

= Lobatus gigas =

*Lobatus gigas* , commonly known as the queen conch , is a species of large edible sea snail , a marine gastropod mollusc in the family of true conches , the Strombidae . This species is one of the largest molluscs native to the tropical northwestern Atlantic , from Bermuda to Brazil , reaching up to 35 @. @ 2 centimetres ( 13 @. @ 9 in ) in shell length . *L. gigas* is closely related to the goliath conch , *Lobatus goliath* , a species endemic to Brazil , as well as the rooster conch , *Lobatus gallus* .

The queen conch is herbivorous and lives in seagrass beds , although its exact habitat varies by development stage . The adult animal has a very large , solid and heavy shell , with knob @-@ like spines on the shoulder , a flared thick , outer lip and a characteristic pink @-@ coloured aperture ( opening ) . The flared lip is absent in younger specimens . The external anatomy of the soft parts of *L. gigas* is similar to that of other snails in its family ; it has a long snout , two eyestalks with well @-@ developed eyes , additional sensory tentacles , a strong foot and a corneous , sickle @-@ shaped operculum .

The shell and soft parts of living *L. gigas* serve as a home to several different kinds of commensal animals , including slipper snails , porcelain crabs and cardinalfish . Its parasites include coccidians . The queen conch is hunted and eaten by several species of large predatory sea snails , and also by starfish , crustaceans and vertebrates ( fish , sea turtles and humans ) . Its shell is sold as a souvenir and used as a decorative object . Historically , Native Americans and indigenous Caribbean peoples used parts of the shell to create various tools .

International trade in queen conch is regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora ( CITES ) agreement , in which it is listed as *Strombus gigas* . This species is not endangered in the Caribbean as a whole , but is commercially threatened in numerous areas , largely due to extreme overfishing .

= = Taxonomy and etymology = =

= = = History = = =

The queen conch was originally described from a shell in 1758 by Swedish naturalist and taxonomist Carl Linnaeus , who originated the system of binomial nomenclature . Linnaeus named the species *Strombus gigas* , which remained the accepted name for over 200 years . Linnaeus did not mention a specific locality for this species , giving only " America " as the type locality . The specific name is the ancient Greek word *gigas* ( ????? ) , which means " giant " , referring to the large size of this snail compared with almost all other gastropod molluscs . *Strombus lucifer* , which was considered to be a synonym much later , was also described by Linnaeus in *Systema Naturae* .

In the first half of the 20th century , the type material for the species was thought to have been lost ; in other words , the shell on which Linnaeus based his original description and which would very likely have been in his own collection , was apparently missing , which created a problem for taxonomists . To remedy this , in 1941 a neotype of this species was designated by the American malacologists William J. Clench and R. Tucker Abbott . In this case , the neotype was not an actual shell or whole specimen , but a figure from a 1684 book *Recreatio mentis , et oculi* , published 23 years before Linnaeus was born by the Italian scholar Filippo Buonanni . This was the first book that was solely about seashells . In 1953 the Swedish malacologist Nils Hjalmar Odhner searched the Linnaean Collection at Uppsala University and discovered the missing type shell , thereby invalidating Clench and Abbott 's neotype designation .

Strombidae 's taxonomy was extensively revised in the 2000s and a few subgenera , including *Eustrombus* , were elevated to genus level by some authors . Petuch and Petuch and Roberts recombined this species as *Eustrombus gigas* , and Landau and collaborators ( 2008 ) recombined it as *Lobatus gigas* .

## == Phylogeny ==

The phylogenetic relationships among the Strombidae were mainly formed by Simone ( 2005 ) and Latiolais ( 2006 ) , using two distinct methods . Simone proposed a cladogram ( a tree of descent ) based on an extensive morpho @-@ anatomical analysis of representatives of Aporrhaidae , Strombidae , Xenophoridae and Struthiolariidae , which included *L. gigas* ( there referred to as *Eustrombus gigas* ) .

