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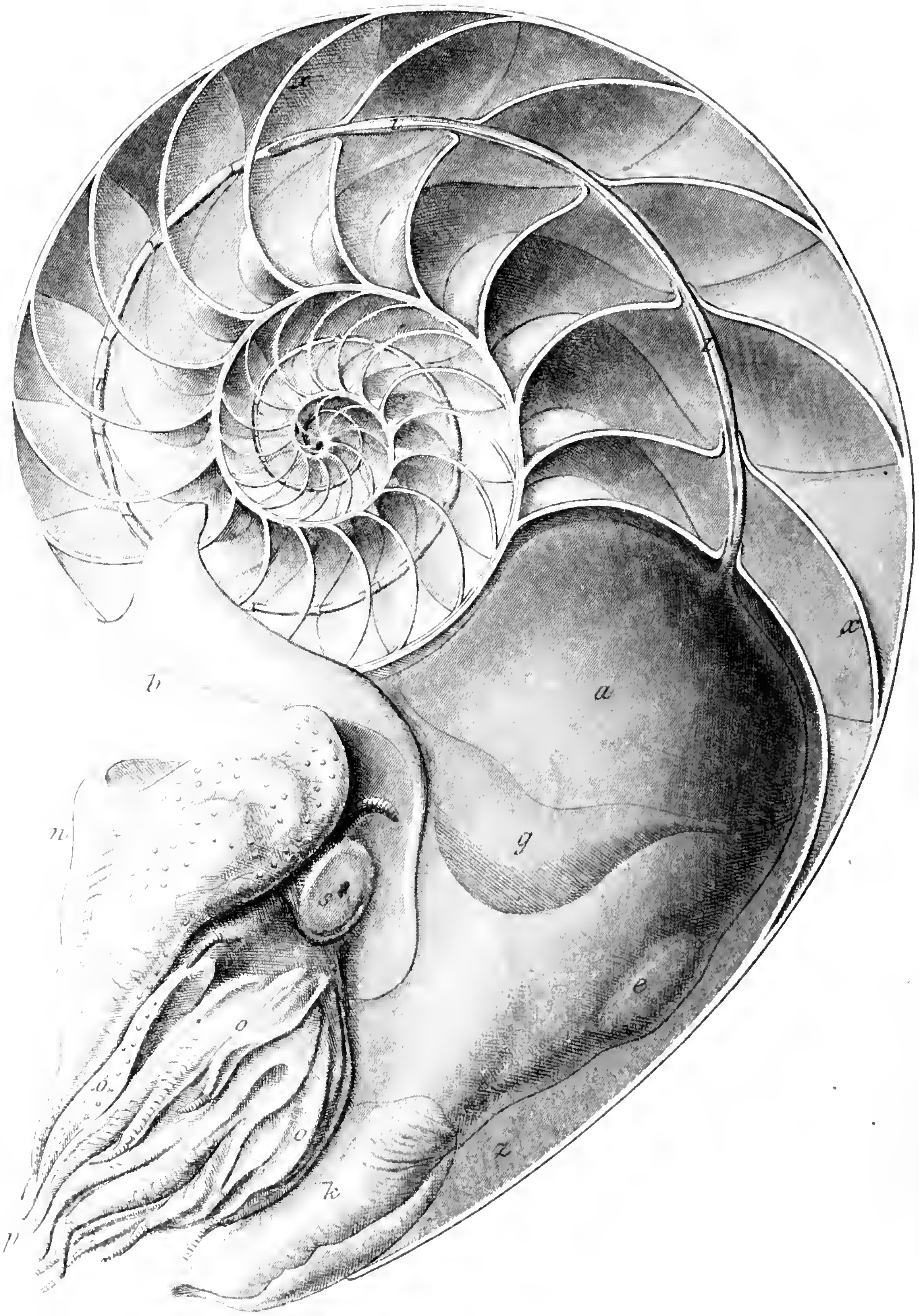
A

MANUAL OF THE MOLLUSCA.

THE PEARLY NAUTILUS

(after Owen)



a	The mantle	n	Hood
b	Its dorsal fold	o o o	Exterior digitations
c	Nidamental Gland	p	Tentacles
d	Shell muscle	s	Eye
i i i	Siphon	x x	Septa
k	Funnel	z	Last chamber

J. W. Lowry fc

London, John Weale, 59, High Holborn, 1851.

A

MANUAL OF THE MOLLUSCA;

OR, A

RUDIMENTARY TREATISE

OF

RECENT AND FOSSIL SHELLS.

BY

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ASSOCIATE OF THE LINNEAN SOCIETY;
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MEMBER OF THE COTTESWOLDE NATURALISTS' CLUB.

ILLUSTRATED BY

A. N. WATERHOUSE AND JOSEPH WILSON LOWRY.

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CHAPTER VI.

SYNOPSIS OF THE GENERA.

NOTICE.

The second part of this Manual is now in preparation, and will be published early in the summer. It will contain an account of the remaining orders of shell-fish: a chapter on the Geographical Distribution of the Mollusca, with a Map of the Marine and Terrestrial Provinces; a chapter on the distribution of Fossil Shells; another on the methods of collecting and preserving Land, Fresh-water, and Sea-shells; the Preface; and an Index of the genera and technical terms.

The writer desires to acknowledge his obligations to Mr. Hugh Cumming, Professor Edward Forbes, and other gentlemen who have assisted him by advice, and the loan of specimens; also to Mr. Van Voorst, for permission to copy some interesting figures from the "British Mollusca;" and his thanks are most especially due to Mr. John Edward Gray, Keeper of the Zoological Department of the British Museum, for access to his library and cabinet, and the use of some of the best engravings which illustrate these pages.

Kingdom ANIMALIA.

Sub-kingdom I. VERTEBRATA.

Class I. Mammalia.
II. Aves.
III. Reptilia.
IV. Pisces.

Sub-kingdom II. MOLLUSCA.

Class I. Cephalopoda.
II. Gasteropoda.
III. Pteropoda.
IV. Brachiopoda.
V. Conchifera.
VI. Tunicata.

Sub-kingdom III. ARTICULATA.

Class I. Insecta.
II. Arachnida.
III. Crustacea.
IV. Cirripeda.
V. Anellata.
VI. Entozoa.

Sub-kingdom IV. RADIATA.

Class I. Acalepha.
II. Echinodermata.
III. Zoophyta.
IV. Foraminifera.
V. Infusoria.
VI. Amorphozoa.

A

MANUAL OF THE MOLLUSCA.

INTRODUCTION.

CHAPTER I.

ON THE POSITION OF THE MOLLUSCA IN THE ANIMAL KINGDOM.

ALL known animals are constructed upon four different types, and constitute as many natural divisions or sub-kingdoms.

1. The first of these primary groups is characterized by an internal skeleton, of which the essential, or ever-present part, is a backbone, composed of numerous joints, or *vertebræ*. These are the animals most familiar to us; beasts, birds, reptiles, and fishes, are four classes which agree in this one respect, and are hence collectively termed vertebrate animals, or the *vertebrata*.

2. Another type is exemplified in the common garden-snail, the nautilus, and the oyster; animals whose soft bodies are protected by an external shell, which is harder than bone, and equally unlike the skeleton of fishes, and the hard covering of the crab and lobster. These creatures form the subject of the present history, and are called *mollusca*.*

* *Mollusca* soft (animals), from *mollis*. The Greeks termed them *Malakia*, whence the modern word *Malacology*, or the study of shell-fish.

3. The various tribes of insects, spiders, crabs, and worms, have no internal skeleton; but to compensate for it, their outer integument is sufficiently hard to serve at once the purposes of bones, and of a covering and defence. This external armature, like the bodies and limbs which it covers, is divided into segments or joints, which well distinguishes the members of this group from the others. The propriety of arranging worms with insects will be seen, if it be remembered, that even the butterfly and bee commence existence in a very worm-like form. This division of jointed animals bears the name of the *articulata.*

4. The fourth part of the animal kingdom consists of the coral-animals, star-fishes, sea-jellies, and those countless microscopic beings which swarm in all waters. Whilst other animals are bi-lateral, or have a right and left side, and organs arranged in pairs,—these have their organs placed in a circle around the mouth or axis of the body, and have hence obtained the appellation of *radiata.*

These groups illustrate successively the grand problems of animal economy. The lower divisions exhibit the perfectionizing of the functions of nutrition and reproduction; the higher groups present the most varied and complete development of the senses, locomotive powers, and instincts. We may also trace in them an ideal progression from the simplest to the most complicated structure and conditions. Commencing with the Infusorial monad, we may ascend in imagination by a succession of closely allied forms, to the sea-urchin and holothuria*; and thence by the lowest organized worms, upwards to the flying insect. Or, starting at the same point, we may pass from the polypes to the tunicaries; and from the higher kinds of shell-fish to the true fishes, and so on to those classes whose physical organization is most nearly identical with our own.

The *mollusca* are thus related to two of the other primary groups;—by the affinity of their simpler forms to the *zoophytes,*

* See the History of British Star-fishes, by Professor E. Forbes.

and of their highest class to the fishes;—to the cirripedes and other articulate animals, they present only superficial and illusive resemblance.

And further, we shall find that although it is customary to speak of shell-fish as "less perfect" animals, yet they really attain the perfection of their own type of structure; indeed it would seem to have been impossible to make any further advance, physical, or psychical, except by adopting a widely different *plan* from that on which the molluscous animals have been constructed.

The evidence afforded by geological researches at present tends to shew that the four leading types of animal structure have existed simultaneously from the very beginning of life upon the globe;* and though perpetually varying in the form under which they were manifested, they have never since entirely ceased to exist.

By adding to the living population of the world, those forms which peopled it in times long past, we may arrive at some dim conception of the great scheme of the animal kingdom. And if at present we see not the limits of the temple of nature, nor fully comprehend its design,—at least we can feel sure that there is a boundary to this present order of things; and that there has been a plan, such as we, from our mental constitution, are able to appreciate, and to study with ever-increasing admiration.

* Mr E. Logan, Geological Surveyor of the Canadas, has discovered *foot prints of a tortoise,* near Montreal, in the "Lingula Shale," or oldest fossi-biferous rock at present known.

Chapter II.

CLASSES OF THE MOLLUSCA.

The *mollusca* are animals with soft bodies, enveloped in a muscular skin, and usually protected by a univalve or bivalve shell. That part of their integument which contains the viscera and secretes the shell, is termed the *mantle;* in the univalves it takes the form of a sac, with an opening in front, from which the head and locomotive organs project: in the bivalves it is divided into two lobes.

The univalve mollusca are *encephalous*, or furnished with a distinct head; they have eyes and tentacula, and the mouth is armed with jaws. Cuvier has divided them into three classes, founded on the modifications of their feet, or principal locomotive organs.

1. The cuttle-fishes constitute the first-class, and are termed *cephalopoda*,* because their feet, or more properly *arms*, are attached to the head, forming a circle round the mouth.

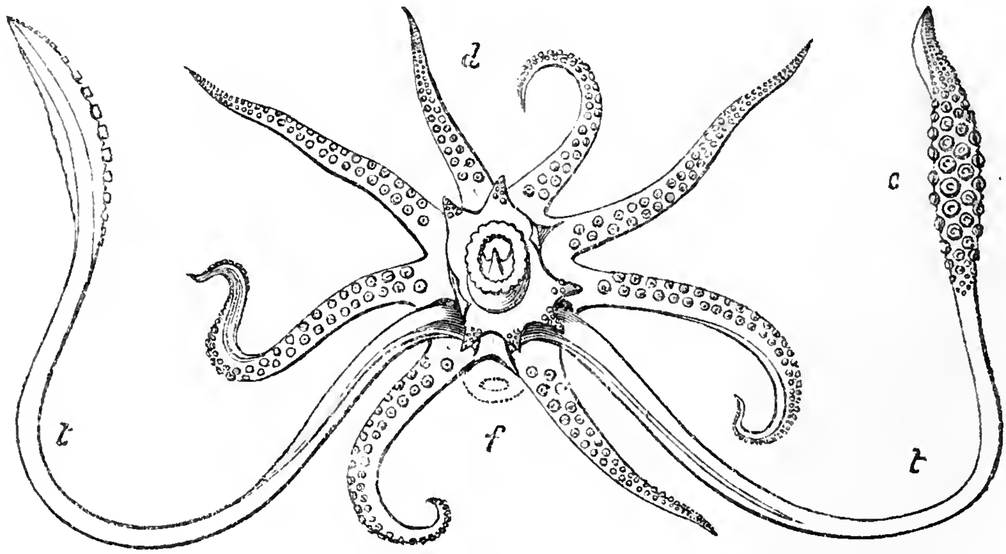


Fig. 1.† *Oral aspect of a Cephalopod.*

* From *Cephale*, the head and *poda* feet. See the frontispiece and pl. I.

† Fig. 1. *Loligo vulgaris*, Lam. ¼. From a specimen taken off Tenby, by J. S. Bowerbank, Esq. The mandibles are seen in the centre, surrounded by the circular lip, the buccal membrane (with two rows of small cups on its lobes), the eight sessile arms, and the long pedunculated tentacles (t), with their enlarged extremities or clubs (c). The *dorsal* arms are lettered (d), the funnel (f).

