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Chapter 1 : Mating and Reproduction

The sexual behavior of mollusks by Beatrice E. Winner, , E.B.M edition, Unknown Binding in English.

Head of Helix pomatia after mating with everted vagina V and penis P. Pulmonate land gastropods are simultaneous hermaphroditic and their reproductive system is complex. It is all completely internal, except for the active protrusion eversion of the penis for copulation. The outer opening of the reproductive system is called the "genital pore"; it is positioned on the right hand side, very close to the head of the animal. This opening is virtually invisible however, unless it is actively in use. The love-dart if available is produced and stored in the stylophore often called dart sac and shot by a forceful eversion of this organ. The mucus glands produce the mucus that is deposited on the dart before shooting. The penis is intromitted to transfer the spermatophore. When a bursa tract diverticulum is present, the spermatophore is received in this organ. Together with the bursa tract and bursa copulatrix these form the spermatophore-receiving organ, which digest sperm and spermatophores. Sperm swim out via the tail of the spermatophore to enter the female tract and reach the sperm storage organ spermathecae within the fertilization pouch-spermathecal complex. Helix pomatia The structure of the reproductive system is strictly hermaphroditic. From the gonads , a hermaphrodite duct, a duct which is designed to transport both sperm and eggs, leads to a portion of the reproductive tract where the duct splits into a strictly male and strictly female portion. The male portion of the reproductive tract includes both a short posterior vas deferens and a longer anterior vas deferens. The posterior vas deferens is followed by the prostate, and the anterior vas deferens flows through the haemocoele , an enlarged blastula filled with blood, of the head and opens into a muscular penis which is engulfed in a small portion of skin called the prepuce sac. Gametes form in the ovotesties , an organ which produces both ova and sperm, and pass down into the hermaphroditic duct to the albumen gland, the junction of where the common duct splits to either vas deferens or oviduct , where they are stored until they are needed for either mating or self-fertilization. It is believed that this junction acts as a regulatory mechanism via contracting muscles, to help direct sperm or eggs into the correct ducts. After getting modified, the sperm passes into the penis. During mating season, the glandular cells in the penis sheath and prepuce swell to facilitate eversion of the penis. The sperm gets pushed through the penis, where they are introduced into the tail end of its copulatory partner. Within the partner snail, after fertilization from the foreign sperm, the eggs pass into the albumen gland where they are coated in mucus which forms the egg capsule. Unlike in land gastropod species where fertilization occurs in fertilization pockets, fertilization in freshwater species happens at the lower end of the hermaphroditic duct, near the junction. Sperm is deposited into the bursa copulatrix which opens up into the vagina. The ova then enter the albumen gland to get a nutrient dense mucus coating which serves to form the egg capsule.

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Chapter 2 : Love dart - Wikipedia

Cephalopod, any member of the class Cephalopoda of the phylum Mollusca, a small group of highly advanced and organized, exclusively marine animals. The octopus, squid, cuttlefish, and chambered nautilus are familiar representatives.

Learn more about this article Despite the highly diverse forms of the members of this taxon, molluscs share a recognizable and characteristic generalized general body plan, made up of a head, a foot, and viscera contained in a central body. They are generally considered unsegmented, although primitive forms aplacophorans and polyplacophorans with repeated body features show intriguing potential for a possibly segmented mollusc-annelid ancestor e. Jacobs et al The mollusc head can house various combinations of sensory structures: In some molluscs these sensory systems can be very well developed the complex cephalopod eye is a prime example. Also found on the head is a feature unique to molluscs: Depending on diet and use, tooth number, shape, arrangement, makeup, and growth have adapted diversely. Especially in the gastropods, number and shape of radular teeth are important taxonomic characters. The radula has also been adapted for diverse feeding methods. Some gastropods and cephalopods have a drill-like radula used to bore holes in the shell of prey, sometimes with the aid of acids secreted from an adjacent boring gland. In cone snails the radula is set on the end of a retractable proboscis and is slung out like a harpoon, to inject toxins into the prey, delivered through piercing, hollow teeth. In some cases these toxins are powerful neurotoxins, deathly to humans. Several lineages of molluscs have evolved suspension feeding, especially in the gastropods and bivalves. The radula in these cases is either highly reduced or lost altogether, and in most cases food particles are caught by ctinidia gills and moved to the mouth by cilia. Except for the aplacophorans, most molluscs have a well-developed, muscular foot. This structure is used in a multitude of ways, for example: A layer of epidermal tissue called the mantle surrounds the body of molluscs. Specialized glands in the mantle are responsible for the extracellular excretions that form shell structures. The ancestral mollusc is thought to have one shell capped over the body like a limpet, and from that a diverse number of shell arrangements have evolved. Molluscs may have have one, two, or eight in chitons shells. Aplacophorans have no shell, but have instead minute aragonite spicules imbedded within the mantle. Secondary loss or much reduced shell vestiges have also occurred independently in multiple mollusc lineages for example nudibranchs, slugs, cephalopods. Shells usually provide external protection, but there have been several independent internalizations within cephalopods and opisthobranchia. In all molluscan groups the shell is produced in layers of usually calcium carbonate, either in calcite or aragonite form. The wide range of pigmentation, shape, size, sculpturing, and twisting of sea shells is, of course, well known. There is much recent developmental work describing gene expression in shell formation, and the roles of highly conserved regulatory genes such as engrailed and Hox genes have been examined e. Jacobs et al , Samadi and Steiner Between the mantle and the body proper is the mantle cavity, which may be organized as one or two separate spaces or grooves. Many important functions occur in the mantle cavity: In aquatic molluscs cilia on the surface of the mantle and organs maintain water flow through the mantle cavity to take away wastes and bring in oxygenated water and food particles for those suspension feeding molluscs. Molluscs have an open circulatory system with a full heart with the exception of the cephalopods, which have a closed circulatory system. Their nervous system is well developed, usually consisting of a dorsal ganglion, a ring of nerves around the esophagus, and two pairs of lateral nerve cords running the length of the body, which are connected transversely in a ladder-like arrangement. There is an enormous range of nervous system development in the molluscs, from the poorly developed ganglia of the aplacophorans to the extreme cephalization of the cephalopods. Important work in the fields of neurobiology has been carried out on the squid Doryteuthis pealeii formerly Loligo pealeii and on Aplysia sea slugs.

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Mollusca is the second largest invertebrate phylum after the arthropods. Some 93, extant species have been described, but the thinking is this number represents only about half of the living species.

In terms of reproduction, humans were created to reproduce sexually and are not asexual in that sense of the word. It really depends on the context. How does the asexual reproduction of Mollusks happen? After they are a year old, mollusks, such as oysters, will spawn asmales. The next year they will spawn as females. When the watersgrow warmer, it will cause a few of the oystâ€¦ers or other mollusksin a bed to spawn, and once these few spawn, it prompts the rest ofthe colony to spawn. Once the egg isfertilized, it will soon grow into a larvae. The larvae will thenattach onto the shell of an adult oyster, or somewhere else theycan attach, and grow into an adult oyster. Do Mollusks reproduce sexually or asexually? Most mollusks reproduce sexually, but many of them are also hermaphroditic both male and female , and are able to impregnate others while also becoming pregnant themselves. Sâ€¦ome mollusks, like clams, simply broadcast huge quantities of sperm into the environment, and hope that eventually it finds another clam. Some, like many squid, have two sexes and a series of elaborate courtship rituals they undergo before mating takes place. What is a mollusk? One of the two main classifications of shellfish the other beingcrustacean , mollusks are invertebrates with soft bodies covered bya shell of one or more pieces. Mollusks areâ€¦ further divided intogastropods also called univalves , such as the abalone and snail;bivalves, like the clam and oyster; and cephalopods, such as theoctopus and squid. A lack of interest or desire in having a sexual relationship with other humans, whether of same gender or opposite gender to themselves. Asexuality is not the same as celibacyâ€¦. Asexual people may be male or female, and they will generally have no desire to ever share their bed with anybody else during their life. But they mostly indulge in private masturbation when alone, although their erotic imagery inside their mind is never about a sexual relationship with somebody else. Their kind of libidinous thoughts may be associated with work or sport or warfare or other such environmental factors in their life, embracing abstract ideas which are not libidinous nor erotic to a normal heterosexual or homosexual person. Asexual people are otherwise completely normal individuals, both physically and mentally healthy and usually intelligent. They usually enjoy non sexual socialising and companionship with other people of both genders, and lead a happy and productive adult life. But they only rarely get married and have no desire to have children, nor are ever apparently capable of becoming pregnant nor causing a pregnancy.