With the exception of *Lambis* and *Terebellum* , the remaining taxa were previously allocated in the genus *Strombus* , including *L. gigas* . However , according to Simone , only *Strombus gracilior* , *Strombus alatus* and *Strombus pugilis* , the type species , remained within *Strombus* , as they constituted a distinct group based on at least five synapomorphies ( traits that are shared by two or more taxa and their most recent common ancestor ) . The remaining taxa were previously considered subgenera and were elevated to genus level by Simone . Genus *Eustrombus* ( now considered a synonym of *Lobatus* ) , in this case , included *Eustrombus gigas* ( now considered a synonym of *Lobatus gigas* ) and *Eustrombus goliath* ( = *Lobatus goliath* ) , which were thus considered closely related .

In a different approach , Latiolais and colleagues ( 2006 ) proposed another cladogram that attempts to show the phylogenetic relationships of 34 species within the family Strombidae . The authors analysed 31 *Strombus* species , including *Lobatus gigas* ( there referred to as *Strombus gigas* ) , and three species in the allied genus *Lambis* . The cladogram was based on DNA sequences of both nuclear histone H3 and mitochondrial cytochrome @-@ c oxidase I ( COI ) protein @-@ coding gene regions . In this proposed phylogeny , *Strombus gigas* and *Strombus gallus* ( = *Lobatus gallus* ) are closely related and appear to share a common ancestor .

## == Common names ==

Common names include " queen conch " and " pink conch " in English , caracol rosa and caracol rosado in Mexico , caracol de pala , cobo , botuto and guarura in Venezuela , caracol reina , lambí in the Dominican Republic , and carrucho in Puerto Rico .

## == Anatomy ==

## == Shell ==

The mature shell is typically 15 ? 31 centimetres ( 5 @. 9 ? 12 @. 2 in ) in length , while the maximum reported size is 35 @. 2 centimetres ( 13 @. 9 in ) . The shell is very solid and heavy , with 9 to 11 whorls and a widely flaring and thickened outer lip . Although this notch is not as well developed as elsewhere in the family , the shell feature is nonetheless visible in an adult dextral ( normal right @-@ handed ) specimen , as a secondary anterior indentation in the lip , to the right of the siphonal canal ( viewed ventrally ) . The animal 's left eyestalk protrudes through this notch .

The spire is a protruding part of the shell that includes all of the whorls except the largest and final whorl ( known as the body whorl ) . It is usually more elongated than in other strombid snails , such as the closely related and larger goliath conch , *Lobatus goliath* that is endemic to Brazil . In *L. gigas* , the glossy finish or glaze around the aperture of the adult shell is primarily in pale shades of pink . It may show a cream , peach or yellow colouration , but it can also sometimes be tinged with a deep magenta , shading almost to red . The periostracum , a layer of protein ( conchiolin ) that is the outermost part of the shell surface , is thin and a pale brown or tan colour .

The overall shell morphology of *L. gigas* is not solely determined by the animal 's genes ; environmental conditions such as location , diet , temperature and depth , and biological interactions such as predation , can greatly affect it . Juvenile conches develop heavier shells when exposed to predators . Conches also develop wider and thicker shells with fewer but longer spines in deeper water .

The shells of juvenile queen conches are strikingly different in appearance from those of the adults . Noticeable is the complete absence of a flared outer lip ; juvenile shells have a simple sharp lip , which gives the shell a conical or biconic outline . In Florida , juvenile queen conches are known as " rollers " , because wave action very easily rolls their shells , whereas it is nearly impossible to roll an adult specimen , due to its shell 's weight and asymmetric profile . Subadult shells have a thin flared lip that continues to increase in thickness until death .