2. In the *gasteropoda*,* or snails, the under side of the body forms a single muscular foot, on which the animals creep or glide.

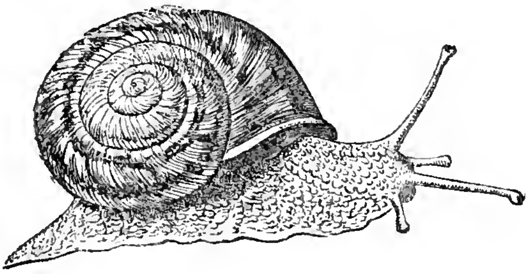


Fig. 2. *A Gasteropod.*†

3. The *pterpoda*‡ only inhabit the sea, and swim with a pair of fins, extending outwards from the sides of the head.

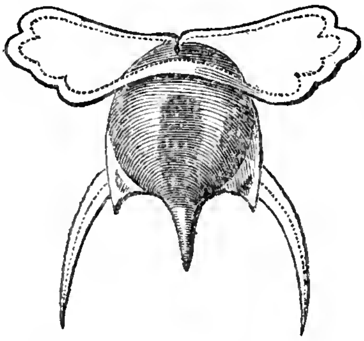


Fig. 3. *A Pteropod.* §

The other mollusca are *acephalous*, or destitute of any distinct head; they are all aquatic, and most of them are attached, or have no means of moving from place to place. They are divided into three classes, characterized by modifications in their breathing-organ and shell.

4. The *brachiapoda*¶ are bivalves, having one shell placed on the back of the animal, and the other in front; they have no

* *Gaster*, the under side of the body.

† Fig. 2. *Helix desertorum.* Forskal. From a living specimen in the British Museum, March, 1850.

‡ *Pteron*, a wing.

§ Fig. 3. *Hyalœa tridentata*, Lam., from Quoy and Gaimard.

¶ *Brachion*, an arm; these organs were supposed to take the place of the feet in the preceding classes.

special breathing organ, but the mantle performs that office ; they take their name from two long ciliated arms, developed from the sides of the mouth, with which they create currents that bring them food.

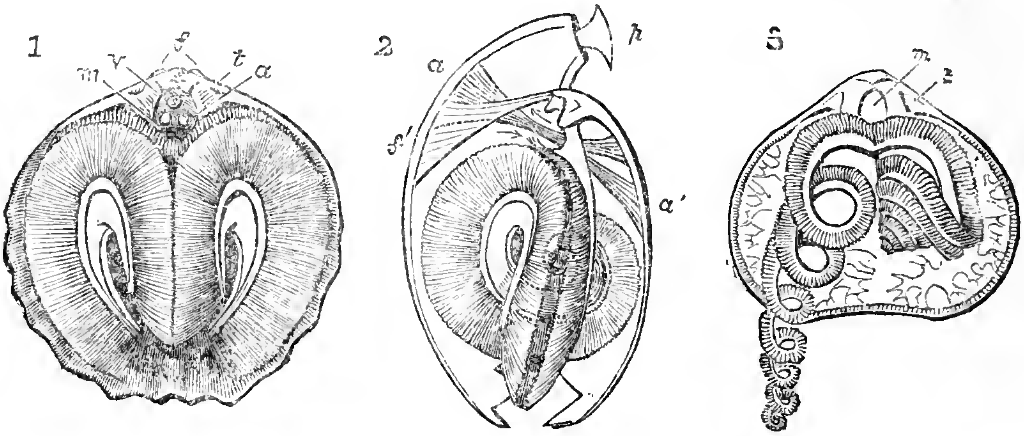


Fig. 4, 5, 6. *Brachiopoda.**

5. The *conchifera,*† or ordinary bivalves, (like the oyster), breathe by two pairs of gills, in the form of flat membraneous plates, attached to the mantle ; one valve is applied to the right, the other to the left side of the body.

6. The *tunicata* have no shell, but are protected by an elastic, gelatinous tunic, with two orifices ; the breathing-organ takes the form of an inner *tunic,* or of a riband stretched across the internal cavity.

Five of these modifications of the molluscan type of organization, were known to Linnæus, who referred the animals of all his genera of shell-fish to one or other of them ;‡ but unfortunately he did not himself adopt the truth which he was the first

* Fig. 4. (3). *Rhynchonella psittacea,* Chem, sp., dorsal valve, with the animal (after Owen). 5, 6, *Terebratula australis,* Quoy. From specimens collected by Mr. Jukes. (2). Ideal side view of both valves, (f, the retractor muscles, by which the valves are opened). (1). Dorsal valve. These woodcuts have been kindly lent by Mr. J. E. Gray.

† *Conchifera,* Shell-bearers.

‡ The Linnæan types were—Sepia, Limax, Clio, Anomia, Ascidia. *Terebratula* was included with Anomia, its organization being unknown.

to see; and here, as in his botany, employed an artificial, in preference to a natural method.

The systematic arrangement of natural objects ought not, however, to be guided by convenience, nor "framed merely for the purposes of easy remembrance and communication." The true method must be suggested by the objects themselves, by their qualities and relations;—it may not be easy to learn,—it may require perpetual modification and adjustment,—but inasmuch as it represents the existing state of knowledge it will aid in the UNDERSTANDING of the subject, whereas a "dead and arbitrary arrangement" is a perpetual bar to advancement, "containing in itself no principle of progression." (*Coleridge.*)

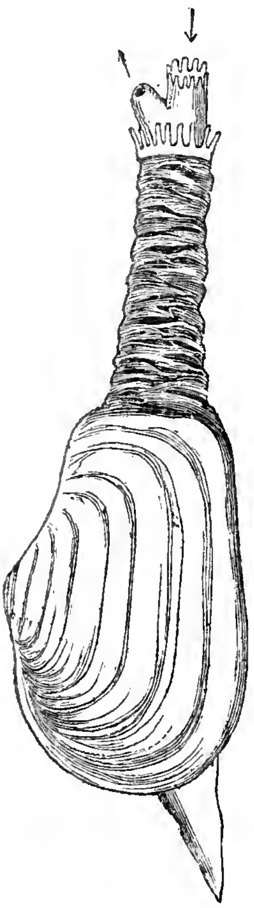


Fig. 7. *A Bivalve.**

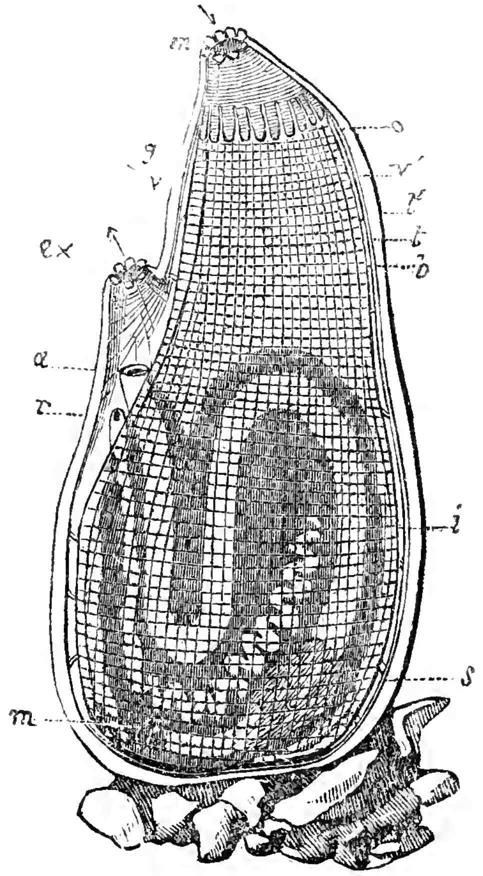


Fig. 8. *A Tunicary.*†

* *Mya truncata*, L. ½. From Forbes and Hanley.

† *Ascidia mentula*, Müll. Ideal representation; from a specimen dredged by Mr. Bowerbank, off Tenby.

Chapter III.

HABITS AND ECONOMY OF THE MOLLUSCA.

Every living creature has a history of its own; each has characteristics by which it may be known from its relatives; each has its own territory, its appropriate food, and its duties to perform in the economy of nature. Our present purpose, however, is to point out those circumstances and trace the progress of those changes which are not peculiar to individuals or to species, but have a wider application, and form the history of a great class.

In their infancy the molluscous animals are more alike, both in appearance and habits, than in after life; and the fry of the acquatic races are almost as different from their parents as the caterpillar from the butterfly. The analogy, however, is reversed in one respect; for whereas the adult shell-fish are often sedentary, or walk with becoming gravity, the young are all swimmers, and by means of their fins and the ocean-currents, they travel to long distances, and thus diffuse their race as far as a suitable climate and conditions are found. Myriads of these little voyagers drift from the shores into the open sea and there perish; their tiny and fragile shells become part of a deposit that is for ever increasing over the bed of the deep sea,—at depths too great for any living thing to inhabit. (*Forbes.*)

Some of these little creatures shelter themselves beneath the shell of their parent for a time, and many can spin silken threads with which they moor themselves, and avoid being drifted away. They all have a protecting shell, and even the young bivalves have eyes at this period of their lives, to aid them in choosing an appropriate locality.

After a few days, or even less, of this sportive existence, the sedentary tribes settle in the place they intend to occupy during the remainder of their lives. The tunicary cements itself to rock or sea-weed; the shipworm adheres to timber, and the *pholas* and *lithodomus* to limestone rocks, in which they soon excavate a chamber which renders their first means of anchorage unnecessary. The *mya* and razor-fish burrow in sand or mud; the mussel and *pinna* spin a byssus; the oyster and *spondylus* attach themselves by spines or leafy expansions of their shell; the *brachiopoda* are all fixed by similar means, and even some of the gasteropods become voluntary prisoners, as the *hipponyx* and *vermetus*.

Other tribes retain the power of travelling at will, and shift their quarters periodically, or in search of food; the river-mussel drags itself slowly along by protruding and contracting its flexible foot; the cockle and *trigonia* have the foot bent, enabling them to make short leaps; the scallop (*pector opercularis*) swims rapidly by opening and shutting its tinted valves. Nearly all the gasteropods creep like the snail, though some are much more active than others; the pond-snails can glide along the surface of the water, shell-downwards; the nucleobranches and pteropods swim in the open sea. The cuttle-fishes have a strange mode of walking, head-downwards, on their outspread arms; they can also swim with their fins, or with their webbed arms, or by expelling the water forcibly from their branchial chamber; the calamary can even strike the surface of the sea with its tail, and dart into the air like the flying-fish. (*Owen.*)

By these means the mollusca have spread themselves over every part of the habitable globe; every region has its tribe; every situation its appropriate species; the land-snails frequent moist places, or woods, or sunny banks and rocks, climb trees, or burrow in the ground. The air-breathing limneids live in fresh-water, only coming occasionally to the surface; and the auriculas live on the sea-shore, or in salt-marshes. In the sea, each zone of depth has its molluscous fauna. The limpet and periwinkle live between tide-marks, where they are left dry twice a-day; the *trochi* and *purpuræ* are found at low water, amongst the sea-weed; the mussel affects muddy shores, the cockle rejoices in extensive sandy flats. Most of the finely-coloured shells of the tropics are found in shallow water, or amongst the breakers. Oyster-banks are usually in four or five fathom water; scallop-banks at twenty fathoms. Deepest of all, the *terebratulæ* are found, commonly at fifty fathoms, and sometimes at one hundred fathoms, even in Polar seas. The fairy-like *pteropoda*, the oceanic-snail, and multitudes of other floating molluscs, pass their lives on the open sea, for ever out of sight of land; whilst the *litiopa* and *scyllæa* follow the gulf-weed in its voyages, and feed upon the green delusive banks.

The food of the mollusca is either vegetable, infusorial, or animal. All the land-snails are vegetable-feeders, and their depredations are but too well known to the gardener and farmer; many a crop of winter corn and spring tares has been wasted by the ravages of the "small grey slug." They have their likings, too, for particular plants, most of the pea-tribe and cabbage-tribe are favourites, but they hold white mustard in abhorence, and fast or shift their quarters while that crop is on the ground.* Some, like the "cellar-snail," feed on cryptogamic vegetation, or on decaying leaves; and the slugs are attracted by *fungi*, or any odorous substances. The round-mouthed sea-snails are nearly all vegetarians, and consequently limited to the shore and the shallow waters in which sea-weeds grow. Beyond fifteen fathoms, almost the only vegetable production is the nullipore; but here corals and horny zoophytes take the place of *algæ* and afford a more nutritious diet.

The whole of the bivalves, and other head-less shell-fish, live on infusoria, or on microscropic vegetables, brought to them by the current which their ciliary apparatus perpetually excites; such, too, must be the sustenance of the *magilus*, sunk in its

* Dilute lime-water and very weak alkaline solutions are more fatal to snails than even salt.

coral bed, and of the *calyptræa*, fettered to its birth-place by its calcarious foot.

The carnivorous tribes prey chiefly on other shell-fish, or on zoophytes; since, with the exception of the cuttle-fishes, their organization scarcely adapts them for pursuing and destroying other classes of animals. One remarkable exception is formed by the *stylina*, which lives parasitically on the star-fish and sea-urchin; and another by the testacelle, which preys on the common earth-worm, following it in its burrow, and wearing a buckler, which protects it in the rear.