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Mollusks have many different feeding habits and many different means of obtaining it. For instance, animals such as squid will eat small fish and octopus will eat animals such as crabs and other crustaceans using their muscular mouth and beak.

From the dark abyss to shallow tide pools, research has recently revealed some of the mysterious behaviors of two famed cephalopods, the Giant Squid and the deadly Blue-ringed octopus click image below for an enlargement. Cephalopods are the most intelligent, most mobile, and the largest of all molluscs. Squid, octopuses, cuttlefish, the chambered nautilus, and their relatives display remarkable diversity in size and lifestyle with adaptations for predation, locomotion, disguise, and communication. These "brainy" invertebrates have evolved suckered tentacles, camera-like eyes, color-changing skin, and complex learning behavior. From myths about their enigmatic fossilized remains to fantastic accounts of tentacled sea monsters, cephalopods also figure prominently in the literature and folklore of human societies around the world. Fossil record There are about 17, named species of fossil cephalopods, compared to the identified living species of cephalopods. Clearly the lineages of extinct taxa were prolific and diverse. So diverse in fact, that paleontologists have identified three distinct fossil clades that are entirely extinct: Endoceratoidea, Actinoceratoidea, and Bactritoidea cladogram A, at right. All members of these clades were squid-like, but had straight external shells called orthocones. They flourished in Paleozoic oceans between the Ordovician mya and Triassic periods mya with shells that, in some species, reached nearly 10 meters in length. More familiar to us in the fossil record are the nautiloids, ammonoids, and belemnites. Nautiloids and ammonoids Nautiloids are the earliest cephalopods found in the fossil record, appearing by the Late Cambrian. The earliest forms were orthoconic having straight shells , but during the Ordovician the nautiloids experienced a rapid diversification and evolved a planispiral coiled in a single plane shell shape. All have shells with nacre and interconnected internal chambers, similar to what we see in the modern nautilus. This morphology is very similar to many of the ammonoids, which first appear in coiled form in the Devonian Period. Though nautiloids and ammonoids may appear the same, they are easily distinguished by the location of their siphuncle and the shapes of their sutures. The photo on the left shows the position of the siphuncle in ammonoids. The other two are of nautiloids exhibiting the simple sutures typical of the group. The siphuncle is an internal tube that runs through and connects the chambers of the shell. Sutures are contact lines between shell chamber walls called septa and the inner shell wall of nautiloid and ammonoid shells. In nautiloids these lines are straight and are called simple sutures above center and right. In contrast, ammonoid sutures dip and fold in undulations called lobes and saddles below left. The most undulated, complex sutures are found in the prolific ammonoids of the Cretaceous , the ammonites below right. One pattern of change in the evolution of ammonoids as a clade is that their suture morphology became more complex with time. That is, ammonoids from the Cretaceous have sutures with more intricate lobes and saddles than those of their relatives from the Permian million years earlier. Hildoceras bifrons left illustrates the typical lobes and saddles of ammonoid sutures. The sutures on the ammonite right are even more complex. Ammonoids, like belemnites, have also played a notable role in folklore. During the Middle Ages, their coiled shells were interpreted by the English, who encountered them in Jurassic-aged rocks exposed throughout Great Britain, as lithified snakes called "snake stones". Similarly, ammonite fossils encountered by the early Romans were mistaken for horns, and termed "ammonites" for the coiled horns of the Egyptian ram-god Ammon. Suture patterns and lifestyle: The diversity of this suture geometry has inspired paleontologists to investigate its function. In one study, paleontologists Daniel et al. They found that simple sutures, like those in nautiloids and early ammonoids, can withstand great pressure but have poor buoyancy control. They interpret that these animals lived at depth and were not fast moving. In contrast, complex sutures like those in ammonites of the Cretaceous did not withstand pressure well, but allowed for very effective buoyancy control. They infer that this reflects a lifestyle at shallower depths. Based on this evidence, it appears that many ammonoid lineages evolved over millions of years, beginning in deep water habitats and evolving to inhabit relatively shallow ones. Another characteristic unique to ammonoid cephalopods is that although most were planispiral, the shells of some species were wide, open-coiled, kinked, twisted, or hooked. The answer is through inference. In this case, paleontologists measured buoyancy and hydrodynamic characteristics of Nautilus, and compared their results to actual tests of ammonoid shells and models in a water flume. They found that planispiral shell shapes like a discus were able to move through the water quickly, while wider and more open shell shapes moved more slowly. These morphologies could mean that planispiral cephalopods lived an active, pelagic lifestyle and wider shelled ammonoids lived near the ocean bottom and were slow movers. Dramatic curves, twists, as well as highly ornate ammonoid shells also suggest that those animals were relatively slow movers inhabiting a quiet marine environment. Belemnites The rostrum of belemnites is the part most frequently preserved left. At right, a long belemnite rostrum in a block containing other marine fossils. The fossil record of most cephalopods in the clade Coloidea squid, cuttlefish, octopuses, and their relatives is poor, especially when compared to their shelly relatives. Their hard parts, if any, are internal, can be greatly reduced in size, and often lack calcification. The extinct belemnites, however, are the exception. These squid-like animals below swam with ammonoids and nautiloids in oceans of the Triassic, Jurassic , and Cretaceous Periods and are considered by paleontologists to be the ancestors of the Coleoidea. Like orthocones, belemnites had a straight shell, but it was internal, not external. It was made of three parts, a proostracum and phragmocone followed by a rostrum. Being highly resistant, the posterior bullet-shaped rostrum is most often preserved and can be found in great quantity and concentration in Mesozoic marine sediments see photos. Before these bullet-shaped fossils were understood as fossils, early Europeans explained them as the products of lightning hitting the ground and named them "thunderbolts" or "thunderstones. They are marine, predatory, and have at least eight arms derived from the molluscan foot. All have a modified radula, and a horny, parrot-like beak for subduing prey. Their mantle is modified into a siphon for movement via jet-propulsion, and their highly developed nervous and sensory systems include complex eyes and a centralized brain. Their name, Cephalopod or "head-foot" in Greek, reflects the unique relationship between the cephalopod head and foot: The ammonoid lineage survived for million years in the oceans of the Paleozoic and Mesozoic. Most had planispiral coiled in a single plane external shells, and throughout their evolutionary history these plentiful predators shared the seas with the nautiloids, a clade of less diverse shelled cephalopods. By the end of the Cretaceous Period however, extinction had wiped out the ammonoids entirely and left only one surviving nautiloid clade, the genus Nautilus. Today, the only living representatives of shelled cephalopods are a few species of Nautilus. These molluscs are slow-moving, restricted to deep water, and have coiled shells that are similar to those of their fossil ancestors. A female Octopus digueti. Members of the Coleoidea are probably the best known of the Cephalopoda, as this group contains the squids Teuthoidea and octopuses Octopoda right. The majority of coleoids are squid species, and most of these animals are torpedo-shaped, fast moving, and have a thin, flexible internal shell called a pen. Cuttlefish sometimes called "cuttles" look like squid, but have stouter bodies with a broad internal shell called a cuttlebone or sepion. They move mostly by undulating their body fins and can live in the water column or at the sediment surface. Octopuses are adapted to a benthic lifestyle, have no shell, can mimic their surroundings, and even "walk" on two of their eight arms. Belemnites are sometimes considered the sister group of extant living coleoids, but have also been interpreted as their ancestor. In , a UC Berkeley graduate student reported that the Indonesian Coconut Octopus, Octopus marginatus, can move along the ocean floor using only the tips of its arms, almost like "walking. It is the sister group of the living species of Nautilus, which is also a monophyletic clade, albeit of only a few species D, below. The phylogenetic relationships within the coleoids is less clear. Some cladograms depict the Sepioidea cuttlefish , Teuthoidea squid , Vampyromorpha vampire "squid" , and Octopoda octopuses as coupled into two sets of sister groups, the Decabrachia and Octopodiformes E, below. While the cladograms from another study Lindgren et al. More on morphology The external shell. One of the most obvious differences in body type, which for cephalopods does reflect shared ancestry, is the presence or absence of an external shell. Clades without an external shell are called endocochleate and include the coleoids; squids, cuttlefish, and octopuses. The internal shell of these taxa, called a gladius, can be cartilaginous, calcareous, chitinous or absent entirely. Presence of an external shell, such as that of the Nautiloids, Ammonoids, and orthoconic cephalopods, is considered a plesiomorphic , or ancestral state. No presentation of cephalopods would be complete without a discussion of the cephalopod eye. This structure is probably the most sophisticated eye of all invertebrates and is as complex as the vertebrate eye, though the two are not homologous. For their body size, cephalopod eyes are relatively large. They contain an iris, pupil, and lens, but not necessarily a cornea. Octopuses are the only cephalopods with a completely protected "closed" cornea. That means that the eyes of squids and sepioids cuttlefish, etc. The pupil in cephalopods is unique in that its morphology is different in octopuses, cuttlefish, and squid. Octopuses have a slit-shaped rectangular pupil. In cuttlefish it is W-shaped, and in squid it is round see below. In Nautilus the eye is much simpler. It is mounted on a stalk, has no lens, and has a very small pupil mm. It can narrow and widen in different brightnesses but resolves images poorly, so probably is useful only to detect light. Differing eye morphologies in cephalopods. From left, a squid Loligo , octopus, cuttlefish, and Nautilus. The hyponome can be aimed in various directions, giving the octopus finer control over its escape route. Arms and tentacles are another distinguishing cephalopod characteristic. All cephalopods have arms, but not all cephalopods have tentacles. Octopuses, cuttlefish, and squid have eight non-retractable arms, but only cuttlefish and squid Sepioidea and Teuthoidea have tentacles two each.