= = = Historic illustrations = = =

Index Testarum Conchyliorum ( published in 1742 by the Italian physician and malacologist Niccolò Gualtieri ) contains three illustrations of adult shells from different perspectives . The knobbed spire and the flaring outer lip , with its somewhat wing @-@ like contour expanding out from the last whorl , is a striking feature of these images . The shells are shown as if balancing on the edge of the lip and / or the apex ; this was presumably done for artistic reasons as these shells cannot balance like this .

One of the most prized shell publications of the 19th century , a series of books titled *Illustrations conchyliologiques ou description et figures de toutes les coquilles connues , vivantes et fossiles* ( published by the French naturalist Jean @-@ Charles Chenu from 1842 to 1853 ) , contains illustrations of both adult and juvenile *L. gigas* shells and one uncoloured drawing depicting some of the animal 's soft parts . Almost forty years later , a colored illustration from the *Manual of Conchology* ( published in 1885 by the American malacologist George Washington Tryon ) shows a dorsal view of a small juvenile shell with its typical brown and white patterning .

= = = Soft parts = = =

Many details about the anatomy of *Lobatus gigas* were not well known until Colin Little 's 1965 general study . In 2005 , R. L. Simone gave a detailed anatomical description . *L. gigas* has a long extensible snout with two eyestalks ( also known as ommatophores ) that originate from its base . The tip of each eyestalk contains a large , well @-@ developed lensed eye , with a black pupil and a yellow iris and a small slightly posterior sensory tentacle . Amputated eyes completely regenerate . Inside the mouth of the animal is a radula ( a tough ribbon covered in rows of microscopic teeth ) of the taenioglossan type . Both the snout and the eyestalks show dark spotting in the exposed areas . The mantle is darkly coloured in the anterior region , fading to light gray at the posterior end , while the mantle collar is commonly orange . The siphon is also orange or yellow . When the soft parts of the animal are removed from the shell , several organs are distinguishable externally , including the kidney , the nephridial gland , the pericardium , the genital glands , stomach , style sac and the digestive gland . In adult males , the penis is also visible .

= = = Foot / locomotion = = =

The species has a large and powerful foot with brown spots and markings towards the edge , but is white nearer to the visceral hump that stays inside the shell and accommodates internal organs . The base of the anterior end of the foot has a distinct groove , which contains the opening of the pedal gland . Attached to the posterior end of the foot for about one third of its length is the dark brown , corneous , sickle @-@ shaped operculum , which is reinforced by a distinct central rib . The base of the posterior two @-@ thirds of the animal 's foot is rounded ; only the anterior third touches the ground during locomotion . The columella , the central pillar within the shell , serves as the attachment point for the white columellar muscle . Contraction of this strong muscle allows the animal 's soft parts to shelter in the shell in response to undesirable stimuli .

*Lobatus gigas* has an unusual means of locomotion , first described in 1922 by George Howard Parker ( 1864 ? 1955 ) . The animal first fixes the posterior end of the foot by thrusting the point of the sickle @-@ shaped operculum into the substrate , then it extends the foot in a forward direction , lifting and throwing the shell forward in a so @-@ called leaping motion . This way of moving is

considered to resemble that of pole vaulting , making *L. gigas* a good climber even of vertical concrete surfaces . This leaping locomotion may help prevent predators from following the snail 's chemical traces , which would otherwise leave a continuous trail on the substrate .

#### = = Life cycle = =

*Lobatus gigas* is gonochoristic , which means each individual snail is either distinctly male or distinctly female . Females are usually larger than males in natural populations , with both sexes existing in similar proportion . After internal fertilization , the females lay eggs in gelatinous strings , which can be as long as 75 feet ( 23 m ) . These are layered on patches of bare sand or seagrass . The sticky surface of these long egg strings allows them to coil and agglutinate , mixing with the surrounding sand to form compact egg masses , the shape of which is defined by the anterior portion of the outer lip of the female 's shell while they are layered . Each one of the egg masses may have been fertilized by multiple males . The number of eggs per egg mass varies greatly depending on environmental conditions such as food availability and temperature . Commonly , females produce 8 ? 9 egg masses per season , each containing 180 @, @ 000 ? 460 @, @ 000 eggs , but numbers can be as high as 750 @, @ 000 eggs . *L. gigas* females may spawn multiple times during the reproductive season , which lasts from March to October , with activity peaks occurring from July to September .