Most of the siphonated univalves are animal-feeders; the carrion-eating stromb and whelk consume the fishes and other creatures whose remains are always plentiful on rough and rocky coasts. Many wage war on their own relatives, and take them by assault; the bivalve may close, and the operculated nerite retire into his home, but the enemy, with rasp-like tongue, armed with silicious teeth, files a hole through the shell,—vain shield where instinct guides the attack! Of the myriads of small shells which the sea heaps up in every sheltered "ness," a large proportion will be found thus bored by the whelks and purples; and in fossil shell-beds, such as that in the Touraine, nearly half the bivalves and sea-snails are perforated,—the relics of antediluvian banquets.

This is on the shore, or on the bed of the sea; far away from land the *carinaria* and *firola* pursue the floating *acalephe;* and the argonaut, with his relative the *spirula*, both carnivorous, are found in the "high seas," in almost every quarter of the globe. The most active and rapacious of all are the calamaries and cuttles, who vindicate their high position in the naturalists' "system," by preying even on fishes.

As the shell-fish are great eaters, so in their turn they afford food to many other creatures; fulfilling the universal law of eating, and being eaten. Civilized man still swallows the oyster, although snails are no longer reckoned "a dainty dish;" mussels, cockles, and periwinkles are in great esteem with children and the other unsophisticated classes of society; and so are scallops and the *haliotis*, where they can be obtained. Two kinds of whelk are brought to the London market in great quantities; and the arms of the cuttle-fish are eaten by the Neapolitans, and also by the East Indians and Malays. In seasons of scarcity, vast quantities of shell-fish are consumed by the poor inhabitants of the Scotch and Irish coasts.* Still more are regularly collected for bait; the calamary is much used in the cod-fishery, off Newfoundland, and the limpet and whelk on our own coasts.

Many wild animals feed on shell-fish; the rat and the racoon seek for them on the sea-shore when pressed by hunger; the South-American otter, and the crab-eating opossum constantly resort to salt-marshes, and the sea, and prey on the mollusca; the great whale lives habitually on the small floating pteropods; sea-fowl search for the litoral species at every ebbing tide; whilst, in their own element, the marine kinds are perpetually devoured by fishes. The haddock is a "great conchologist;" and some good northern sea-shells have been rescued, unbroken, from the stomach of the cod; whilst even the strong valves of the *cyprina* are not proof against the teeth of the cat-fish *(anarhicas)*.

They even fall a prey to animals much their inferiors in sagacity; the star-fish swallows the small bivalve entire, and dissolves the animal out of its shell; and the bubble-shell *(phyline)*, itself predacious, is eaten both by star-fish and sea-anemone *(actinia)*.

The land-snails afford food to many birds, especially to the thrush tribe; and to some insects, for the luminous larva of the glow-worm lives on them, and some of the large predacious beetles *(e. g. carabus violaceus* and *goerius olens)*, occasionally kill slugs.

The greatest enemies of the *mollusca*, however, are those of their own nation; scarcely one-half the shelly tribes graze peace-

* See Hugh Miller's "Scenes and Legends of the North of Scotland."

fully on sea-weed, or subsist on the nutrient particles which the sea itself brings to their mouths; the rest browse on living zoophytes, or prey upon the vegetable-feeders.

Yet in no class is the instinct of "self-preservation" stronger, nor the means of defence more adequate; their shells seem expressly given to compensate for the slowness of their movement, and the dimness of their senses. The cuttle-fish escapes from attack by swimming backwards and beclouding the water with an inky discharge; and the sea-hare *(aplysia)* pours out, when irritated, a copious purple fluid, formerly held to be poisonous. Others rely on passive resistance, or on concealment for their safety. It has been frequently remarked that molluscs resemble the hue and appearance of the situation they frequent; thus, the limpet is commonly overgrown with *balani* and sea-weed, and the ascidian with zoophytes, which form an effectual disguise; the *lima* and *modiola* spin together a screen of grotto-work. One ascidian *(a. cochligera)* coats itself with shell-sand, and the carrier-trochus cements shells and corals to the margin of its habitation, or so loads it with pebbles, that it looks but like a little heap of stones.

It must be confessed that the instincts of the shell-fish are of a low order, being almost limited to self-preservation, the escape from danger, and the choice of food. Their history offers none of those marvels which the entomologist loves to relate. An instance of something like social feeling has been observed in a Roman snail *(helix pomatia)* who, after escaping from a garden, returned to it in quest of his fellow-prisoner;—but the accomplished naturalist who witnessed the circumstance hesitated to record a thing so unexampled. The limpet, too, if we may trust the observations of Mr. Robert, of Lyme Regis, is fond of home, or at least possesses a knowledge of topography, and returns to the same roost after an excursion with each tide. Professor Forbes has immortalized the sagacity of the razor-fish, who submits to be salted in his hole, rather than expose himself to be caught, after finding that the enemy is lying in wait for him.

On the other hand, Mr. Bowerbank has a curious example of "instinct at fault," in the fossil spine of a sea-urchin, which appears to have been drilled by a carnivorous gasteropod!

We have spoken of shell-fish as articles of food, but they have other uses, even to man; they are the toys of children, who hear in them the roaring of the sea; they are the pride of "collectors" —whose wealth is in a cone or "wentle-trap;"* and they are the ornaments of barbarous tribes. The Friendly-islander wears the orange-cowry as a mark of chieftanship (*Stutchbury*), and the New Zealander polishes the *elenchus* into an ornament more brilliant than the "pearl ear-drop" of classical or modern times. (*Clarke.*) One of the most beautiful substances in nature is the shell-opal, formed of the remains of the ammonite. The forms and colours of shells (as of all other natural objects), answer some particular purpose, or obey some general law; but besides this, there is much that seems specially intended for our study, and calculated to call forth enlightened admiration. Thus the tints of many shells are concealed during life by a dull external coat, and the pearly halls of the nautilus are seen by no other eyes than ours. Or descending to mere "utility," how many tracts of coast are destitute of limestone, but abound in shell-banks which may be burned into lime; or in shell-sand, for the use of farmers.†

* The extravagant prices that have been given for rare shells, are less to be regretted, because they have induced voyagers to collect. Mere shell-collecting, however, is no more *scientific* than pigeon-fancying, or the study of old china. For *educational* purposes the best shells are the *types* of genera, or species which illustrate particular points of structure; and, fortunately for students, the prices are much diminished of late years. A *Carinaria* once "worth 100 guineas" (Sowerby) is now worth 1s. only; a Wentle-trap which fetched 40 guineas in 1701 (Rumphius) was worth only 20 guineas in 1753, and may now be had for 5s.! The *Conus gloria-maris* has fetched £50 more than once, and *Cypræa* umbilicata has been sold for £30 this year, 1850.

† Shell-sand is only beneficial on peaty soils, or heavy clay land. It sometimes hardens into limestone, as on the coast of Devon; and at Guadaloupe, where it contains litoral shells and human skeletons of recent date.

Not much is known respecting the individual duration of the shell-fish, though their length of life must be very variable. Many of the aquatic species are annuals, fulfilling the cycle of their existence in a single year; whole races are entombed in the wintry tide of mud that grows from year to year in the beds of rivers, and lakes, and seas; thus, in the Wealden clay we find layer above layer of small river-snails, alternating with thin strata of sediment, the index of immeasureably distant years. Dredgers find that whilst the adults of some shell-fish can be taken at all seasons, others can be obtained late in the autumn or winter only; those caught in spring and summer being young, or half-grown; and it is a common remark that *dead* shells (of some species) can be obtained of a larger size than any that we find alive, because they attain their full-growth at a season when our researches are suspended. Some species require part of two years for their full development; the young of the *doris* and *eolis* are born in the summer time, in the warm shallows near the shore; on the approach of winter they retire to deeper water, and in the following spring return to the tidal rocks, attain their full-growth early in the summer, and after spawning-time disappear.

The land-snails are mostly biennial; hatched in the summer and autumn, they are half-grown by the winter-time, and acquire their full-growth in the following spring or summer. In confinement, a garden-snail will live for six or eight years; but in their natural state it is probable that a great many die in their second winter, for clusters of empty shells may be found, adhering to one another, under ivied walls, and in other sheltered situations; the animals having perished in their hybernation. Some of the spiral sea-shells live a great many years, and tell their age in a very plain and interesting manner, by the number of fringes *(varices)* on their whirls; the contour of the *ranella* and *murex* depends on the regular recurrence of these ornaments, which occur after the same intervals in well-fed individuals, as in their less fortunate kindred. The Ammonites appear, by their *varices*, or periodic mouths (pl. III., fig. 3), to have lived and continued growing for many years.

Many of the bivalves, like the mussel and cockle, attain their full-growth in a year. The oyster continues enlarging his shell by annual "shoots," for four or five years, and then ceases to grow outwards; but very aged specimens may be found, especially in a fossil state, with shells an inch or two in thickness. The giant-clam *(tridacna)*, which attains so large a size that poets and sculptors have made it the cradle of the sea-goddess,—must enjoy an unusual longevity; living in the sheltered lagoons of coral-islands, and not discursive in its habits, the corals grow up around, until it is often nearly buried by them; but although there seems to be no certain limit to its life (though it may live a century for all that we know), yet the time will probably come when it will be overgrown by its neighbours, or choked with sediment.

The fresh-water molluscs of cold climates bury themselves during winter, in the mud of their ponds and rivers; and the land-snails hide themselves in the ground, or beneath moss and dead leaves. In warm climates they become torpid during the hottest and driest part of the year.

Those genera and species which are most subject to this "summer sleep," are remarkable for their tenacity of life; and numerous instances have been recorded of their importation from distant countries, in a living state. In June, 1850, a living pond-mussel was sent to Mr. Gray, from Australia, which had been more than a year out of water.* The pond-snails (*ampullariæ*) have been found alive in logs of mahogany from Honduras (Mr. Pickering); and M. Caillaud carried some from Egypt to Paris, packed in saw-dust. Indeed, it is not easy to ascertain the limit of their endurance; for Mr. Laidlay having placed a number in a drawer for this purpose, found them alive after *five*

* "It was alive 498 days after it was taken from the pond; and in the interim had been only twice for a few hours in water, to see if it was alive."—*Rev. W. O. Newnham.*

years, although in the warm climate of Calcutta. The *cyclostomas*, which are also *operculated*, are well known to survive imprisonments of many months; but in the ordinary land-snails such cases are more remarkable. Some of the large tropical *bulimi*, brought by Lieutenant Graves from Valparaiso, revived after being packed, some for thirteen, others for twenty months. In 1849, Mr. Pickering received from Mr. Wollaston a basket-full of Madeira snails (of twenty or thirty different species), three-fourths of which proved to be alive, after several months' confinement, including a sea-voyage. Mr. Wollaston has himself told us that specimens of two Madeira snails (*helix papilio* and *tectiformis*) survived a fast and imprisonment in pill-boxes, of two years and a half, and that a large number of the small *helix turricula*, brought to England at the same time, were *all* living after being inclosed in a dry bag for a year and a half.

But the most interesting example of resuscitation occurred to a specimen of the Desert snail, from Egypt, chronicled by Dr. Baird.* This individual was fixed to a tablet in the British Museum, on the 25th of March, 1846; and on March 7th, 1850, it was observed that he must have come out of his shell in the interval (as the paper had been discoloured, apparently in his attempt to get away); but finding escape impossible, had again retired, closing his aperture with the usual glistening film; this led to his immersion in tepid water, and marvellous recovery. He is now (March 13th, 1850) alive and flourishing, and has sat for his portrait. (Fig. 2.)

The permanency of the shell-bearing races is effectually provided for by their extreme fecundity; and though exposed to a hundred dangers in their early life, enough survive to re-people the land and sea abundantly. The spawn of a single *doris* may contain 600,000 eggs (Darwin); a river-mussel has been estimated to produce 300,000 young in one season, and the oyster cannot be much less prolific. The land-snails have fewer enemies, and, fortunately, lay fewer eggs.

* An. Nat. Hist. 1850.

Lastly, the *mollusca* exhibit the same instinctive care with insects and the higher animals, in placing their eggs in situations where they will be safe from injury, or open to the influences of air and heat, or surrounded by the food which the young will require. The tropical *bulimi* cement leaves together, to protect and conceal their large, bird-like, eggs; the slugs bury theirs in the ground; the oceanic-snail attaches them to a floating raft;

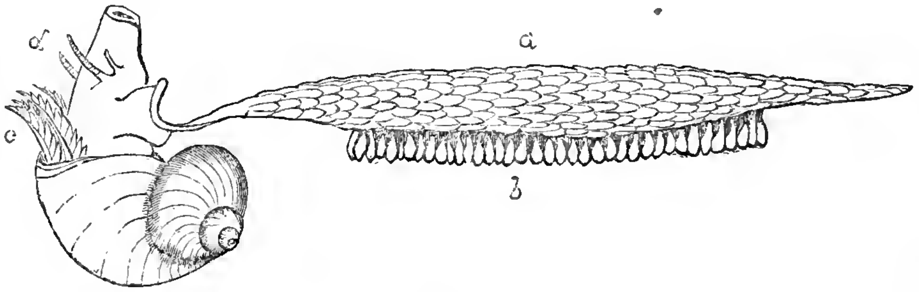


Fig. 9. *Ianthina with its raft.*

and the argonaut carries them in her frail boat. The horny capsules of the whelk are clustered in groups, with spaces pervading the interior, for the free passage of sea-water; and the nidamental ribbon of the *doris* and *eolis* is attached to a rock, or some solid surface from which it will not be detached by the waves. The river-mussel and *cyclas* carry their parental care still further, and nurse their young in their own mantle, or in a special *marsupium*, designed, like that of the opossum, to protect them until they are strong enough to shift for themselves.