Chapter 5 : Are mollusks asexual

a behavior that allows for only mutual copulation kin selection the theory that it can be advantageous to support the reproductive success of close relatives (since they hold some of your genes).

General features Size range and diversity of structure Typical molluscan features have been substantially altered, or even lost, in many subgroups. Among the cephalopods the giant squids Architeuthis , the largest living invertebrates, attain a body length of eight metres more than 26 feet ; with the tentacle arms extended, the total length reaches to 22 metres. Other cephalopods exceed a length of one metre. Many of the remaining molluscan classes show a large variation in size: Finally, gastropods of the family Entoconchidae, which are parasitic in echinoderm sea cucumbers , may reach a size of almost 1. In contrast, there are also minute members, less than one millimetre 0. Distribution and abundance The mollusks have adapted to all habitats except air. Although basically marine, bivalves and gastropods include freshwater species. Gastropods have also adapted to land, with thousands of species living a fully terrestrial existence. Found on rocky, sandy, and muddy substrata, mollusks burrow, crawl, become cemented to the surface, or are free-swimming. Mollusks are found worldwide, but there is a preponderance of some groups in certain areas of the world. The close association of many molluscan groups with their food sourceâ€"whether by direct dependence on a specific food supply e. In general, cold-water regions support fewer species. Importance to humans Mollusks are of general importance within food chains and as members of ecosystems. Certain species are of direct or indirect commercial and even medical importance to humans. Many gastropod species, for example, are necessary intermediate hosts for parasitic flatworms class Trematoda, phylum Platyhelminthes , such as the species that cause schistosomiasis in humans. Most bivalves contribute to the organic turnover in the intertidal littoral zones of marine and fresh water because, as filter feeders, they filter up to 40 litres 10 gallons of water per hour. This filtering activity, however, may also seriously interfere with the various populations of invertebrate larvae plankton found suspended and free-swimming in the water. One species, the zebra mussel Dreissena polymorpha , is regarded as a particularly harmful exotic invader. Carried from Europe in ship ballast water, zebra mussels were taken to the Great Lakes in To date, they have caused millions of dollars in commercial damage by clogging the water pipes of power plants and cooling systems. They are driving many native freshwater bivalve species to extinction. Many gastropods, bivalves, and cephalopods are a source of food for many cultures and therefore play an important role in the fishing industries of many countries. Many shell-bearing molluscan species are also used to fabricate ornaments and are harvested for the pearl and mother-of-pearl industries. Natural history Reproduction and life cycles Mollusks are primarily of separate sexes, and the reproductive organs gonads are simple. Reproduction via an unfertilized gamete parthenogenesis is also found among gastropods of the subclass Prosobranchia. Most reproduction, however, is by sexual means. Eggs and sperm are released into the water by members of some primitive species, and fertilization occurs there. In prosobranch gastropods, water currents may cause a simple internal fertilization within the mantle cavity, or males may fertilize eggs internally using a muscular penis. Both male and female reproductive organs may be present in one individual hermaphroditism in some species, and various groups exhibit different adaptations to this body form. For example, in hermaphroditic bivalves and prosobranch gastropods, male and female gonads are functional at separate times and in rhythmic and consecutive patterns successive hermaphroditism. Conversely, male and female gonads are functional at the same time simultaneous hermaphroditism in solenogasters and many other gastropods. Fertilization by transfer of capsules containing sperm spermatophores typically occurs in cephalopods and some gastropods. In cephalopods, transfer of spermatophores is usually combined with copulation by a modified arm, or hectocotylus. Copulation in solenogasters , often by means of a special genital cone, may be supported by copulatory stylets. Various penis formations, in part with copulatory stylets, or darts, are widely found in gastropods. Eggs are deposited singly or in groups, generally on some hard surface and often within jelly masses or leathery capsules. Squids of the suborder Oegopsida and some gastropods have eggs that are suspended in the water. The eggs of cephalopods, on the other hand, possess a large amount of yolk, which displaces the dividing cells and causes a characteristic type of development. Many mollusks develop into free-swimming larvae; these larvae are either feeding planktotrophic or nonfeeding lecithotrophic. The larva in primitive bivalves is a pericalymma test cell larva in which the embryo is protected below a covering test of cells provided with one to four girdles of cilia , at the apex of which is a sensory plate of ciliated cells. After the developing juvenile has grown out apically of the test which then is lost , the animal settles and develops into an adult. The test in other lecithotrophic larvae is restricted to a preoral girdle of ciliated cells the prototrochus and is called the trochophore larva. Trochophores are encountered in the development of many marine annelid species phylum Annelida. In more advanced mollusks such as in marine gastropods and bivalves , the trochophore larva develops into a veliger larva. In these generally planktotrophic larvae, the girdle of ciliated cells widens to form a velum that entraps food and also propels the microscopic mollusk through the water. As the larva continues to develop, the shell, mantle cavity, tentacles, and foot appear. After a specific amount of time, which varies according to species and environmental conditions, the larva loses the velum and metamorphoses into an adult. A substantial change in shell morphology usually marks the transition to adult form. Secondary newly evolved larvae have developed among some freshwater bivalves and some cephalopods. Maternal protection of the developing eggs brood is not unexceptional behaviour in solenogasters, bivalves, and certain gastropod adults. Direct development without a larval stage or the bearing of live young from a yolky egg, or both, are typical in cephalopods and most nonmarine and many marine gastropods. Many species go through two breeding seasons per year, whereas in some cephalopod species mating or egg laying appears to be rapidly followed by death effected by hormones. Habitats, feeding habits, and associations Caudofoveates subclass Chaetodermomorpha, class Aplacophora burrow in muddy sediments at depths of 10 to more than 7, metres 33 to 23, feet and consume