Queen conch embryos hatch 3 ? 5 days after spawning . At the moment of hatching , the protoconch ( embryonic shell ) is translucent and has a creamy , off @-@ white background color with small , pustulate markings . This coloration is different from other Caribbean *Lobatus* , such as *Lobatus raninus* and *Lobatus costatus* , which have unpigmented embryonic shells . Afterwards , the emerging two @-@ lobed veliger ( a larval form common to various marine and fresh @-@ water gastropod and bivalve mollusks ) spend several days developing in the plankton , feeding primarily on phytoplankton . Metamorphosis occurs some 16 ? 40 days from the hatching , when the fully grown protoconch is about 1 @. @ 2 mm high . After the metamorphosis , *L. gigas* individuals spend the rest of their lives in the benthic zone ( on or in the sediment surface ) , usually remaining buried during their first year of life . The queen conch reaches sexual maturity at approximately 3 to 4 years of age , reaching a shell length of nearly 180 mm and weighing up to 5 pounds . Individuals may usually live up to 7 years , though in deeper waters their lifespan may reach 20 ? 30 years and maximum lifetime estimates reach 40 years . It is believed that the mortality rate tends to be lower in matured conchs due to their thickened shell , but it could be substantially higher for juveniles . Estimates have demonstrated that its mortality rate decreases as its size increases and can also vary due to habitat , season and other factors .

#### = = Ecology = =

#### = = = Distribution = = =

*Lobatus gigas* is native to the tropical Western Atlantic coasts of North and Central America in the greater Caribbean tropical zone . Although the species undoubtedly occurs in other places , this species has been recorded within the scientific literature as occurring , in : Aruba , ( Netherlands Antilles ) ; Barbados ; the Bahamas ; Belize ; Bermuda ; North and northeastern regions of Brazil ( though this is contested ) ; Old Providence Island in Colombia ; Costa Rica ; the Dominican Republic ; Panama ; Swan Islands in Honduras ; Jamaica ; Martinique ; Alacran Reef , Campeche , Cayos Arcas and Quintana Roo , in Mexico ; Puerto Rico ; Saint Barthélemy ; Mustique and Grenada in the Grenadines ; Pinar del Río , North Havana Province , North Matanzas , Villa Clara , Cienfuegos , Holguín , Santiago de Cuba and Guantánamo , in the Turks and Caicos Islands and Cuba ; South Carolina , Florida , with the Florida Keys and Flower Garden Banks National Marine Sanctuary , in the United States ; Carabobo , Falcon , Gulf of Venezuela , Los Roques archipelago , Los Testigos Islands and Sucre in Venezuela ; St. Croix in the Virgin Islands .

### == Habitat ==

*Lobatus gigas* lives at depths from 0 @. @ 3 ? 18 m to 25 ? 35 m . Its depth range is limited by the distribution of seagrass and algae cover . In heavily exploited areas , the queen conch is more abundant in the deepest range . The queen conch lives in seagrass meadows and on sandy substrate , usually in association with turtle grass ( species of the genus *Thalassia* , specifically *Thalassia testudinum* and also *Syringodium* sp . ) and manatee grass ( *Cymodocea* sp . ) . Juveniles inhabit shallow , inshore seagrass meadows , while adults favor deeper algal plains and seagrass meadows . The critical nursery habitats for juvenile individuals are defined by a series of characteristics , including tidal circulation and macroalgal production , which together enable high rates of recruitment and survival . *L. gigas* is typically found in distinct aggregates that may contain several thousand individuals .