If any one imbued with the spirit of Paley or Chateaubriand, should study these phenomena, he might discover more than the "barren facts" which alone appear, without significance, to the unspiritual eye; he would see at every step fresh proofs of the wisdom and goodness of God, who thus manifests his greatness by displaying the same care for the maintenance of his feeblest creatures, as for the well-being of man, and the stability of the world.

Chapter IV.

STRUCTURE AND PHYSIOLOGY OF THE MOLLUSCA.

Molluscous animals possess a distinct nervous system, instruments appropriated to the five senses, and muscles by which they execute a variety of movements. They have organs, by which food is procured and digested,—a heart, with arteries and veins, through which their colourless fluids circulate,—a breathing-organ,—and in most instances, a protecting shell. They produce eggs; and the young generally pass through one preparatory, or larval, stage.

The nervous system, upon which sensation and the exercise of muscular motion depend, consists of a brain or principal *centre*, and of various nerves possessing distinct properties: the *optic* nerves are only sensible of light and colours; the *auditory* nerves convey impressions of sound; the *olfactory*, of odours; the *gustatory*, of flavours; whilst the nerves of touch or feeling are widely diffused, and indicate in a more general way the presence of external objects. The nerves by which motion is produced, are distinct from these, but so accompany them as to appear like parts of the same cords. Both kinds of nerves cease to act when their connection with the centre is interrupted or destroyed. There is reason to believe, that most of the movements of the lower animals result from the reflection of external stimulants (like the process of *breathing* in man), without the intervention of the will.*

In the *mollusca*, the principal part of the nervous system is a ring surrounding the throat *(œsophagus)*, and giving off nerves to different parts of the body. The points from which the nerves radiate, are enlargements, termed centres *(ganglia)*, those on the

* See Müller's Elements of Philosophy, edited by Dr. Baly.

sides and upper part of the ring represent the brain, and supply nerves to the cyes, tentacles, and mouth; other centres, connected with the lower side of the œsophageal ring, send nerves to the foot, viscera, and respiratory organ. In the bivalves, the branchial centre is the most conspicuous, and is situated on the posterior adductor muscle. In the tunicaries, the corresponding nervous centre may be seen between the two orifices in the muscular tunic. This scattered condition of the nervous centres is eminently characteristic of the entire sub-kingdom.

Organs of special sense.—Sight. The eyes are two in number, placed on the front or sides of the head; sometimes they are *sessile*, in others stalked, or placed on long pedicels *(ommatophora)*. The eyes of the cuttle-fishes resemble those of fishes in their large size and complicated structure. Each consists of a strong fibrous globe *(slerotic)*, transparent in front *(cornea)*, with the opposite internal surface *(retina)* covered by a dark pigment which receives the rays of light. This chamber is occupied by an aqueous humour, a crystalline lens, and a vitreous humour, as in the human eye. In the *strombidœ*, the eye is not less highly organised, but in most of the *gasteropoda* it has a more simple structure, and perhaps only possesses sensibility of light without the power of distinct vision. The larval bivalves have also a pair of eyes in the normal position (fig. 30) near the mouth; but their development is not continued, and the adults are either eyeless, or possess merely rudimentary organs of vision, in the form of black dots (*ocelli*) along the margin of the mantle.* These supposed eyes have been detected in a great many bivalves, but they are most conspicuous in the scallop, which has received the name of *argus* from Poli, on this account (fig. 10).

In the tunicaries similar *ocelli* are placed between the tentacles which surround the orifices.

* "Each possesses a cornea, lens, choroid and nerve; they are, without doubt, organs of vision."—*Garner.*

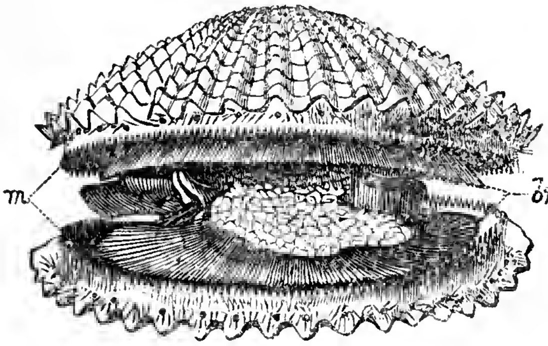


Fig. 10. *Pecten varius.**

Sense of Hearing. In the highest cephalopods, this organ consists of two cavities in the rudimentary cranium which protects the brain ; a small calcarious body or *otolithe* is suspended in each, as in the vestibular cavities of fishes.† Similar auditory capsules occur near the base of the tentacles in the *gasteropoda*, and they have been detected, by the vibration of the otolithes, in many bivalves and brachiopods. With the exception of *tritonia* and *eolis*, none of mollusca have been observed to emit sounds. (*Grant*).

Sense of Smell, This faculty is evidently possessed by the cuttle-fishes and gasteropods; snails discriminate their food by it, slugs are attracted by offensive odours, and many of the marine *zoophaga* may be taken with animal baits. In the pearly nautilus, there is a hollow plicated process beneath each eye,

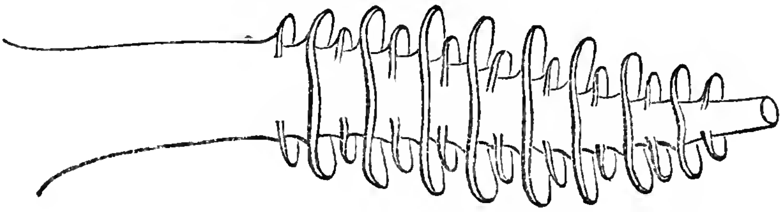


Fig. 11. *Tentacle of a Nudibranch.*‡

* *Pecten varius,* L., from a specimen dredged by Mr. Bowerbank, off Tenby ; *m,* the pallial curtains ; *br,* the branchiæ.

† In the Octopods, there is a foramen near the eye, and in some of the Calamaries a plicated organ, which M. D'Orbigny regards as an external ear.

‡ Fig. 11. Tentacle of *Eolis coronata,* Forbes, from Alder and Hancock.

which M. Valenciennes regards as the organ of smell*. Messrs. Hancock and Embleton attribute the same function to the lamellated tentacles of the nudibranchs, and compare them with the olfactory organs of fishes.

The labial tentacles of the bivalves are considered to be organs for discriminating food, but in what way is unknown (fig. 18. *l. t.*) The *sense of taste*, is also indicated rather by the habits of the animals, and their choice of food, than by the structure of a special organ. The *acephala* appear to exercise little discrimination in selecting food, and swallow anything that is small enough to enter their mouths, including living animalcules, and even the sharp *spicula* of sponges. In some instances, however, the oral orifice is well guarded, as in *pecten* (fig. 10.) In the *Encephala*, the tongue is armed with spines, employed in the comminution of the food, and cannot possess a very delicate sense. The more ordinary and diffused *sense of touch* is possessed by all the mollusca; it is exercised by the skin, which is everywhere soft and lubricous, and in a higher degree by the fringes of the bivalves (fig. 12), and by the filaments and tentacles (*vibracula*) of the gasteropods; the eye-pedicels of the snail are evidently endowed with great sensitiveness in this respect. That shell-fish are not very sensible of pain, we may well believe, on account of their tenacity of life, and the extent to which they have the power of reproducing lost parts.

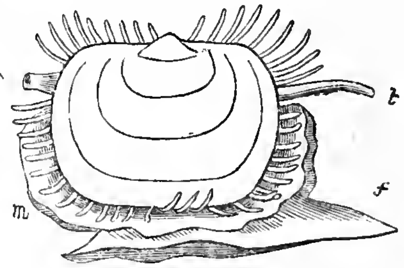


Fig. 12. *Lepton Squamosum.*†

Muscular System. The muscles of the *mollusca* are principally connected with the skin, which is exceedingly contractile in every part. The snail affords a remarkable, though familiar

* Mr. Owen regards the membraneous *lamellæ* between the oral tentacles and in front of the mouth, as the seat of the olfactory sense. *See Fig.* 44.

† Fig. 12. *Lepton sqaumosum Mont.*, from a drawing by Mr. Alder, in the British Mollusca; copied by permission of Mr. Van Voorst.

instance, when it draws in its eye-stalks, by a process like the inversion of a glove-finger; the branching gills of some of the sea-slugs, and the tentacles of the cuttle-fishes, are also eminently contractile.*

The inner tunic of the *ascidians* (fig. 8, *t.*) presents a beautiful example of muscular tissue, the crossing fibres having much the appearance of basket-work; in the transparent *salpians*, these fibres are grouped in flat bands, and arranged in characteristic patterns. In this class (*tunicata*) they act only as *sphincters* (or circular muscles), and by their sudden contraction expel the water from the branchial cavity. The muscular foot of the bivalves is extremely flexible, having layers of circular fibres for its protrusion, (fig. 18. *f*) and longitudinal bands for its retraction (fig. 30 *h*); its structure and mobility has been compared to that of the human tongue. In the burrowing shell-fish (such as *solen*), it is very large and powerful, and in the boring species, its surface is studded with silicious particles (*spicula*), which render it a very efficient instrument for the enlargement of their cells. (*Hancock.*) In the attached bivalves it is not developed, or exists only in a rudimentary state, and is subsidiary to a gland which secretes the material of those threads with which the mussel and *pinna* attach themselves. (Fig. 13.) These threads are termed the *byssus*; the plug of the *anomia*, and the pedicel of *terebratula* are modifications of the *byssus*.

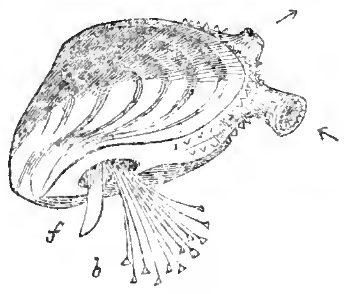


Fig. 13. *Dreissena.*†

In the cuttle-fishes alone, we find muscles attached to internal cartilages which represent the bones of *vertebrate* animals; the muscles of the arms are inserted in a cranial cartilage, and those of the fins in the lateral cartilages, the equivalents of the pectoral fins of fishes.

* The muscular fibres of shell-fish do not exhibit the transverse stripes which characterize *voluntary* muscles in the higher animals.

† Fig. 13. *Dreissena polymorpha* (Pallas sp.) from the Surrey timber-docks. *f*, foot. *b*, byssus.

Muscles of a third kind are attached to the shell. The valves of the oyster (and other *mono-myaries*) are connected by a single muscle; those of the *cytherea* (and other *di-myaries*), by two; the contraction of which brings the valves together. They are hence named *adductors;* and the part of the shell to which they are attached is always indicated by scars. (Fig. 14, *a. a'*).

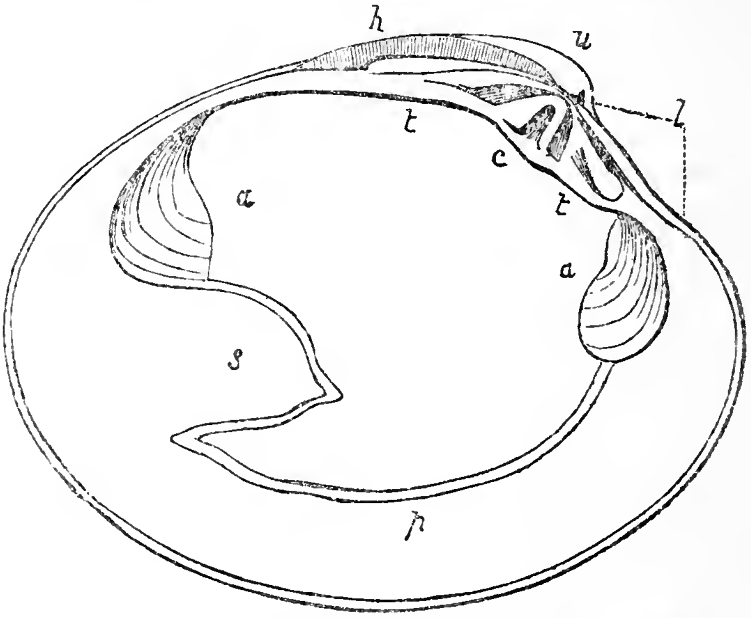


Fig. 14. *Left valve of Cytherea chione.**

The border of the mantle is also muscular, and the place of its attachment is marked in the shell by a line called the *pallial impression* (*p*); the presence of a bay, or *sinus* (*s*), in this line, shews that the animal had retractile siphons; the foot of the animal is withdrawn by *retractor* muscles also attached to the shell, and leaving small scars near those of the adductors (Fig. 30*).