microorganisms and loose organic material detritus. In contrast, solenogasters subclass Neomeniamorpha, class Aplacophora prey on some members of the class Cnidaria e. Chitons class Polyplacophora cling to hard bottoms of the intertidal zone , scraping algae from the rock surfaces by using their strong rasping teeth radula ; several members of the polyplacophoran family Lepidopleuridae consume detritus found at depths down to 7, metres, and Hanleyidae as well as Hopaliidae even depend on animal food. The few extant members of the class Monoplacophora inhabit secondary hard bottoms at depths of to 6, metres and capture detritus by means of head appendages velum around the mouth. The scaphopods dwell in sand or sandy mud down to 7, metres and nourish themselves on protozoa , crustaceans , or small mollusks captured by the filamentous head tentacles captacula. Except for the carnivorous septibranch anomalodermata, all bivalves are ciliary suspension feeders, using food-sorting organs near the mouth labial palps and respiratory gills modified to assist in feeding ctenidia. Found in marine and fresh water, most bivalves burrow into sediments to depths of 10, metres or attach themselves to hard surfaces by means of tough threads secreted by the byssus gland in the foot. The members of some species may even bore into wood or rock. Cephalopods are generally carnivores , feeding on crustaceans and fishes , but some have adapted a microvorous diet of detritus and microscopic organisms and plants. Some cephalopods are offshore pelagic jet swimmers, moving from the surface to depths of 5, metres, while others dwell near the bottom benthic at depths of 8, metres. The greatest ecological diversity is shown by the gastropods. The marine members are found from the spring-tide line to deep-sea trenches 10, metres deep and inhabit nearly all possible habitats, even floating weeds. Both shelled and naked gastropods have pelagic members that spend their entire lives swimming in the water; others penetrate marine hot vents or interstices between sand grains. Some gastropods are parasitic , while others are predatory. Freshwater snails also are found in groundwaters and may inhabit hot springs. Widely distributed throughout all terrestrial habitats, various members of the gastropod order Stylommatophora are adapted to certain regions. Some littoral bivalves, such as Tridacna, as well as some sea slugs , such as Aeolidia, share an obligatory symbiosis with zooxanthellae a group of algae. Another metabolic association exists between certain bacteria and several bivalves and gastropods of deep-sea hot vents or other sulfide systems. There are several parasitic mollusks. Locomotion Mollusks have a wide range of locomotory patterns. Solenogasters and various smaller gastropods glide upon cilia that beat rapidly against a pathway of mucus secretions. This pattern of movement is supported or replaced in larger mollusks by the propulsive waves that run along the surface of the foot and are controlled by the actions of the dorsoventral musculature Figure 1. Burrowing occurs as an interaction between musculature and the hydrostatic skeleton see below Internal features ; it is performed in caudofoveates and several sea slugs by the whole anterior body but is restricted to the foot in scaphopods, bivalves, and some specialized gastropods. Buoyancy floating and jet propulsion are found in cephalopods; floating is also known in gastropods, and swimming of a different kind is practiced by some opisthobranch and prosobranch gastropods as well as in scallops and related bivalves. Octopods use their arms to crawl or even to swim or float with the help of the body skin interconnecting the arms interbrachiate web. Some bivalve groups bore into hard surfaces by secreting strong chemicals that dissolve the substrate or by drilling, using the shell and radula. A sedentary sessile way of life has been adopted by many bivalves and some gastropods. Features of defense The external cover that extends over the mantle may consist of a hardened epithelial layer called a cuticle, separate calcareous plates, or a shell. Another defense includes the ability of most solenogasters and chitons to roll the body up. Chitons, neopilinids, and limpets can adhere firmly to the substrate by a powerful suction pad foot. Protection is also afforded if the animal is able to withdraw into its shell; a snail has the added advantage of having a hardened plate operculum on the foot that blocks the shell opening auricle once the animal has withdrawn. Burrowing by caudofoveates, scaphopods, many bivalves, and some gastropods also offers protection from predators. In many gastropods, slippery mucus is secreted from mantle extensions, or parapodia, as a defense against larger predators, such as sea stars starfish. In scaphopods, mucus is secreted against an aggressor from the anterior mantle. Certain molluscan subgroups secrete noxious chemicals either as a poisonous secretion of the salivary glands or as distasteful acids in mantle cells. Glandular secretions by solenogasters or the gastropod superfamily Eolidacea prevent the stinging nettle capsules nematocysts of cnidarians, when consumed, from expulsing the stingers; moreover, some gastropods are able to store and then use the capsules in their own defense when attacked by a predator. For example, the ink in cephalopods, the luminous cloud secreted by some deep-sea squids, and the purple fluid from the sea hare Aplysia ; a gastropod of the subclass Opisthobranchia distract and confuse the predator and conceal the prey. Camouflage or frightening coloration are effective in protecting cuttlefishes , octopuses , and sea slugs, as well as other gastropods. As a result, molluscan form varies much among levels and subgroups Figure 1. External features The most obvious external molluscan features are the dorsal epidermis called the mantle or pallium , the foot , the head except in bivalves , and the mantle cavity. The mantle in caudofoveates and solenogasters is covered by cuticle that contains scales or minute, spinelike, hard bodies spicules , or both aplacophoran level. The chitons class Polyplacophora develop a series of eight articulating plates or valves often surrounded by a girdle of cuticle with spicules; in all other mollusks, the mantle secretes an initially homogeneous shell. The mantle and shell are laterally compressed in scaphopods and bivalves; in gastropods and cephalopods the head is free of the mantle and shell. In bivalves a dorsal hinge ligament joins two shell valves, which are further held together by two adductor muscles with attachment points on the inner aspect of each valve. The head, when present, has tentacles called captacula in scaphopods, labial palps in bivalves, head tentacles in gastropods, and arms in cephalopods. The primitive ciliary gliding surface with forward pedal and sole glands is reduced in caudofoveats and some gastropods, as well as in some bivalves, and it is narrowed to a ridged tract in solenogasters as well as some members of the placophore genus Cryptoplax.

