , lobsters , crayfish , shrimp , krill and barnacles . Thanks to recent molecular studies , it is now well accepted that the crustacean group comprises all animals in the Pancrustacea clade other than hexapods . In other words , some crustaceans are more closely related to insects and other hexapods than they are to certain other crustaceans .

The 67 @, @ 000 described species range in size from *Stygotantulus stocki* at 0 @. @ 1 mm ( 0 @. @ 004 in ) , to the Japanese spider crab with a leg span of up to 3 @. @ 8 m ( 12 @. @ 5 ft ) and a mass of 20 kg ( 44 lb ) . Like other arthropods , crustaceans have an exoskeleton , which they moult to grow . They are distinguished from other groups of arthropods , such as insects , myriapods and chelicerates , by the possession of biramous ( two @- @ parted ) limbs , and by their larval forms , such as the nauplius stage of branchiopods and copepods .

Most crustaceans are free @- @ living aquatic animals , but some are terrestrial ( e.g. woodlice ) , some are parasitic ( e.g. *Rhizocephala* , fish lice , tongue worms ) and some are sessile ( e.g. barnacles ) . The group has an extensive fossil record , reaching back to the Cambrian , and includes living fossils such as *Triops cancriformis* , which has existed apparently unchanged since the Triassic period . More than 10 million tons of crustaceans are produced by fishery or farming for human consumption , the majority of it being shrimp and prawns . Krill and copepods are not as widely fished , but may be the animals with the greatest biomass on the planet , and form a vital part of the food chain . The scientific study of crustaceans is known as carcinology ( alternatively , malacostracology , crustaceology or crustalogy ) , and a scientist who works in carcinology is a carcinologist .

= = Structure = =

The body of a crustacean is composed of segments , which are grouped into three regions : the cephalon or head , the thorax , and the pleon or abdomen . The head and thorax may be fused together to form a cephalothorax , which may be covered by a single large carapace . The crustacean body is protected by the hard exoskeleton , which must be moulted for the animal to grow . The shell around each somite can be divided into a dorsal tergum , ventral sternum and a lateral pleuron . Various parts of the exoskeleton may be fused together .

Each somite , or body segment can bear a pair of appendages : on the segments of the head , these include two pairs of antennae , the mandibles and maxillae ; the thoracic segments bear legs , which may be specialised as pereopods ( walking legs ) and maxillipeds ( feeding legs ) . The abdomen bears pleopods , and ends in a telson , which bears the anus , and is often flanked by uropods to form a tail fan . The number and variety of appendages in different crustaceans may be partly responsible for the group 's success .

Crustacean appendages are typically biramous , meaning they are divided into two parts ; this includes the second pair of antennae , but not the first , which is usually uniramous , the exception being in the Class Malacostraca where the antennules may be generally biramous or even triramous . It is unclear whether the biramous condition is a derived state which evolved in crustaceans , or whether the second branch of the limb has been lost in all other groups . Trilobites , for instance , also possessed biramous appendages .

The main body cavity is an open circulatory system , where blood is pumped into the haemocoel by a heart located near the dorsum . Malacostraca have haemocyanin as the oxygen @- @ carrying pigment , while copepods , ostracods , barnacles and branchiopods have haemoglobins . The alimentary canal consists of a straight tube that often has a gizzard @- @ like " gastric mill " for grinding food and a pair of digestive glands that absorb food ; this structure goes in a spiral format . Structures that function as kidneys are located near the antennae . A brain exists in the form of ganglia close to the antennae , and a collection of major ganglia is found below the gut .

In many decapods , the first ( and sometimes the second ) pair of pleopods are specialised in the

male for sperm transfer . Many terrestrial crustaceans ( such as the Christmas Island red crab ) mate seasonally and return to the sea to release the eggs . Others , such as woodlice , lay their eggs on land , albeit in damp conditions . In most decapods , the females retain the eggs until they hatch into free @-@ swimming larvae .

= = Ecology = =

The majority of crustaceans are aquatic , living in either marine or freshwater environments , but a few groups have adapted to life on land , such as terrestrial crabs , terrestrial hermit crabs , and woodlice . Marine crustaceans are as ubiquitous in the oceans as insects are on land . The majority of crustaceans are also motile , moving about independently , although a few taxonomic units are parasitic and live attached to their hosts ( including sea lice , fish lice , whale lice , tongue worms , and *Cymothoa exigua* , all of which may be referred to as " crustacean lice " ) , and adult barnacles live a sessile life ? they are attached headfirst to the substrate and cannot move independently . Some branchiurans are able to withstand rapid changes of salinity and will also switch hosts from marine to non @-@ marine species . Krill are the bottom layer and the most important part of the food chain in Antarctic animal communities . Some crustaceans are significant invasive species , such as the Chinese mitten crab , *Eriocheir sinensis* , and the Asian shore crab , *Hemigrapsus sanguineus* .

= = Life cycle = =

= = = Mating system = = =

The majority of crustaceans have separate sexes , and reproduce sexually . A small number are hermaphrodites , including barnacles , remipedes , and Cephalocarida . Some may even change sex during the course of their life . Parthenogenesis is also widespread among crustaceans , where viable eggs are produced by a female without needing fertilisation by a male . This occurs in many branchiopods , some ostracods , some isopods , and certain " higher " crustaceans , such as the Marmorkrebs crayfish .