The gasteropods withdraw into their shells when alarmed, by a shell-muscle, which passes into the foot, or is attached to the *operculum;* its impression is horse-shoe-shaped in the limpet, as also in *navicella*, *concholepas*, and the nautilus; it be-

* Fig. 14. *Cytherea chione*, L., coast of Devon, (original); *h*, the hinge ligament; *u*, the umbo; *l*, the lunule; *c*, cardinal tooth; *t t'*, lateral teeth; *a*, anterior adductor; *a'*, posterior adductor; *p*, pallial impression; *s*, sinus, occupied by retractor of the siphons.

comes deeper with age. In the spiral univalves, the scar is less conspicuous, being situated on the *columella*, and sometimes divided, forming two spots. It corresponds to the posterior *retractors* in the bivalves.

Digestive system. This part of the animal economy is all-important in the *radiate* classes, and scarcely of less consequence in the *mollusca.* In the ascidians (fig. 8, *i*), the alimentary canal is a convoluted tube, in part answering to the *œsophagus*, and in part to the intestine; the stomach is distinguished by longitudinal folds, which increase its extent of surface; it receives the secretion of the liver by one or more apertures. In those bivalves, which have a large foot, the digestive organs are concealed in the upper part of that organ; the mouth is unarmed, except by two pairs of soft membranous *palpi*, which look like accessory gills (fig. 18. *l. t.*) The ciliated arms of the brachipods, occupy a similar position (figs. 4, 5, 6), and are regarded as their equivalents. The encephalous mollusca are frequently armed with horny jaws, working vertically like the mandibles of a bird; in the land-snails, the upper jaw is opposed only by the denticulated tongue, whilst the limneïds have two additional horny jaws, acting laterally. The tongue is muscular, and armed with recurved spines (or *lingual teeth*), arranged in a great variety of patterns, which are eminently characteristic of the genera.* Their teeth are amber-coloured, glossy, and translucent; and being silicious (they are insoluble in acid), they can be used like a file, for the abrasion of very hard substances. With them the limpet rasps the stony nullipore, the whelk bores holes in other shells, and the cuttle-fish doubtless uses its tongue in the same manner as the cat. The tongue, or lingual ribbon, usually forms a triple band, of which the central part is called the *rachis*, and the lateral tracts *pleuræ*, the rachidian teeth

* The preparation of the lingual ribbon as a permanent microscopic object, requires some nicety of manipulation, but the arrangement of the teeth may be seen by merely compressing part of the animal between two pieces of glass.

sometimes form a single series, overlapping each other, or there are lateral teeth on each side of a median series. The teeth on the pleuræ are termed *uncini;* they are extremely numerous in the plant-eating gasteropods. (Fig. 15. A.)*

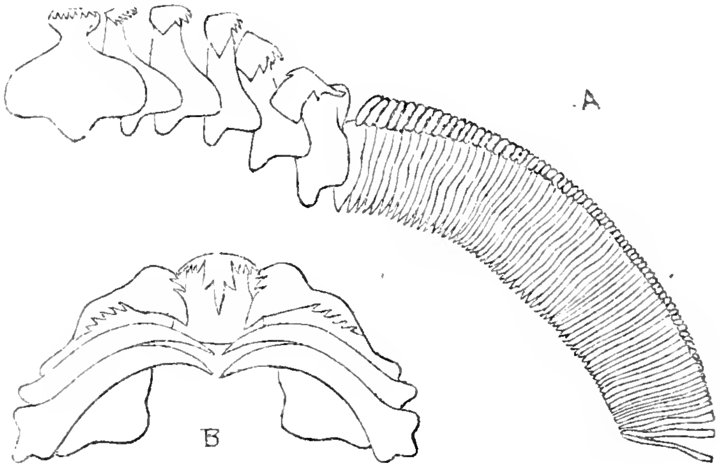


Fig. 15. *Lingual Teeth of Mollusca.*

Sometimes the tongue forms a short semi-circular ridge, contained between the jaws; at others, it is extremely elongated, and when withdrawn, its folds extend backwards to the stomach. The lingual ribbon of the limpet is longer than the whole animal; the tongue of the whelk has 100 rows of teeth; and the great slug has 160 rows, with 180 teeth in each row.

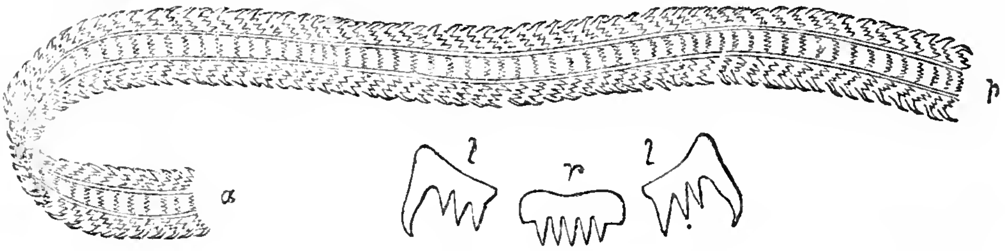


Fig. 16. *Tongue of the Whelk.*†

The front of the tongue is frequently curved, or bent quite over; it is the part of the instrument in use, and its teeth are

* Fig. 15. A. Lingual teeth of *trochus cinerarius* (after Lovén). Only the median tooth, and the (5) lateral teeth, and (90) *uncini* of one side of a single row are represented. B. One row of the lingual teeth of *cypræa europæa;* consisting of a median tooth, and three *uncini* on each side of it.

† Fig. 16. Lingual ribbon of *buccinum undatum* (original), from a preparation communicated by Wm. Thomson, Esq., of King's College.

often broken or blunted. The posterior part of the lingual ribbon usually has its margins rolled together, and united, forming a tube, which is presumed to open gradually. The new teeth are developed from behind forwards, and are brought successively into use, as in the sharks and rays amongst fishes. In the *bulladæ* the *rachis* of the tongue is unarmed, and the business of communicating the food is transferred to an organ which resembles the gizzard of a fowl, and is often paved with calcarious plates, so large and strong as to crush the small shell-fish which are swallowed entire. In the *aplysia*, which is a vegetable-feeder, the gizzard is armed with numerous small plates and spines. The stomach of some bivalves contains an instrument called the "crystalline stylet," which is conjectured to have a similar use. In the cephalopods there is a crop in which the food may accumulate, as well as a gizzard for its trituration.

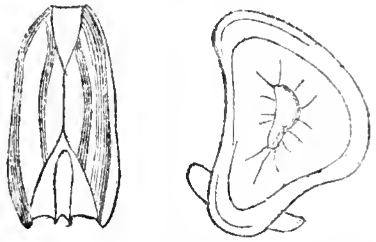


Fig. 17. *Gizzard of Bulla.**

The *liver* is always large in the mollusca (fig. 10); its secretion is derived from arterial blood, and is poured either into the stomach, or the commencement of the intestine. In the nudibranchs, whose stomachs are often remarkably branched, the liver accompanies all the gastric ramifications, and even enters the respiratory papillæ on the backs of the eolids. The existence of a *renal* organ has been ascertained in most classes; in the bivalves it was detected by the presence of uric acid. The intestine is more convoluted in the herbivorous than in the carnivorous tribes: in the bivalves and in *haliotis* it passes through the ventricle of the heart; its termination is always near the respiratory aperture (or excurrent orifice, when there are

* Fig. 17. Gizzard of *bulla lignaria* (original). Front and side view of a half-grown specimen, with the part nearest the head of the animal downwards; in the front view the plates are in contact. The *cardiac* orifice is in the centre, in front; the *pyloric* orifice is on the posterior dorsal side, near the small transverse plate.

two*), and the excrements are carried away by the water which has already passed over the gills.

Besides the organs already mentioned, the encephalous mollusks are always furnished with well-developed *salivary glands*, and some have a rudimentary *pancreas;* many have also special glands for the secretion of coloured fluids, such as the purple of the *murex*, the violet liquid of *ianthina* and *aplysia*, the yellow of the *bulladæ*, the milky fluid of *eolis*, and the inky secretion of the cuttle-fishes. A few exhale peculiar odours, like the garlic-snail (*helix alliaria*) and *eledone moschata*. Many are phosphorescent, especially the floating tunicaries (*salpa* and *pyrosoma*), and bivalves which inhabit holes (*pholadidæ*). Some of the cuttle-fishes are slightly luminous; and one land-slug, the *phosphorax*, takes its name from the same property.

Circulating system. The *mollusca* have no distinct absorbent system, but the product of digestion (*chyle*) passes into the general abdominal cavity, and thence into the larger veins, which are perforated with numerous round apertures. The circulating organs are the heart, arteries, and veins; the blood is colourless, or pale bluish white. The *heart* consists of an *auricle* (sometimes divided into two), which receives the blood from the gills; and a muscular *ventricle* which propels it into the arteries of the body. From the capillary extremities of the arteries it collects again into the veins, circulates a second time through the respiratory organ, and returns to the heart as arterial blood. Besides this *systemic* heart, the circulation is aided by two additional *branchial* hearts in the cuttle-fishes; and by four in the *brachiopoda*. Mr. Alder has counted from 60 to 80 pulsations per minute in the nudibranchs, and 120 per minute in a *vitrina*. Both the arteries and veins form occasionally wide spaces, or

* In most of the gasteropods the intestine returns upon itself, and terminates on the right side, near the head. Occasionally it ends in a perforation more or less removed from the margin of the aperture, as in *trochotoma*, *fissurella*, *macrochisma*, and *dentalium*. In *chiton* the intestine is straight, and terminates posteriorly.

sinuses; in the cuttle-fishes the œsophagus is partly or entirely surrounded by a venous *sinus;* and in the *acephala* the viceral cavity itself forms part of the circulating system.

The circulation in the tunicaries presents a most remarkable exception to the general rule, for their blood ebbs and flows in the same vessels, as it was supposed to do in the human veins before the time of Harvey. In the transparent *salpæ* it may be seen passing from the heart into vessels connected with the *viscera* and tunics, and thence into the branchial vessels; but when this has continued for a time, the movement ceases, and recommences in the opposite direction, passing from the heart to the gill and thence to the system. (*Lister.*) In the compound tunicaries, there is a common circulation through the connecting medium, in addition to the individual currents.

Aquiferous canals. Sea-water is admitted to the visceral cavity of many of the mollusks (as it is also in radiate animals), by minute canals, opening externally in the form of pores. These *aquiferous pores* are situated either in the centre of the creeping disc, as in *cypræa, conus,* and *ancillaria;* or at its margin, as in *haliotis, doris,* and *aplysia.* In the cuttle-fishes, they are variously placed, on the sides of the head, or at the bases of the arms; some of them conduct to the large sub-orbital pouches, into which the tentacles are retracted.

Respiratory system. The respiratory process consists in the exposure of the blood to the influence of air, or water containing air; during which oxygen is absorbed and carbonic acid liberated. It is a process essential to animal life, and is never entirely suspended, even during hybernation. Those air-breathers that inhabit water are obliged to visit the surface frequently; and stale water is so inimical to the water-breathers, that they soon attempt to escape from the confinement of a glass or basin, unless the water is frequently renewed.* In general,

* When aquatic plants are kept in the same glass with water-breathing snails, a balance is produced; which enables both to live without change of water.

fresh-water is immediately fatal to marine species, and salt-water to those which properly inhabit fresh; but there are some which affect brackish water, and many which endure it to a limited extent. The depth at which shell-fish live, is influenced by the quantity of oxygen which they require; the most active and energetic races live only in shallow water, or near the surface; those found in very deep water are the lowest in their instincts, and are specially organized for their situation. Some water-breathers require only moist sea-air, and a bi-diurnal visit from the tide,—like the periwinkle, limpet, and *kellia;* whilst many air-breathers live entirely in the water or in damp places by the water-side. In fact, the nature of the respiratory process is the same, whether it be aquatic or aërial, and it is essential in each case that the surface of the breathing-organ should be preserved moist. The process is more complete in proportion to the extent and minute sub-division of the vessels, in which the circulating fluid is exposed to the revivifying influence.

The land-snails (*pulmonifera*), have a lung, or air-chamber, formed by the folding of the mantle, over the interior of which the pulmonary vessels are distributed; this chamber has a round orifice, on the right side of the animal, which opens and closes at irregular intervals. The air in this cavity seems to renew itself with sufficient rapidity (by the law of diffusion), without any special mechanism.

In the aquatic shell-fish, respiration is performed by the mantle, or by a portion of it specialized, and forming a gill (*branchia*). It is effected by the mantle alone in one family of tunicaries (*pelonaiadæ*), in all the *brachiopoda*, and in one family of gasteropods (*actæonidæ*).

In most of the *tunicata*, the breathing organ forms a distinct *sac* lining the muscular tunic, or mantle (fig. 8. *b.*); this sac has only one external aperture, and conducts to the mouth, which is situated at its base. It is a sieve-like structure, and its inner surface is clothed with vibratile cilia* which create a perpetual

* From *cilium*, an eyelash; they are only visible under favourable circum-

current, setting in through the (branchial) orifice, escaping through the meshes of the net, and passing out by the anal orifice of the outer tunics. The regularity of this current is interrupted only by spasmodic contractions of the mantle, occurring at irregular intervals, by which the creature spirts out water from *both* orifices, and thus clears its cavity of such accumulated particles as are rejected by the mouth; and too large to escape through the branchial pores. In the salpians, these contractions are *rythmical*, and have the effect of propelling them backwards. In the ordinary bivalves, the gills form two membranous plates on each side of the body; the muscular mantle is still sometimes united, forming a chamber with two orifices, into one of which the water flows, whilst it escapes from the other; there is a third opening in front, for the foot, but this in no wise influences the branchial circulation. Sometimes the orifices are drawn out into long tubes, or *siphons*, especially in those shell-fish which burrow in sand. (Figs. 19 and 7.)