Chapter 6 : cephalopod | Definition, Etymology, Species, & Facts | www.nxgvision.com

Table www.nxgvision.comentative sampling of same-sex sexual behavior across non-human taxa, ranging from observations in a wild setting to genetic manipulations in the laboratory.

See Article History Alternative Titles: Cephalopoda, Siphonopoda Cephalopod, any member of the class Cephalopoda of the phylum Mollusca , a small group of highly advanced and organized, exclusively marine animals. The octopus , squid , cuttlefish , and chambered nautilus are familiar representatives. The extinct forms outnumber the living, the class having attained great diversity in late Paleozoic and Mesozoic times. The extinct cephalopods are the ammonites, belemnites, and nautiloids, except for five living species of Nautilus. The best-known feature of the cephalopods is the possession of arms and tentacles , eight or 10 in most forms but about 90 in Nautilus. Except for the nautilus, all living members of the class show great modification and reduction of the characteristic molluscan shell. Cephalopods range greatly in size. The giant squids Architeuthis species are the largest living invertebrates; A. The smallest cephalopod is the squid Idiosepius, rarely an inch in length. The average octopus usually has arms no longer than 30 centimetres 12 inches and rarely longer than a metre 39 inches. But arm spans of up to nine metres 30 feet have been reported in Octopus dofleini. The shell of the fossil ammonite Pachydiscus seppenradensis from the Cretaceous measures centimetres 6 feet 8 inches in diameter; it is considered to have been the largest shelled mollusk. Cephalopods occur in large numbers and form one of the greatest potential food resources of the oceans. They are eaten in most parts of the world and have been accepted as part of the general diet in North America and northern Europe. They also are indirectly important to humans since they furnish a large part of the diet of sperm whales and smaller whales, seals, fishes, and seabirds. Natural history Reproduction and life cycles The sexes are usually separate in the Cephalopoda. Sexual dimorphism is usually expressed in slight differences of size and in the proportions of various parts. In the argonaut and the blanket octopus Tremoctopus the males differ in appearance and size from the females. The female reproductive system is simple, consisting of the posterior ovary and paired oviducts. Nidamental glands exist in species that lay eggs encased in heavy gelatinous capsules. In males the reproductive system contains a series of chambers or sacs along the course of the vas deferens , which produce long tubes spermatophores to contain the spermatozoa. Since spermatophores vary in appearance from species to species, they are important taxonomic characters. During courtship the male deposits spermatophores in the female, either within the mantle cavity or on a pad below the mouth, by means of a specially modified arm, the hectocotylus. The hectocotylized arm of Octopus bears a deep groove on one side, ending in a spoonlike terminal organ. In Argonauta and Tremoctopus the arm is highly modified and in mating is autotomized self-amputated and left within the mantle cavity of the female. In the squids a much larger section of the arm may be modified; often the suckers are degenerate and the distal half of the arm bears rows of slender papillae, although special pouches and flaps may often be found. The modified arm of Nautilus is termed the spadix. Little is known about the mating habits of most cephalopods. In the common octopus the male and female remain some distance apart while the male caresses the female with the tip of the hectocotylized arm. The male then inserts the tip of the arm into the mantle cavity of the female, where it remains for more than an hour, during which time the spermatophores travel down the spermatophoral groove of the arm. In the cuttlefish Sepia , according to the Dutch zoologist L. Tinbergen, the pair swims side by side, the male indulging in some courtship behaviour with its arms. In loliginid squids a somewhat similar type of mating occurs, except that it takes place en masse in schools of thousands of individuals. In loliginids they are fertilized as they are ejected and before being fixed in the egg capsule. In the octopods they may be fertilized as they pass through oviductal glands near the end of the oviduct. In cuttlefishes the eggs are fertilized before the heavy capsule is formed. Egg laying in octopods is accomplished by the female individually fixing the eggs singly or in festoons by a short stalk or thread. In loliginids the eggs in fingerlike capsules often form immense moplike patches, the result of the communal spawning of perhaps hundreds of individuals. Spawning of oceanic squids is very poorly known. The number of eggs laid during a spawning period varies greatly; it may range from only a few dozen in octopuses with large eggs to more than , in the common octopus, laid over a period of about two weeks. In cuttlefishes the number of eggs is smaller, about to being laid in a season. In loliginids several thousand eggs may be laid by a single female, and the egg mop of the European common squid, resulting from the efforts of many individuals, may contain more than 40, eggs. The eggs of most cephalopods are enclosed within a capsule that may be gelatinous and transparent the squids of the genus Loligo or opaque and leathery Octopus and cuttlefishes. The eggs of oceanic species may be laid in large sausagelike gelatinous masses or singly. The eggs of most coastal species are laid inshore and are attached singly or in clusters, primarily to rocks and shells on the bottom. Parental care is exhibited by some octopuses, in which the female broods over the eggs in the den, and in the argonaut Argonauta , in which the eggs are carried in a special shell secreted by the female. In most squids and cuttlefishes the eggs are left uncared-for. Squids that attach their eggs to the bottom engulf them in a gelatinous mass that protects them from disease and deters predators. Cuttlefishes squirt their eggs with ink when they are laid to camouflage the otherwise white eggs. All cephalopod eggs have a remarkable amount of yolk , unlike that in the rest of the Mollusca, so that segmentation is incomplete and restricted to one end of the egg, where the embryo develops. The embryo of a cuttlefish Sepia , squid Loligo , or octopus Octopus has a yolk sac. In certain presumably archaic Teuthoidea there is less yolk, and the yolk sac is nearly absent. Development of the embryo is direct, without the distinctive larval stages and metamorphoses that occur in other mollusks. Incubation time varies, but in Octopus young hatch in about 50 days and in Loligo in about 40 days. At hatching, the young may closely resemble the adult and assume the adult habitat or they may differ from the adult and spend a considerable time in the plankton as part of the drifting life. The juveniles of many cephalopods were described as distinct genera before their juvenile status was discovered. In octopods with small eggs e. In octopods with large eggs e. In the order Sepioidea cuttlefishes and bottle-tailed squids the young closely resemble the adults and are only briefly planktonic. In the Teuthoidea squids , especially the Oegopsida, the larvae may differ widely from the adult and the juvenile period may be quite long. Little is known about the life span of cephalopods. Studies have shown that in Octopus joubini raised from the egg in aquariums, sexual maturity and spawning were reached in five months; in a loliginid squid Sepioteuthis sepioidea , likewise raised from the egg, sexual maturity and full growth were also attained in five months. It thus appears that the smaller inshore species may have a life span of no more than one year or, exceptionally, two or three. Nothing is known of the life span of the large oceanic squids, but it is presumed that giants such as Architeuthis attain their bulk only after a period of perhaps four to five years. In the smaller octopuses and squids, observational data indicate that many of the males die after mating and females after the first major spawning. Behaviour Cephalopods are unique among the invertebrates in the degree of cephalization and cerebralization attained. The uniting of the major ganglionic centres of the central nervous system constitutes a brain of considerable complexity. Wells, and others have demonstrated that Octopus is capable of learning and has considerable intelligence. The behaviour of squids and octopuses differs considerably because of their different modes of life. Laboratory behavioral studies have dealt mainly with learning processes and have centred around food acceptance, reward and punishment, maze work, and shape discrimination. By means of surgical techniques it has been possible to determine the various functional centres of the brain of Octopus and the transmission and receiving pathways. In addition, field studies in tropical seas near Indonesia have recorded tool-using behaviour in the veined octopus Amphioctopus marginatus. In biologists reported having observed the animals excavating coconut half shells from the ocean floor and carrying them for use as portable shelters. Such behaviour is regarded as the first documented example of tool use by an invertebrate. Research of a detailed nature has also been concerned with colour change. Most cephalopods possess colour pigment cells chromatophores and reflecting cells iridocytes in the skin. The chromatophores are expanded by nerves controlled by the brain, and the colours are exposed brown, black, red, yellow, or orange red. Colours and colour patterns are exhibited according to specific behavioral conditionsâ€”e. Alarm patterns are the most readily recognized, consisting of strong contrasting light and dark areas, bars and peripheral dark outlines, or vivid displays of spots, like huge eyes. Displayed by permission of The Regents of the University of California. Other behavioral patterns are found in changes in skin texture, including the erection of branched or spikelike papillae and curling of the arms. These actions often are attempts by cephalopods to conceal or camouflage themselves through imitating bottom objects such as sand, coral, or seaweed. The ink of cephalopods is used for both defense and escape. In squids the ink is ejected as a spindle-shaped mass about the size of the squid itself, the ink coagulating in the water. Many cephalopods but not Nautilus and Octopus possess special light organs photophores , which emit chemical light or bioluminescence. Light is produced by the enzymatic reaction of luciferin and luciferase or, in bottle-tailed squids sepiolids , indirectly, through cultures of luminescent bacteria. Photophores distributed over the body are employed at night or in the mid depths in various ways: The light organs of the squid Histioteuthis are highly complicated, consisting of reflector, light source, directive muscles, lens , diaphragm, window, and colour screens. Octopuses, squids, and cuttlefishes display considerable skill and cunning in hunting, stalking patiently, or luring prey within reach of their arms or tentacles. Both cuttlefishes and octopuses may use the tips of their arms as wormlike lures to attract small fishes, and octopuses have been reported to thrust stones between the valves of clams to prevent their closing. This has not been verified by later observers, but such intelligence is not beyond belief. Locomotion Cephalopods move by crawling, swimming, or jet propulsion , mainly the latter. The mantle , which has a passive role in the majority of mollusks, has become involved in locomotion in cephalopods, having almost entirely lost its rigid shell and become highly muscular. Its expansion and contraction produce a locomotory water current by drawing water into the mantle cavity and expelling it through the funnel. The rapid ejection of this jet of water enables the animal to execute quick backward and forward movements. Water is drawn into the mantle cavity by the relaxation of the circular muscles and resultant expansion of the mantle. It enters around the neck region or aperture of the mantle through the funnel in some deep-sea octopuses. In the oceanic squids the system is more efficient, with a nonreturn valve that prevents water from entering the wrong way through the funnel.