### == Diet ==

Strombid gastropods were widely accepted as carnivores by several authors in the 19th century , a concept that persisted until the first half of the 20th century . This erroneous idea originated in the writings of Jean @-@ Baptiste Lamarck , who classified strombids with other supposedly carnivorous snails . This idea was subsequently repeated by other authors , but were not supported by observation . Subsequent studies have refuted the concept , proving beyond doubt that strombid gastropods are herbivorous animals . In common with other Strombidae , *Lobatus gigas* is a specialized herbivore , that feeds on macroalgae ( including red algae , such as species of *Gracilaria* and *Hypnea* ) , seagrass and unicellular algae , intermittently also feeding on algal detritus . The green macroalgae *Batophora oerstedii* is one of its preferred foods .

### == Interactions ==

A few different animals establish commensal interactions with *L. gigas* , which means that both organisms maintain a relationship that benefits ( the commensal ) species but not the other ( in this case , the queen conch ) . Commensals of this species include certain mollusks , mainly slipper shells ( *Crepidula* spp . ) The porcelain crab *Porcellana sayana* is also known to be a commensal and a small cardinalfish , known as the conch fish ( *Astrapogon stellatus* ) , sometimes shelters in the conch 's mantle for protection . *L. gigas* is very often parasitized by protists of the phylum Apicomplexa , which are common mollusk parasites . Those coccidian parasites , which are spore @-@ forming , single @-@ celled microorganisms , initially establish themselves in large vacuolated cells of the host 's digestive gland , where they reproduce freely . The infestation may proceed to the secretory cells of the same organ . The entire life cycle of the parasite typically occurs within a single host and tissue .

*L. gigas* is a prey species for several carnivorous gastropod mollusks , including the apple murex *Phyllonotus pomum* , the horse conch *Pleuroploca gigantea* , the lamp shell *Turbinella angulata* , the moon snails *Natica* spp. and *Polinices* spp . , the muricid snail *Murex margaritensis* , the trumpet triton *Charonia variegata* and the tulip snail *Fasciolaria tulipa* . Crustaceans are also conch predators , such as the blue crab *Callinectes sapidus* , the box crab *Calappa gallus* , the giant hermit crab *Petrochirus diogenes* , the spiny lobster *Panulirus argus* and others . Sea stars , vertebrates , including fish ( such as the permit *Trachinotus falcatus* and the porcupine fish *Diodon hystrix* ) , loggerhead sea turtles ( *Caretta caretta* ) and humans also dine on the queen conch .

### == Human uses ==

Conch meat has been consumed for centuries and has traditionally been an important part of the diet in many islands in the West Indies and Southern Florida . It is consumed raw , marinated , minced or chopped in a wide variety of dishes , such as salads , chowder , fritters , soups , stew ,

pâtés and other local recipes . In Spanish @-@ speaking regions , for example in the Dominican Republic , *Lobatus gigas* meat is known as lambí . Although conch meat is used mainly for human consumption , it is also sometimes employed as fishing bait ( usually the foot ) . *L. gigas* is among the most important fishery resources in the Caribbean : its harvest value was US \$ 30 million in 1992 , increasing to \$ 60 million in 2003 . The total annual harvest of meat of *L. gigas* ranged from 6 @,@ 519 @,@ 711 kg to 7 @,@ 369 @,@ 314 kg between 1993 and 1998 , later production declined to 3 @,@ 131 @,@ 599 kg in 2001 . Data about US imports shows a total of 1 @,@ 832 @,@ 000 kg in 1998 , as compared to 387 @,@ 000 kg in 2009 , a nearly 80 % reduction twelve years later .