= = = Eggs = = =

In many groups of crustaceans , the fertilised eggs are simply released into the water column , while others have developed a number of mechanisms for holding on to the eggs until they are ready to hatch . Most decapods carry the eggs attached to the pleopods , while peracarids , notostracans , anostracans , and many isopods form a brood pouch from the carapace and thoracic limbs . Female Branchiura do not carry eggs in external ovisacs but attach them in rows to rocks and other objects . Most leptostracans and krill carry the eggs between their thoracic limbs ; some copepods carry their eggs in special thin @-@ walled sacs , while others have them attached together in long , tangled strings .

= = = Larvae = = =

Crustaceans exhibit a number of larval forms , of which the earliest and most characteristic is the nauplius . This has three pairs of appendages , all emerging from the young animal 's head , and a single naupliar eye . In most groups , there are further larval stages , including the zoea ( pl. zoeæ or zoeas ) . This name was given to it when naturalists believed it to be a separate species . It follows the nauplius stage and precedes the post @-@ larva . Zoea larvae swim with their thoracic appendages , as opposed to nauplii , which use cephalic appendages , and megalopa , which use abdominal appendages for swimming . It often has spikes on its carapace , which may assist these small organisms in maintaining directional swimming . In many decapods , due to their accelerated

development , the zoea is the first larval stage . In some cases , the zoea stage is followed by the mysis stage , and in others , by the megalopa stage , depending on the crustacean group involved .

#### = = Classification = =

The name " crustacean " dates from the earliest works to describe the animals , including those of Pierre Belon and Guillaume Rondelet , but the name was not used by some later authors , including Carl Linnaeus , who included crustaceans among the " Aptera " in his *Systema Naturae* . The earliest nomenclaturally valid work to use the name " Crustacea " was Morten Thrane Brännich 's *Zoologiæ Fundamenta* in 1772 , although he also included chelicerates in the group .

The subphylum Crustacea comprises almost 67 000 described species , which is thought to be just 1 ? 10 to 1 ? 100 of the total number as the majority of species remain as yet undiscovered . Although most crustaceans are small , their morphology varies greatly and includes both the largest arthropod in the world ? the Japanese spider crab with a leg span of 3 @. @ 7 metres ( 12 ft ) ? and the smallest , the 1 @- @ micrometre @- @ long ( 0 @. @ 00004 in ) *Stygotantulus stocki* . Despite their diversity of form , crustaceans are united by the special larval form known as the nauplius .

The exact relationships of the Crustacea to other taxa are not completely settled as of April 2012 . Studies based on morphology led to the Pancrustacea hypothesis , in which Crustacea and Hexapoda ( insects and allies ) are sister groups . More recent studies using DNA sequences suggest that Crustacea is paraphyletic , with the hexapods nested within a larger Pancrustacea clade .

Although the classification of crustaceans has been quite variable , the system used by Martin and Davis largely supersedes earlier works . Mystacocarida and Branchiura , here treated as part of Maxillopoda , are sometimes treated as their own classes . Six classes are usually recognised :

#### = = Fossil record = =

Crustaceans have a rich and extensive fossil record , which begins with animals such as *Canadaspis* and *Perspicaris* from the Middle Cambrian age Burgess Shale . Most of the major groups of crustaceans appear in the fossil record before the end of the Cambrian , namely the Branchiopoda , Maxillopoda ( including barnacles and tongue worms ) and Malacostraca ; there is some debate as to whether or not Cambrian animals assigned to Ostracoda are truly ostracods , which would otherwise start in the Ordovician . The only classes to appear later are the Cephalocarida , which have no fossil record , and the Remipedia , which were first described from the fossil *Tesnusocaris goldichi* , but do not appear until the Carboniferous . Most of the early crustaceans are rare , but fossil crustaceans become abundant from the Carboniferous period onwards .

Within the Malacostraca , no fossils are known for krill , while both Hoplocarida and Phyllopoda contain important groups that are now extinct as well as extant members ( Hoplocarida : mantis shrimp are extant , while Aeschronectida are extinct ; Phyllopoda : *Canadaspidida* are extinct , while *Leptostraca* are extant ) . Cumacea and Isopoda are both known from the Carboniferous , as are the first true mantis shrimp . In the Decapoda , prawns and polychelids appear in the Triassic , and shrimp and crabs appear in the Jurassic ; however , the great radiation of crustaceans occurred in the Cretaceous , particularly in crabs , and may have been driven by the adaptive radiation of their main predators , bony fish . The first true lobsters also appear in the Cretaceous .

#### = = Consumption by humans = =

Many crustaceans are consumed by humans , and nearly 10 @, @ 700 @, @ 000 tons were produced in 2007 ; the vast majority of this output is of decapod crustaceans : crabs , lobsters , shrimp , crawfish , and prawns . Over 60 % by weight of all crustaceans caught for consumption are shrimp and prawns , and nearly 80 % is produced in Asia , with China alone producing nearly half the world 's total . Non @- @ decapod crustaceans are not widely consumed , with only 118 @, @

000 tons of krill being caught , despite krill having one of the greatest biomasses on the planet .