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The habitats the animals in the phylum mollusca occupy vary about as much as the animals themselves. you will find mollusks in marine environments in the form of octopus, nudibranches, squid and many more.

Mating Mating systems Gastropod reproductive behavior is as varied as the animals themselves Baur, Hermaphroditism is universal among the pulmonate gastropods, nearly universal among opisthobranch gastropods, but rare in all other gastropod taxa primarily marine snails. While the term simultaneous hermaphroditism refers to the condition in which an adult animal has both a functioning male system and a functioning female system, it does not necessarily imply that an individual engages both sexual functions in any single mating. Although inseminations are always internal, that is, by penial insertion, copulation patterns differ among taxonomic groups. The pond snail, Lymnaea stagnalis. The upper snail is mating as a male, the lower snail as a female. Koene and Anton Pieneman. In single-sexed gastropods gonochoric , each member of a mating pair performs its role according to its sexual identity. Similarly for most of the simultaneous hermaphrodites, each animal performs only one role in a given mating, with role preferences varying within and between individuals Fig. After completing one unilateral sperm donation, the partners often switch roles in a second mating such reciprocity can be conditional or unconditional. The remaining species of pulmonates and opisthobranchs mate in a simultaneously reciprocal manner, that is, with both members of the pair acting simultaneously as male and female Fig. In these cases, both animals receive sperm in every mating. Snails with tall shells tend to mate unilaterally by shell-mounting, whereas snails with flat shells tend to mate simultaneously reciprocal in a face-to-face manner. Bizarre mating practices Animals such as Aplysia californica, which have their male and female genitalia located on different parts of the body and normally mate unilaterally, can form daisy chains which may contain as many as six mating individuals Fig. The first individual in the chain acts only as a male, the last individual acts only as a female, and all animals in between act as female to one partner and male to a second partner. A chain of copulating Aplysia californica. The twisted bodies of two slugs, Limax punctulatus, are attached to the tree branch. The two twisted penes hang below, each weighted with blue blood. Sperm is exchanged externally at the tips of the penes. Certain terrestrial slugs, notably in the genus Limax, mate by hanging their penes from a vertical perch, then twisting their bodies and their penes around one another before sperm is exchanged at the tips of the penes Fig. For reasons unknown, evolution in this group of animals has favored penes of ever increasing length. In one Italian species, the penis length during mating measures Dart shooting is a feature of courtship in about 6 of 75 families of terrestrial molluscs. The term "dart shooting" is something of a misnomer because the dart does not actually fly through the air, although it is forcefully expelled. The dart itself appears in a variety of sizes, shapes and numbers in different species. Most species have just a single dart which is shot once, but some species shoot multiple darts and still other species stab repeatedly with the same dart. Courting individuals belonging to the Japanese species Euhadra subnimbosa, for example, use the same dart to stab their partners on average 3, times Koene and Chiba, ! The function of dart shooting is explained below. This is usually a reciprocal event within a mating pair. In such instances, one or both of the slugs will gnaw at the stuck penis apophallation until the slugs are free to go their separate ways. Numerous species of freshwater and terrestrial pulmonates contain hermaphroditic individuals that lack penes aphally. Such animals reproduce either by outcrossing as females or by using their own sperm to fertilize their own eggs selfing. Indeed, selfing also occurs in some species that are fully functional as simultaneous hermaphrodites, but that have trouble finding partners. Mate finding Potential mates must be located and identified using the chemical senses olfaction and contact sensations because gastropods have no sense of hearing and little or no vision. Sea slugs in the genus Aplysia release a bouquet of pheromones when laying eggs, and these substances attract conspecifics that may then mate with the egg-laying individual. Terrestrial species may locate potential mates by sensing cues in mucus trails, then following the trials to find the source. Contact chemosensation, as well as tactile stimulation, is probably important for courtship interactions in all species. Generally, gastropods do not discriminate among potential partners, although body size seems to be assessed in some species where mates of large size are preferred. Sperm competition Sperm competition is responsible for many sexually selected traits in gastropods. In some, but not all species, the received sperm can be stored for many months to years before it is used to fertilize eggs. Meanwhile, the receiving individual may mate with additional sperm donors. When the multiply mated individual eventually fertilizes its eggs, it will generally select sperm at random as in a raffle from the stored pool. Together, the features of promiscuity, sperm storage and internal fertilization combine to cause intense sperm competition in gastropods. Therefore, evolution has favored traits that enhance the survival and use of the sperm that are transferred during matings. Some species use a spermatophore to package the sperm and thereby protect them during transfer. Mating order may also be important when successive transfers are made to the same recipient from different sperm donors, a phenomenon known as sperm precedence. Other species, however, exhibit second donor sperm precedence or no apparent precedence. Another important consequence of sperm competition is the very large numbers of sperm contained in each ejaculate about 5. Because of sperm competition, the costs of reproduction via the male function can approach, or even equal, that of the female function Greeff and Michiels, The function of dart shooting Figure 5: This snail was hit in the head by a dart while courting a potential mate. Speculation as to its function has a long history, dating back at least as far as the 17th century. In this species, the single dart is solid and has a sharp tip; it is made of pure calcium carbonate crystals. The dart is rapidly expelled from the genital pore in the later stages of courtship and it often, but not always, penetrates into the flesh of the potential mate Fig. A role for the dart in either mate selection or arousal is excluded by the fact that the outcome of a dart shot has absolutely no influence on the subsequent mating behavior of either member of the mating pair. As a consequence, snails that hit their partners with a dart sire more offspring than competing snails whose darts miss the same partner. The mucus that clings to the surface of the dart is crucial to its effectiveness. Neural controls for mating Identified cell clusters The expression of male sexual behavior is mainly controlled by neurons in the central nervous system. A population of neurons with homologous representations in several gastropod species has been identified in the right cerebral ganglion Koene et al. In Aplysia califonica, the neurons are located in the H-cluster, the only cluster among a total of 13 that is not present bilaterally in the cerebral ganglia. In Lymnaea stagnalis the neurons are in the right anterior lobe, and in Cornu aspersus they are found in the right mesocerebral lobe. The significance of the right-side bias is that it coincides with the right-side placement of the genital organs. Anatomical studies have demonstrated that neurons in the named clusters send axonal projections to the penis, dart sac and related male structures, while electrophysiological studies have linked activity in these neurons to motor behaviors related