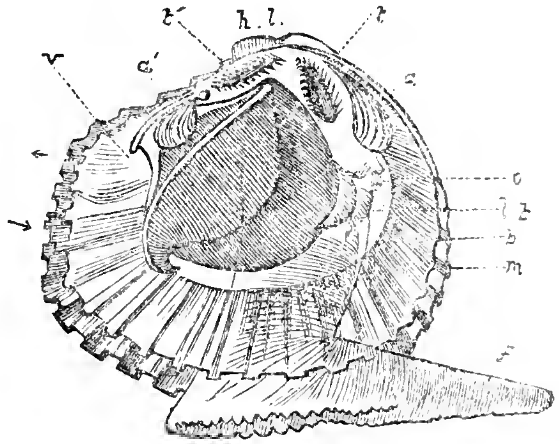


Fig. 18. *Trigonia pectinata.**

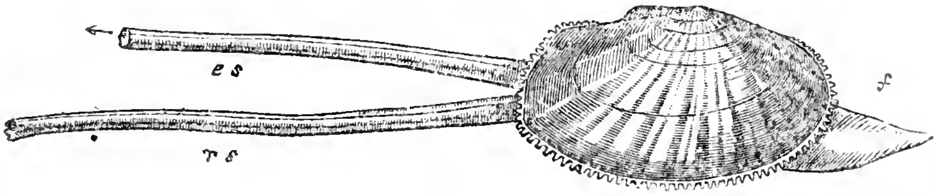


Fig. 19. *Bivalve with long siphons.*†

stances, with the aid of a microscope; but the currents they cause are easily made perceptible by dropping fine sand into the water over them.

* *Trigonia pectinata,* Lam. (original). Brought from Australia by the late Captain Owen Stanley. The gills are seen in the centre through the transparent mantle. *o,* mouth; *l t,* labial tentacles; *f,* foot; *v,* vent.

† Fig. 19. *Psammobia vespertina,* Chemn. after Poli, reduced one half. The arrows indicate the direction of the current. *r s,* respiratory siphon. *e s,* excurrent siphon.

Those bivalves which have no siphons, and even those in which the mantle is divided into two lobes, are provided with valves or folds which render the respiratory channels just as complete in effect. These currents are not in any way connected with the opening and closing of the valves, which is only done in moving; or in efforts to expel irritating particles.*

In some of the *gasteropoda* the respiratory organs form tufts, exposed on the back and sides (as in the *nudibranches*), or protected by a fold of the mantle (as in the *inferobranches* and *tectibranches* of Cuvier). But in most the mantle is inflected, and forms a vaulted chamber over the back of the neck, in which are contained the pectinated or plume-like gills (fig. 61). In the carnivorous gasteropods (*siphonostomata*) the water passes into this chamber through a *siphon*, formed by a prolongation of the upper margin of the mantle, and protected by the *canal* of the shell; after traversing the length of the gill, it returns and escapes through a posterior siphon, generally less developed, but very long in *ovulum volva*, and forming a tubular spine in *typhis*.

In the plant-eating sea-snails (*holostomata*), there is no true siphon, but one of the "neck-lappets" is sometimes curled up and performs the same office, as in *paludina* and *ampullaria* (fig. 84). The in-coming and out-going currents in the branchial chamber, are kept apart by a valve-like fringe, continued from the neck-lappet. The out-current is still more effectually isolated in *fissurella*, *haliotis*, and *dentalium*, where it escapes by a hole in the shell, far removed from the point at which it entered. Near this outlet are the anal, renal, and generative orifices.

The cephalopods have two or four plume-like gills, symmetrically placed in a branchial chamber, situated on the under-side

* If a river-mussel be placed in a glass of water, and fine sand let fall gently over its respiratory orifices, the particles will be seen to rebound from the vicinity of the upper aperture, whilst they enter the lower one rapidly. But as this kind of food is not palatable, the creature will soon give a plunge with its foot, and closing its valves, spirt the water (and with it the sand) from both orifices; the motion of the foot is, of course, intended to change its position.

of the body; the opening is in front, and occupied by a *funnel*, which, in the nautilus, closely resembles the siphon of the *paludina*, but has its edges united in the cuttle-fishes. The free edge of the mantle is so adapted that it allows the water to enter the branchial chamber on each side of the funnel; its muscular walls then contract and force the water through the funnel, an arrangement chiefly subservient to locomotion.* Mr. Bowerbank has observed, that the *eledone* makes twenty respirations per minute, when resting quietly in a basin of water.

In most instances, the water on the surface of the gills is changed by ciliary action alone; in the *cephalopods* and *salpians*, it is renewed by the alternate expansion and contraction of the respiratory chamber, as in the *vertebrate* animals.

The respiratory system is of the highest importance in the economy of the mollusca, and its modifications afford most valuable characters in classification. It will be observed that the Cuvierian *classes* are based on a variety of particulars, and are very unequal in importance; but the *orders* are characterized by their respiratory conditions, and are of much more nearly equal value.

	Orders.	*Classes.*
ENCEPHALA	Dibranchiata. Owen.	CEPHALOPODA.
	Tetrabranchiata. Owen.	
	Nucleobranchiata. Bl.	GASTEROPODA.
	Prosobranchiata. M. Edw.	
	Pulmonifera. Cuv.	
	Opisthobranchiata. M. Edw.	
	Aporobranchiata. Bl.	PTEROPODA.
ACEPHALA	Palliobranchiata. Bl.	BRACHIOPODA.
	Lamellibranchiata. Bl.	CONCHIFERA.
	Heterobranchiata. Bl.	TUNICATA.

The Shell. The relation of the shell to the breathing-organ is very intimate; indeed, it may be regarded as a *pneumo-skeleton*,

* A very efficient means of locomotion in the slender pointed calamaries, which dart backwards with the recoil, like rockets.

being essentially a calcified portion of the mantle, of which the breathing-organ is at most a specialised part.*

The shell is so characteristic of the mollusca that they have been commonly called "testacea" (from *testa* "a shell"), in scientific books; and the popular name of "shell-fish," though not quite accurate, cannot be replaced by any other epithet in common use. In one whole class, however, and in several families, there is nothing that would be popularly recognised as a shell.

Shells are said to be *external* when the animal is contained in them, and *internal* when they are concealed in the mantle; the latter, as well as the shell-less species, being called *naked* mollusks.

Three-fourths of the *mollusca* are *univalve*, or have but one shell; the others are mostly *bivalve*, or have two shells; the *pholads* have accessory plates, and the shell of *chiton* consists of eight pieces. Most of the *multivalves* of old authors were articulate animals (*cirripedes*), erroneously included with the *mollusca*, which they resemble only in outward appearance.

All, except the argonaut, acquire a rudimental shell before they are hatched, which becomes the *nucleus* of the adult shell; it is often differently shaped and coloured from the rest of the shell, and hence the *fry* are apt to be mistaken for distinct species from their parents.

In *cymba* (fig. 20) the nucleus is large and irregular; in *fusus antiquus* it is cylindrical; in the *pyramidellidæ* it is oblique; and it is spiral in *carinaria*, *atlanta*, and many limpets, which are symmetrical when adult.

The rudimentary shell of the *nudibranchs* is shed at an early

* In its most reduced form the shell is only a hollow cone, or plate, protecting the breathing organ and heart, as in *limax*, *testacella*, *carinaria*. Its peculiar features always relate to the condition of the breathing-organ; and in *terebratula* and *pelonaia* it becomes identified with the gill. In the nudibranchs the vascular mantle performs wholly or in part the respiratory office. In the cephalopods the shell becomes complicated by the addition of a distinct, internal, chambered portion (*phragmocone*), which is properly a *visceral* skeleton; in *spirula* the shell is reduced to this part.

age, and never replaced. In this respect the molluscan shell differs entirely from the shell of the crab and other articulate animals, which is periodically cast off and renewed.

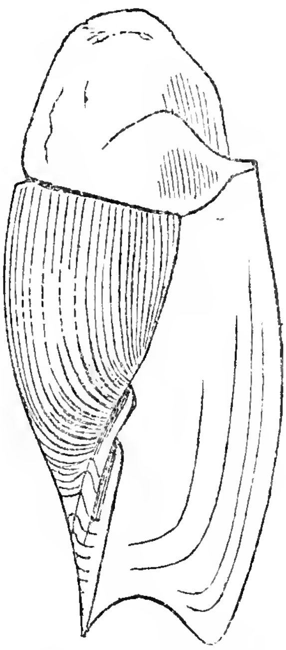


Fig. 20. *Cymba.**

In the bivalves the embryonic shell forms the *umbo* of each valve; it is often very unlike the after-growth, as in *unio pictorum, cyclas henslowiana* and *pecten pusio.* In attached shells like the oyster and anomia the umbo frequently presents an exact imitation of the surface to which the young shell originally adhered.

Shells are composed of carbonate of lime, with a small proportion of animal matter. The source of this lime is to be looked for in their food. Modern inquiries into organic chemistry have shown that vegetables derive their elements from the mineral kingdom (air, water, and the soil), and animals theirs from the vegetable. The sea-weed filters the salt-water, and separates lime as well as organic elements; and lime is one of the most abundant mineral matters in land plants. From this source the *mollusca* obtain lime in abundance, and, indeed, we find frequent instances of shells becoming unnaturally thickened through the superabundance of this earth in their systems. On the other hand, instances occur of thin and delicate-shelled varieties, in still, deep water, or on clay bottoms; whilst in those districts which are wholly destitute of lime, like the lizard in Cornwall, and similar tracts of magnesian-silicate in Asia Minor, there are no mollusca. (*Forbes.*)

The texture of shells is various and characteristic. Some, when broken, present a dull lustre like marble or china, and are termed *porcellanous;* others are pearly or *nacreous;* some have a *fibrous* structure; some are *horny*, and others *glassy* and *translucent.*

* Fig. 20. *Cymba proboscidalis,* Lam., from a very young specimen in the cabinet of Hugh Cuming, Esq., from Western Africa.

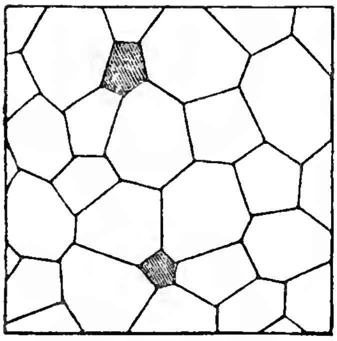


Fig. 21. *Pinna.*

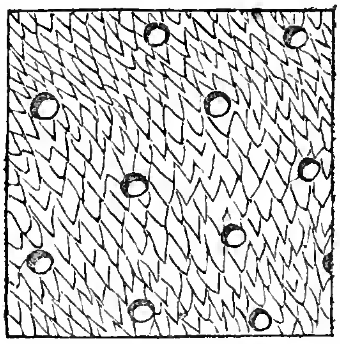


Fig. 22. *Terebratula.*

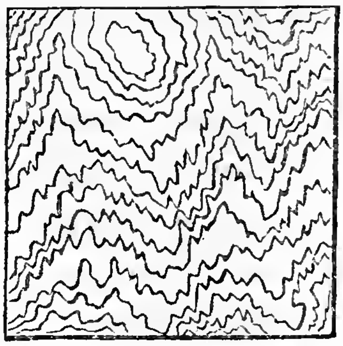


Fig. 23. *Pearl.**

The *nacreous* shells are formed by alternate layers of very thin membrane and carbonate of lime, but this alone does not give the pearly lustre which appears to depend on minute undulations of the layers, represented in fig. 23. This lustre has been successfully imitated on engraved steel buttons. Nacreous shells, when polished, form "mother of pearl;" when digested in weak acid, they leave a membraneous residue which retains the original form of the shell. This is the most easily destructible of shell-textures, and in some geological formations we find only casts of the nacreous shells, whilst those of fibrous texture are completely preserved.

Pearls are produced by many bivalves, especially by the Oriental pearl-mussel (*avicula margaritifera*), and one of the British river-mussels (*unio margaritiferus*). They are caused by particles of sand, or other foreign substances, getting between the animal and its shell; the irritation causes a deposit of nacre, forming a projection on the interior, and generally more brilliant than the rest of the shell. Completely spherical pearls can only be formed loose in the muscles, or other soft parts of the animal. The Chinese obtain them artificially, by introducing into the living mussel foreign substances, such as pieces of mother-of-pearl fixed to wires, which thus become coated with a more brilliant material.

* Figs. 21, 22, 23. Magnified sections of shells, from Dr. Carpenter. Fragments of shell ground very thin, and cemented to glass slides with Canada balsam, are easily prepared, and form curious microscopic objects. A great variety of them may be procured of Mr. C. M. Topping, of Pentonville.