Queen conch shells were used by Native Americans and Caribbean Indians in a wide variety of ways . South Florida bands ( such as the Tequesta ) , the Carib , the Arawak and Taíno used conch shells to fabricate tools ( such as knives , axe heads and chisels ) , jewelry , cookware and used them as blowing horns . In Mesoamerican history , Aztecs used the shell as part of jewelry mosaics such as the double @-@ headed serpent . The Aztecs also believed that the sound of trumpets made from queen conch shells represented divine manifestations , and used them in religious ceremonies . In central Mexico , during rain ceremonies dedicated to Tlaloc , the Maya used conch shells as hand protectors ( in a manner similar to boxing gloves ) during combat . Ancient middens of *L. gigas* shells bearing round holes are considered an evidence that pre @-@ Columbian Lucayan Indians in the Bahamas used the queen conch as a food source .

Brought by explorers , queen conch shells quickly became a popular asset in early modern Europe . In the late 17th century they were widely used as decoration over fireplace mantels and English gardens , among other places . In contemporary times , queen conch shells are mainly utilized in handicraft . Shells are made into cameos , bracelets and lamps , and traditionally as doorstops or decorations by families of seafaring men . The shell continues to be popular as a decorative object , though its export is now regulated and restricted by the CITES agreement . In modern culture , queen conch shells are often represented in everyday objects such as coins and stamps .

Very rarely ( about 1 in 10 @,@ 000 conchs ) , a conch pearl may be found within the mantle . Though they occur in a range of colors corresponding to the colors of the interior of the shell , pink specimens are the most valuable . These pearls are considered semi @-@ precious , and a popular tourist curio . The best specimens have been used to create necklaces and earrings . A conch pearl is a non @-@ nacreous pearl ( formerly referred to by some sources as a ' calcareous concretion ' ) which differs from most pearls that are sold as gemstones .

= = Status = =

= = = Threats = = =

Within the conch fisheries , one of the threats to sustainability stems from the fact that there is almost as much meat in large juveniles as there is in adults , but only adult conchs can reproduce , and thus sustain a population . In many places where adult conchs have become rare due to overfishing , larger juveniles and subadults are taken before they ever mate . On a number of islands , subadults provide the majority of the harvest . *Lobatus gigas* abundance is declining throughout its range as a result of overfishing and poaching . Trade from many Caribbean countries such as Antigua and Barbuda , Honduras , Haiti and the Dominican Republic is known or thought to be unsustainable . As of 2001 , queen conch populations in at least 15 Caribbean countries and states were overfished and / or overexploited . Illegal harvest , including fishing in foreign waters and subsequent illegal international trade , is a common problem in the region . The Caribbean " International Queen Conch Initiative " is an international attempt at managing this species .

= = = Conservation = = =

The queen conch fishery is usually managed under the regulations of individual nations . In the

United States all taking of queen conch is prohibited in Florida and in adjacent Federal waters . No international regional fishery management organization exists for the whole Caribbean area , but in places such as Puerto Rico and the Virgin Islands , queen conch is regulated under the auspices of the Caribbean Fishery Management Council ( CFMC ) . In 2014 , the Parties to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region ( Cartagena Convention ) included queen conch in Annex III of its Protocol Concerning Specially Protected Areas and Wildlife ( SPAW Protocol ) . Species included in the Annex III require special measures to be taken to ensure their protection and recovery , and their use is authorised and regulated accordingly .

This species has been mentioned in the Convention on International Trade in Endangered Species of Wild Fauna and Flora ( CITES ) since 1985 . In 1992 the United States proposed queen conch for listing in CITES Appendix II , making queen conch the first large @-@ scale fisheries product to be regulated by CITES ( as *Strombus gigas* ) . In 1995 CITES began reviewing the biological and trade status of the queen conch under its " Significant Trade Review " process . These reviews are undertaken to address concerns about trade levels in an Appendix II species . Based on the 2003 review , CITES recommended that all countries prohibit importation from Honduras , Haiti and the Dominican Republic , according to Standing Committee Recommendations . Queen conch meat continues to be available from other Caribbean countries , including Jamaica and Turks and Caicos , which operate well @-@ managed queen conch fisheries . For conservation reasons , the Government of Colombia currently bans the commercialisation and consumption of the conch between the months of June and October .