to copulation and dart shooting Chase, For example, recordings from intact animals using fine, implanted wires revealed dramatic increases in spiking activity during eversion of the penis. Additional neurons implicated in the control of male mating behavior are located in the right pedal ganglion. An intriguing aspect of the neurons implicated in male sexual behavior is that many of them show immunoreactivity for the neuropeptide APGWamide. Together, these findings indicate that many of the neurons responsible for male mating behavior in gastropods are phylogenetically conserved Fig. Evolutionarily conserved locations red of neurons controlling male sexual behavior. Reproduced with permission of the Company of Biologists. Regulation of mating frequency and sexual roles The expression of mating behavior, like that of other motivated behaviors, is regulated in order to maximize the benefits while minimizing the costs. One example of this is that animals that have recently mated as males are unlikely to quickly re-mate as males. Consequently, for experimental studies, animals are generally kept in social isolation to increase the mating probabilities. In Lymnaea stagnalis, the readiness to mate as a male proclivity is regulated by the volume of the prostate gland De Boer et al. Animals that have an insufficient supply of seminal fluid do not mate. As the supply of seminal fluid increases, so too does the rate of discharge in the nerve that innervates the prostate. Lesions of this nerve reduce male sexual drive. Presumably, input from this nerve changes the excitability of neurons that trigger courtship behavior. In other snails, for example Cornu aspersus, that mate irregularly but that do not use seminal fluid because the sperm are contained in a spermatophore , the mating intervals are obviously regulated in some other, unknown, manner. Also, a complicating factor with Cornu aspersus, and with all other gastropods that mate simultaneously and reciprocally, is that proclivity is potentially influenced by both male and female drives. In these cases, it is likely that mating frequency is regulated by a combination of male and female drives. An open question is how sex roles are established in individuals that can change their roles from one mating event to another Anthes et al. Egg laying Figure 7: The garden snail, Cornu aspersus, laying a clutch of eggs. Forms of deposition Most species are oviparous, meaning that fertilized eggs are encapsulated but otherwise externalized with little or no embryonic development. Aquatic gastropods generally deposit their eggs in gelatinous masses that are attached to a hard surface. Opisthobranchs lay huge numbers of fertilized eggs. For example, a single specimen of Aplysia californica was observed depositing one mass that contained , eggs Kandel, Moreover, during the spawning season, an individual Aplysia californica will typically lay eggs at intervals of 1 or 2 days. By contrast, land snails lay eggs only two or three times per season, with egg numbers per clutch ranging from a few dozen to more than Lymnaea stagnalis lays egg masses containing between 50 and eggs once a week during the breeding season. Egg laying behavior in Aplysia The behaviors that are associated with egg laying appear in a stereotyped sequence Ferguson et al. First, the animal slows its locomotion and begins to move its head and neck in certain characteristic ways. These movements become increasingly frequent so that by the time the animal is ready to oviposit, it is immobile but far from quiescent. Large, side-to-side movements of the head appear initially, probably to aid in finding a suitable substrate. Once a site has been selected, the substrate is prepared by small, up-and-down undulations of the head. Weaving movements of the head appear after the eggs have begun to emerge; these are side-to-side movements that serve to distribute the egg string. The eggs come out from the genital pore, which is located near the base of the right tentacle. As soon as the egg cordon leaves the genital pore it enters an external groove that lies within the skin on the right side of the neck; this directs the cordon towards the mouth. As the head moves from side to side, the egg string is brought into contact with the mouth where it receives a sticky secretion that facilitates its attachment to the substrate.

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Chapter 8 : Reproductive system of gastropods - Wikipedia

Many young people engage in sexual risk behaviors and experiences that can result in unintended health outcomes. For example, among U.S. high school students surveyed in 1 40% had ever had sexual intercourse. 10% had four or more sexual partners. 7% had been physically forced to have sexual.

There is a complex hermaphroditic reproductive system in pulmonate snails those snails that have a lung rather than a gill or gills. Their reproductive system is completely internal, except for the active protrusion eversion of the penis for copulation. The outer opening of the reproductive system is called the "genital pore"; it is positioned on the right hand side, very close to the head of the animal. This opening is virtually invisible however, unless it is actively in use. Drawing of a transverse section of the dart sac also known as the bursa telae of Helix pomatia during the process of creating a new love dart. The love dart is created and stored before use in a highly muscular internal anatomical structure known as the stylophore or dart sac also known as the bursa telae. The exact positioning of the stylophore varies, but it is in the vicinity of the eversible penis and the vagina, where these two structures open into the "atrium", a common area right inside the genital pore. The opening of the stylophore leads directly into the atrium in certain species in the families Vitrinidae , Parmacellidae , Helminthoglyptidae , Bradybaenidae , Urocyclidae , Ariophantidae , and Dyakiidae. The opening of the stylophore can instead lead to the penis, as is the case in some species of Aneitinae a subfamily of Athoracophoridae , Sagdidae , Euconulidae , Gastrodontidae and Onchidiidae. Alternatively, it can lead to the vagina, as in the case in some species of Ariopeltinae a subfamily of Oopeltidae , Ariolimacinae a subfamily of Ariolimacidae , Philomycidae , other species within the Bradybaenidae , and also in the Hygromiidae , Helicidae and Dyakiidae. In all the other families there is reduction or loss of dart-making ability in some of the species cf. Many species have only one dart sac, however other species have several. Snails in the family Bradybaenidae have more than one dart sac, and some species of Hygromiidae and Helmintoglyptidae have four dart sacs. Calcareous darts[edit] Calcareous composed of calcium carbonate darts are found in a limited number of pulmonate families [1] within the Stylommatophora. Most of these families are within the land snail superfamily Helicoidea: Calcium carbonate darts are also found in the family Zonitidae within the superfamily Zonitoidea , and in one family of slugs, the Philomycidae , which are within the superfamly Arionoidea. Within the more ancient clade Systellommatophora , chitin darts are found in the pulmonate sea slugs of the family Onchidiidae , in the superfamily Onchidioidea. During evolution, darts appear to have been lost secondarily, i. Vestigial darts ones that exist only in a rudimentary condition occur in the family Sagdidae , [14] and in many Helicoidea , the surrounding organs have also degenerated become non-functional. The sarcobelum is a fleshy or cuticle-coated papilla which is considered to be a degenerated, previously dart-bearing, organ. The morphology of the dart is almost always species-specific. Some darts have a round cross section, others are bladed or vaned. In some cases the blades on the sides of the dart are bifurcated or divided into two parts. Some darts are shaped like a needle or a thorn , others have a tip like an arrowhead , or look like a dagger. What all the shapes have in common is their ability to pierce. Images[edit] Note: SEM images of love darts from eight different species of pulmonate land snails.