Similar prominences and concretions—pearls which are not *pearly*—are formed inside porcellanous shells; these are as variable in colour as the surfaces on which they are formed.*

The *fibrous* shells consist of successive layers of prismatic cells containing translucent carbonate of lime; and the cells of each successive layer correspond, so that the shell, especially when very thick (as in the fossil *inoceramus* and *trichites*), will break up vertically, into fragments, exhibiting on their edges a structure like arragonite, or satin-spar. Horizontal sections exhibit a cellular net-work, with here and there a dark cell, which is empty. (fig. 21.)

The oyster has a *laminated* structure, owing to the irregular accumulation of the cells in its successive layers, and breaks up into horizontal plates.

In the boring-shells (*pholadidæ*) the carbonate of lime has an atomic arrangement like arragonite, which is considerably harder than calcarious spar; in other cases the difference in hardness depends on the proportion of animal matter, and the manner in which the layers are aggregated.†

In many bivalve shells there occurs a minute *tubular structure*, which is very conspicuous in some sections of pinna and oyster-shell.

The *brachiopoda* exhibit a characteristic structure by which the smallest fragment of their shells may be determined; it consists of elongated and curved cells, matted together, and often perforated by circular holes, arranged in quincunx order (fig. 22).

But the most complex shell-structure is presented by the *porcellanous* gasteropoda. These consist of three strata which readily separate in fossil shells, on account of the removal of their

* They are pink in *turbinellus* and strombus; white in *ostrea*; white or glassy, purple or black in mytilus; rose-coloured and translucent in *pinna*. (*Gray*.)

† The *specific gravity* of floating shells (such as *argonauta* and *ianthina*) is lower than that of any others. (*De la Beche*.)

animal cement. In fig. 24, *a* represents the outer, *b* the middle, and *c* the inner stratum; they may be seen, also, in fig. 25.

Each of these three strata is composed of very numerous vertical plates, like cards placed on edge; and the direction of the plates is sometimes transverse in the central stratum, and lengthwise in the outer and inner (as in *cypræa*, *cassis*, *ampullaria*, and *bulimus*), or longitudinal in the middle layer, and transverse in the others (*e. g. conus*, *pyrula*, *oliva*, and *voluta*).

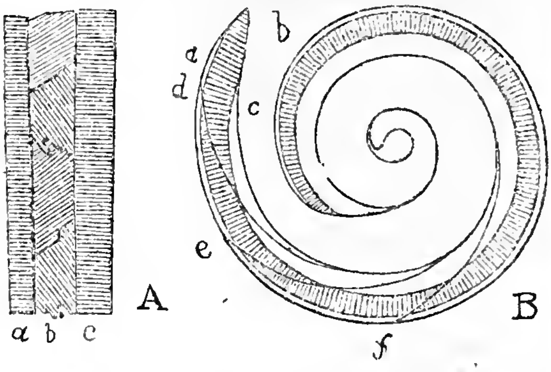


Fig. 24. *Sections of a cone.**

Each *plate*, too, is composed of a series of prismatic cells, arranged obliquely (45°), and their direction being changed in the successive plates, they cross each other at right angles. Tertiary fossils best exhibit this structure, either at their broken edge, or in polished sections.† *(Bowerbank)*.

The argonaut-shell, and the bone of the cuttle-fish, have a peculiar structure; and the *Hippurite* is distinguished by a cancellated texture, unlike any other shell, except, perhaps, some of the *cardiaceæ* and *chamaceæ*.

Epidermis. All shells have an outer coat of animal matter called the "epidermis" (or *periostracum*), sometimes thin and transparent, at others thick and opaque. It is thick and olive-coloured in all fresh-water shells, and in many *arctic* sea-shells (*e. g. cyprina* and *astarte*); the colours of the land-shells often

* Sections of *conus ponderosus*, Brug., from the Miocene of the Touraine. A, longitudinal section of a fragment, B, complete horizontal section; *a*, outer layer; *b*, middle; *c*, inner layer; *d*, *e*, *f*, lines of growth.

† It is necessary to bear in mind that fossil shells are often *pseudomorphous*, or mere casts, in spar or chalcedony, of cavities once occupied by shells; such are the fossils found at Blackdown, and many of the London clay fossils at Barton. The Palæozoic fossils are often *metamorphic*, or have undergone a re-arrangement of their particles, like the rocks in which they occur.

depend on it; sometimes it is silky as in *helix sericea*, or fringed with hairs, as in *trichotropis;* in the whelk and some species of *triton* and *conus* it is thick and rough like coarse cloth, and in some *modiolas* it is drawn out into long beard-like filaments.

In the cowry and other shell-fish with large mantle lobes, the epidermis is more or less covered up by an additional layer of shell deposited externally.

The *epidermis* has life, but not sensation, like the human scarf-skin; and it protects the shell against the influence of the weather, and chemical agents; it soon fades, or is destroyed, after the death of the animal, in situations where, whilst living, it would have undergone no change. In the bivalves it is organically connected with the margin of the mantle.

It is most developed in shells which frequent damp situations, amongst decaying leaves, and in fresh-water shells. All fresh-waters are more or less saturated with carbonic-acid gas, and in limestone countries hold so much lime in solution as to deposit it in the form of *tufa* on the mussels and other shells.* But in the absence of lime to neutralise the acid, the water acts on the shells, and would dissolve them entirely if it were not for their protecting epidermis. As it is we can often recognise fresh-water shells by the erosion of those parts where the epidermis was thinnest, namely, the points of the spiral shells and the *umbones* of the bivalves, those being also the parts longest exposed. Specimens of *melanopsis* and *bithinia* become truncated again and again in the course of their growth, until the adults are sometimes only half the length they should be, and the discoidal *planorbis* sometimes becomes perforated by the removal of its inner whirls; in these cases the animal closes the break in its shell with new layers. Some of the unios thicken their umbones enormously, and form a layer of animal matter with each new layer of shell, so that the river-action is arrested at a succession of steps.

* As at Tisbury, in Wiltshire, where remarkable specimens of *anodons* were obtained by the late Miss Benett.

FORMATION AND GROWTH OF THE SHELL.

The shell, as before stated, is formed by the *mantle* of the shell-fish, indeed, each layer of it was once a portion of the mantle, either in the form of a simple membrane, or as a layer of cells; and each layer was successively calcified (or hardened with carbonate of lime) and thrown off by the mantle to unite with those previously formed. Being extra-vascular it has no inherent power of repair. (*Carpenter.*)

The epidermis and cellular structures are formed by the margin (or *collar*) of the mantle; the membranous and nacreous layers, by the thin and transparent portion which contains the viscera; hence we find the pearly texture only as a lining inside the shell, as in the *nautilus,* and all the *aviculidæ* and *turbinidæ.*

If the margin of a shell is fractured during the life-time of the animal, the injury will be completely repaired by the reproduction both of the epidermis and of the outer layer of shell with its proper colour. But if the apex is destroyed, or a hole made at a distance from the aperture, it will merely be closed with the material secreted by the visceral mantle. Such inroads are often made by boring worms and shells, and even by a sponge (*cliona*) which completely mines the most solid shells. In Mr. Gray's cabinet is the section of a cone, in whose apex a colony of *lithodomi*

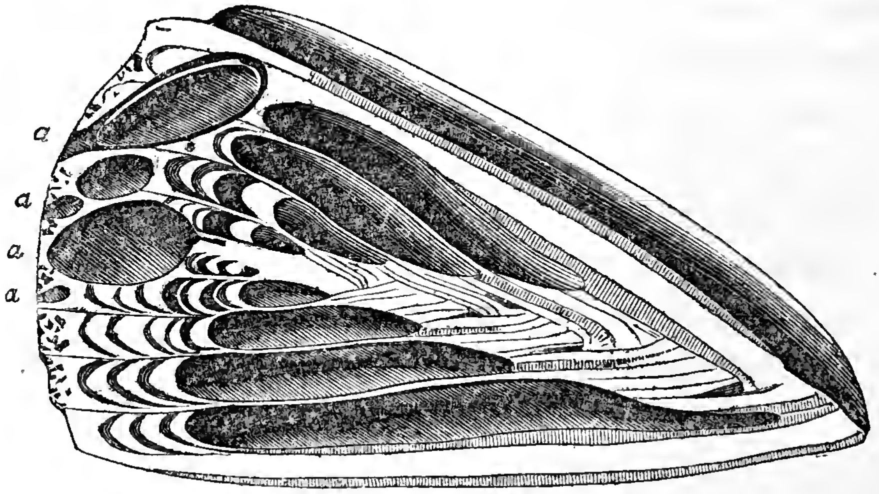


Fig. 25. *Section of a cone perforated by lithodomi.*

had settled, compelling the animal to contract itself, faster even than it could form shell to fill up the void.

Lines of growth. So long as the animal continues growing, each new layer of shell extends beyond the one formed before it; and, in consequence, the external surface becomes marked with *lines of growth.* During winter, or the season of rest which corresponds to it, shells cease to grow; and these periodic resting-places are often indicated by interruptions of the otherwise regular lines of growth and colour, or by still more obvious signs. It is probable that this pause, or cessation from growth, extends into the breeding season; otherwise there would be two periods of growth, and two of rest in each year. In many shells the growth is uniform; but in others each stage is finished by the development of a fringe, or ridge (*varix*), or of a row of spines, as in *tridacna* and *murex.* (*Owen, Grant.*)

Adult characters. The attainment of the full-growth proper to each species is usually marked by changes in the shell.

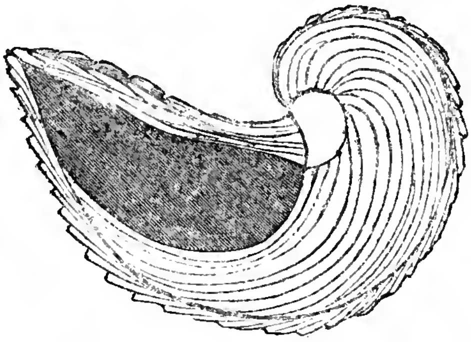


Fig. 26. *Section of gryphæa.**

Some bivalves, like the oyster, and *gryphæa* (fig. 26), continue to increase in thickness long after they have ceased to grow outwards; the greatest addition is made to the lower valve, especially near the umbo; and in the *spondylus* some parts of the mantle secrete more than others, so that cavities, filled with fluid, are left in the substance of the shell.

The adult *teredo* and *fistulana* close the end of their burrows; the *pholadidea* fills up the great *pedal* opening of its valves; and the *aspergillum* forms the porous disk from which it takes its name. Sculptured shells, particularly *ammonites*, and species of *rostellaria* and *fusus*, often become plain in the last part of their

* Fig. 26. Section of *gryphæa incurva*, Sby. Lias, Dorset, (original; diminished one half), the upper valve is not much thickened; the interior is filled with lias.

growth. But the most characteristic change is the thickening and contraction of the aperture in the univalves. The young cowry (fig. 27) has a thin, sharp lip, which becomes curled inwards, and enormously thickened and toothed in the adult; the *pteroceras* (pl. 4, fig. 3) developes its scorpion-like claws, only when full-grown; and the land-snails form a thickened lip, or narrow their aperture with projecting processes, so that it is a marvel how they pass in and out, and how they can exclude their eggs, (*e. g.* pl. 12, fig. 4, *anastoma;* and fig. 5, *helix hirsuta*).

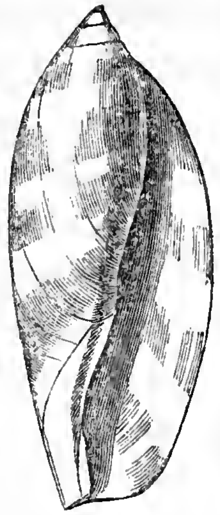


Fig. 27. *Young Cowry.**

Yet at this time they would seem to require more space and accommodation in their houses than before, and there are several curious ways in which this is obtained. The *neritidæ* and *auriculidæ* dissolve all the internal spiral column† of their shells; the cone (fig. 24, B,) removes all but a paper-like portion of its inner whirls; the cowry goes still further, and continues removing the *internal* layers of its shell-wall, and depositing new layers *externally* with its overlapping mantle (fig. 76), until, in some cases, all resemblance to the young shell is lost in the adult.

The power which mollusks possess of dissolving portions of their own shells, is also exhibited by the *murices,* in removing those spines from their whirls which interfere with their growth; and by the *purpuræ* and others in wearing away the wall of their aperture. The agency in these cases is supposed to be chemical.

Decollated shells. It frequently happens that as spiral shells become adult they cease to occupy the upper part of their cavity; the space thus vacated is sometimes filled with solid shell, as in *magilus;* or it is partitioned off, as in *vermetus, euomphalus, turritella* and *triton* (fig. 62). The deserted apex is sometimes very thin, and becoming dead and brittle, it breaks away, leaving

* *Cypræa testudinaria,* L., young.

† This is sometimes done by the hermit-crab to the shells it occupies.

the shell truncated, or decollated. This happens constantly with the *truncatellæ, cylindrellæ,* and *bulimus decollatus;* amongst the fresh-water shells it depends upon local circumstances, but is very common with *pirena* and *cerithidea.*

Forms of shells. These will be described particularly under each class; enough has been said to show that in the molluscan shell (as in the vertebrate skeleton) indications are afforded o many of the leading affinities and structural peculiarities of the animal. It may sometimes be difficult to determine the genus of a shell, especially when its form is very simple; but this results more from the imperfection of our technicalities and systems, than from any want of co-ordination in the animal and its shell.