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Chapter 9 : The Cephalopoda

In some families of pulmonate land snails, one unusual feature of the reproductive system and reproductive behavior is the creation and utilization of love darts, the throwing of which have been identified as a form of sexual selection.

A cuttlefish, a coleoid cephalopod, moves primarily by undulating its body fins. Mollusca is one of the most diverse groups of animals on the planet, with at least 50, living species and more likely around , It includes such familiar organisms as snails, octopuses, squid, clams, scallops, oysters, and chitons. Mollusca also includes some lesser known groups like the monoplacophorans , a group once thought to be extinct for millions of years until one was found in in the deep ocean off the coast of Costa Rica. Molluscs are a clade of organisms that all have soft bodies which typically have a "head" and a "foot" region. Often their bodies are covered by a hard exoskeleton, as in the shells of snails and clams or the plates of chitons. A part of almost every ecosystem in the world, molluscs are extremely important members of many ecological communities. They range in distribution from terrestrial mountain tops to the hot vents and cold seeps of the deep sea, and range in size from meter-long giant squid to microscopic aplacophorans , a millimeter or less in length, that live between sand grains. These creatures have been important to humans throughout history as a source of food, jewelry, tools, and even pets. For example, on the Pacific coast of California, Native Americans consumed large quantities of abalone and especially owl limpets. However, the impact of Native Americans on these molluscan communities pales by comparison to the overharvesting of some molluscan taxa by the United States in the s and s. Species whose members once numbered in the millions, now teeter on the verge of extinction. For example, fewer than white abalone remain after several million individuals were captured and sold as meat in the s. Besides having yummy soft parts, molluscs often have desirable hard parts. The shells of some molluscs are considered quite beautiful and valuable. Molluscs can also be nuisances, such as the common garden snail; and molluscs make up a major component of fouling communities both on docks and on the hulls of ships. On the left is a marine snail, the California Trivia Trivia californiana. Here the mantle covers much of the shell. Note how a portion of the mantle is rolled into a tube shape to form the siphon just above the head. At the right is a restoration of one of the largest of all molluscs, the Giant Squid Architeuthis. They also have a very long and rich fossil record going back more than million years, making them one of the most common types of organism used by paleontologists to study the history of life. Systematics Molluscan systematics are still in flux. As you can see from the cladogram below, there is still no agreement on some of the major relationships. The polytomies shown indicate that the question of which molluscs are the most closely related is still a matter of debate. However, new types of data and much larger and more sophisticated analyses continue to be performed. The resolved relationships shown such as cephalopods, scaphopods, and gastropods are recent discoveries. Visit the mollusca pages on the Tree of Life for more on molluscan systematics. Morphology Despite their amazing diversity, all molluscs share some unique characteristics that define their body plan. The body has a head, a foot and a visceral mass. This is all covered with a mantle also known as a pallium that typically secretes the shell. In some groups, like slugs and octopuses, the mantle is secondarily lost, while in others, it is used for other activities, such as respiration. The freshwater Sinistral Pond Snail Physella sp. Click on the photo for a closer look. The radula is generally used for feeding. The ventral foot is used in locomotion. Typically, at least in the more primitive members of each group, there are one or more pairs of gills called ctenidia which lie in a posterior cavity the pallial cavity or in a posterolateral groove surrounding the foot. The pallial cavity typically contains a pair of sensory osphradia for smelling and is the space into which the kidneys, gonads, and anus open. Molluscs are coelomate, although the coelom is reduced and represented by the kidneys, gonads, and pericardium, the main body cavity which surrounds the heart. Life history and ecology Molluscs occur in almost every habitat found on Earth, where they are often the most conspicuous organisms. While most are found in the marine environment, extending from the intertidal to the deepest oceans, several major gastropod clades live predominantly in freshwater or terrestrial habitats. Remarkably, one study found around species within a single locality at a coral reef in New Caledonia. In terrestrial communities, gastropods can achieve reasonably high diversity and abundance: Many marine molluscs emerge from their eggs as planktonic trochophore larvae, however, Sinistral Pond Snails Physella sp. The whitish, jellybean-shaped organisms are ostracodes crustaceans. Marine molluscs occur on a large variety of substrates including rocky shores, coral reefs, mud flats, and sandy beaches. Gastropods and chitons are characteristic of these hard substrates, and bivalves are commonly associated with softer substrates where they burrow into the sediment. However, there are many exceptions: Some microscopic gastropods even live interstitially between sand grains. Large concentrations of gastropods and bivalves are found at hydrothermal vents in the deep sea. Living in these or other dysoxic habitats appears to be a plesiomorphic condition for the Mollusca and several outgroups. For example, the fauna of Palaeozoic hydrothermal vent communities includes the molluscan groups Bivalvia , Monoplacophora and Gastropoda as well as the outgroups Brachiopoda and Annelida. The adoption of different feeding habits appears to have had a profound influence on molluscan evolution. The change from grazing to other forms of food acquisition is one of the major features in the radiation of the group. Based on our current understanding of relationships, the earliest molluscs grazed on encrusting animals and detritus. Such feeding may have been selective or indiscriminate and will have encompassed algal, diatom, or cyanobacterial films and mats, or encrusting colonial animals. Truly herbivorous grazers are relatively rare and are limited to some polyplacophorans and a few gastropod groups. Cephalopods are mainly active predators as are some gastropods, while a few chitons and septibranch bivalves capture microcrustaceans. Most bivalves are either suspension or deposit feeders that indiscriminately take in particles, but then elaborately sort them based on size and weight, typically assimilating bacteria, protists, and diatoms. The fossil record The Mollusca include some of the oldest metazoans known. Late Precambrian rocks of southern Australia and the White Sea region in northern Russia contain bilaterally symmetrical, benthic animals with a univalved shell Kimberella that resembles those of molluscs. The earliest unequivocal molluscs are helcionelloid molluscs that date from Late Ediacaran Vendian rocks. In the Early Cambrian the Coeloscleritophora are also present. Most of the familiar groups, including gastropods, bivalves, monoplacophorans, and rostroconchs, all date from the Early Cambrian, whereas cephalopods are first found in the Middle Cambrian, polyplacophorans in the Late Cambrian, and the Scaphopoda in the Middle Ordovician. The Late Vendian-Early Cambrian taxa bear little resemblance to the Cambrian-Ordovician taxa most of which remain extant today. On the left is Inoceramus sp. After their initial appearance, molluscan taxonomic diversity tended to remain low until the Ordovician, when gastropods, bivalves, and cephalopods show large increases in diversity. For bivalves and gastropods this diversification increases throughout the Phanerozoic, with relatively small losses at the end-Permian and end-Cretaceous extinction events. Cephalopod diversity is much more variable through the Phanerozoic, whereas the remaining groups monoplacophorans, rostroconchs, polyplacophorans, and scaphopods maintain low diversity over the entire Phanerozoic or became extinct. Original text by Paul Bunje, Mollusca phylogeny based on Sigwart, J. Proceedings of The Royal Society B