Monstrosities. The whirls of spiral shells are sometimes separated by the interference of foreign substances, which adhere to them when young; the garden-snail has been found in this condition, and less complete instances are common amongst sea-shells. Discoidal shells occasionally become spiral (as in specimens of *planorbis* found at Rochdale), or irregular in their growth, owing to an unhealthy condition. The discoidal *ammonites* sometimes show a slight tendency to become spiral, and more rarely become unsymmetrical, and have the keel on one side, instead of in the middle.

All attached shells are liable to interference in their growth, and malformations consequent on their situation in cavities, or from coming in contact with rocks. The *dreissena polymorpha* distorts the other fresh-water mussels by fastening their valves with its *byssus;* and *balani* sometimes produce strange protuberances on the back of the cowry, to which they have attached themselves when young.*

In the miocene tertiaries of Asia Minor, Professor Forbes

* In the British Museum there is a *helix terrestris* (chemn.) with a small stick passing through it, and projecting from the apex and umbilicus. Mr. Pickering has, in his collection, a *helix hortensis* which got entangled in a nut-shell when young, and growing too large to escape, had to endure the incubus to the end of its days.

discovered whole races of *neritina*, *paludina*, and *melanopsis*, with whirls ribbed or keeled, as if through the unhealthy influence of brackish water. The fossil periwinkles of the Norwich Crag are similarly distorted, probably by the access of fresh-water; parallel cases occur at the present day in the Baltic.

Reversed shells. Left-handed, or reversed varieties of spiral shells have been met with in some of the very common species, like the whelk and garden-snail. *Bulimus citrinus* is as often sinistral as dextral; and a reversed variety of *fusus antiquus* was more common than the normal form in the *pliocene* sea. Other shells are constantly reversed, as *pyrula perversa*, many species of *pupa*, and the entire genera, *clausilia*, *cylindrella*, *physa*, and *triphoris*. Bivalves less distinctly exhibit variations of this kind; but the attached valve of *chama* has its *umbo* turned to the right or left indifferently; and of two specimens of *lucina childreni* in the British Museum, one has the right, the other the left valve flat.

The colours of shells are usually confined to the surface beneath the epidermis, and are secreted by the border of the mantle, which often exhibits similar tints and patterns (*e. g. voluta undulata*, fig. 73). Occasionally the inner strata of porcellanous shells are differently coloured from the exterior, and the makers of shell-cameos avail themselves of this difference to produce white or rose-coloured figures on a dark ground.*

The secretion of colour by the mantle depends greatly on the action of light; shallow-water shells are, as a class, warmer and brighter coloured than those from deep water; and bivalves which are habitually fixed or stationary (like *spondylus* and *pecten pleuronectes*) have the upper valve richly tinted, whilst the lower one is colourless. The backs of most spiral shells are darker

* Cameos in the British Museum, carved on the shell of *cassis cornuta*, are white on an orange ground; on *c. tuberosa*, and *madagascariensis*, white upon dark claret-colour; on *c. rufa*, pale salmon-colour on orange; and on *strombus gigas*, yellow on pink. By filing some of the olives (*e. g. oliva utriculus*) they may be made into very different coloured shells.

than the under sides; but in *ianthina* the base of the shell is habitually turned upwards, and is deeply dyed with violet. Some colours are more permanent than others; the red spots on the *naticas* and *nerites* are commonly preserved in tertiary and oolitic fossils, and even in one example (of n. subcostata schl.) from *Devonian* limestone. *Terebratula hastata,* and some *pectens* of the carboniferous period, retain their markings; the *orthoceras anguliferus* of the *Devonian* beds has zig-zag bands of colour; and a terebratula of the same age, from arctic North America,* is ornamented with several rows of dark red spots.

The operculum. Most spiral shells have an *operculum,* or lid, with which to close the aperture when they withdraw for shelter (see gasteropoda). It is developed on a particular lobe at the posterior part of the foot, and consists of horny layers, some times hardened with shelly matter (fig. 28).

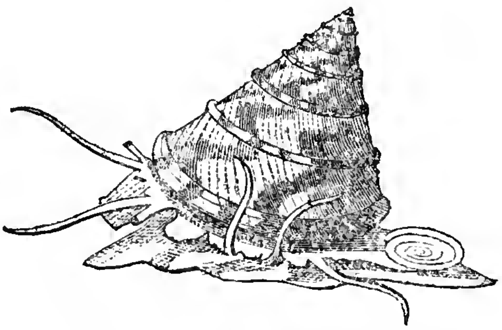


Fig. 28. *Trochus ziziphinus.*†

It has been considered by Adanson, and more recently by Mr. Gray, as the equivalent of the dextral valve of the conchifera; but however similar in appearance, its anatomical relations are altogether different. In position it represents the *byssus* of the bivalves (Lovén); and in function it is like the plug with which unattached specimens of *bysso-arca* close their aperture. (*Forbes.*)

Homologies of the shell.‡ The shell is so simple a structure that its modifications present few points for comparison; but even these are not wholly understood, or free from doubt. The

* Presented to the British Museum by Sir John Richardson.

† *Trochus ziziphinus,* from the original, taken in Pegwell Bay abundantly. This species exhibits small tentacular processes, neck-lappets, side-lappets, tentacular filaments, and an operculigerous lobe.

‡ Parts which correspond in their real nature—(their origin and development)—are termed *homologous;* those which agree merely in appearance, or office, are said to be *analogous.*

bivalve shell may be compared to the outer tunic of the *ascidian*, cut open and converted into separable valves. In the *conchifera* this division of the mantle is vertical, and the valves are right and left. In the *brachiopoda* the separation is horizontal, and the valves are dorsal and ventral. The *monomyarian* bivalves lie habitually on one side (like the *pleuronectidæ* among fishes); and their shells, though *really* right and left, are termed "upper" and "lower" valves. The univalve shell is the equivalent of *both* valves of the bivalve. In the *pteropoda* it consists of dorsal and ventral plates, comparable with the valves of *terebratula*. In the *gasteropoda* it is equivalent to both valves of the *conchifera* united above.* The nautilus shell corresponds to that of the gasteropod; but whilst its chambers are shadowed forth in many spiral shells, the *siphuncle* is something additional; and the entire shell of the cuttle-fish and argonaut† have no known equivalent or parallel in the other molluscous classes. The student might imagine a resemblance in the shell of the *orthoceras* to a *back-bone;* but the true homologue of the vertebrate skeleton is found in the neural and muscular cartilages of the cephalopod; whilst its *phragmocone* is but the representative of the calcarious axis (or *splanchno-skeleton*) of a coral, such as *amplexus* or *siphonophyllia.*

Temperature and hybernation. Observations on the *temperature* of the *mollusca* are still wanted; it is known, however, to vary with the medium in which they live, and to be sometimes a degree or two higher or lower than the external temperature; with snails (in cool weather), it is generally a degree or two higher.

The *mollusca* of temperate and cold climates are subject to *hybernation;* during which state the heart ceases to beat, respira-

* Compare *fissurella* or *trochus* (fig. 28) with *lepton squamosum* (fig. 12). The disk of *hipponyx* is analogous to the ventral plate of hyalæa and terebratula.

† The argonaut shell is compared by Mr. Adams to the nidamental capsules of the *whelk;* a better analogue would have been found in the *raft* of the *ianthina*, which is secreted by the *foot* of the animal, and serves to *float* the egg-capsules.

tion is nearly suspended, and injuries are not healed. They also *æstivate*, or fall into a summer sleep when the heat is great; but in this the animal functions are much less interrupted. (*Muller*.)

Reproduction of lost parts. It appears from the experiments of Spallanzani, that snails, whose ocular tentacles have been destroyed, reproduce them completely in a few weeks; others have repeated the trial with a like result. But there is some doubt whether the renewal takes place if the brain of the animal be removed as well as its horns. Madame Power has made similar observations upon various marine snails, and has found that portions of the foot, mantle, and tentacles, were renewed. Mr. Hancock states that the species of *eolis* are apt to make a meal off each other's *branchiæ*, and that, if confined in stale water, they become sickly and lose those organs; in both cases they are quickly renewed under favourable circumstances.

Reproduction by gemmation. The social and compound tunicaries resemble zoophytes, in the power they possess of budding out new individuals, and thus of multiplying their communities indefinitely, as the leaves on a tree. This gemmation takes place only at particular points, so that the whole assemblages are aggregated in characteristic patterns. The buds of the social tunicaries are supported at first by their parents, those of the compound families by the general circulation, until they are in a state to contribute to the common weal.

Viviparous reproduction. This happens in a few species of gastropods, through the retention of the eggs in the oviduct, until the young have attained a considerable growth. It also *appears* to take place in the acephalans, because their eggs generally remain within some part of the shell of the parent until hatched.

Alternate generation. Amongst the tunicaries an example is found of regulated diversity in the mode of reproduction. The salpians produce long chains of embryos, which, unless broken by accident, remain connected during life;—each individual of these compound specimens produces *solitary young*, often so unlike the parent as to have been described and named by naturalists as distinct species;—these solitary salpians again produce chains of embryos, like their grand-parents. (*Chamisso.*)

Oviparous reproduction. The sexes are distinct in the most highly organised (or *diœcious*) mollusca; they are united in the (*monœcious*) land-snails, pteropods, brachiopods, tunicaries, and in part of the conchifers. The prosobranchs pair; but in the diœcious acephalans and cuttle-fishes, the *spermatozoa* are merely discharged into the water, and are inhaled with the respiratory currents by the other sex. The monœcious land-snails require reciprocal union; the limneïds unite in succession, forming floating chains.

The *eggs* of the land-snails are separate, and protected by a shell, which is sometimes albuminous and flexible, at others calcarious and brittle; those of the fresh-water species are soft, mucous, and transparent. The spawn of the sea-snails consists of large numbers of eggs, adhering together in masses, or spread out in the shape of a strap or ribbon, in which the eggs are arranged in rows; this *nidamental ribbon* is sometimes coiled up spirally, like a watch-spring, and attached by one of its edges. The eggs of the carnivorous gasteropods are inclosed in tough albuminous capsules, each containing numerous germs; these are deposited singly, or in rows, or agglutinated in groups, equalling the parent animal in bulk (fig. 70). The nidamental capsules of the cuttle-fish are clustered like grapes, each containing but one embryo; those of the calamary are grouped

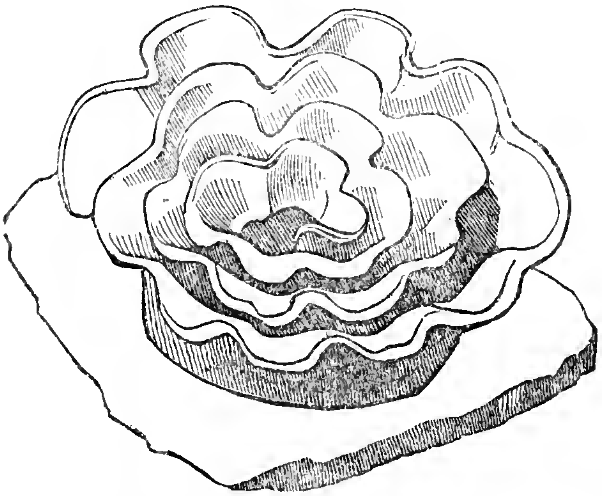


Fig. 29. *Spawn of Doris.**

* Nidamental ribbon of *Doris Johnstoni.* (*Alder and Hancock.*)

in radiating masses, each elongated capsule containing 30 or 40 ova. The material with which the eggs are thus cemented together, or enveloped, is secreted by the *nidamental gland*, an organ largely developed in the female gasteropods and cephalopods (fig. 43, n).

Development. The molluscan *ovum* consists of a coloured yolk (*vitellus*), surrounded by albumen. On one side of the yolk is a pellucid spot, termed the *germinal vesicle*, having a spot or *nucleus* on its surface. This germinal vesicle is a nucleated cell, capable of producing other cells like itself; it is the essential part of the egg, from which the *embryo* is formed; but it undergoes no change without the influence of the *spermatozoa*.* After impregnation, the germinal vesicle, which then subsides into the centre of the yolk, divides spontaneously into two; and these again divide and subdivide into smaller and still smaller globules, each with its pellucid centre or nucleus, until the whole presents a uniform granular appearance. The next step is the formation of a ciliated *epithelium* on the surface of the embryonic mass; movements in the albumen become perceptible in the vicinity of the *cilia*, and they increase in strength, until the embryo begins to revolve in the surrounding fluid.†

* No instance of "partheno-genesis" is known among the *mollusca;* the most "equivocal" case on record is that related by Mr. Gaskoin. A specimen of *helix lactea,* Müll., from the South of Europe, after being *two years* in his cabinet, was discovered to be still living; and on being removed to a plant-case it revived, and six weeks afterwards had produced twenty young ones!

† According to the observations of Professor Lovén (on certain bivalve mollusca), the ova are excluded immediately after the inhalation of the spermatozoa, and apparently from their influence; but impregnation does not take place within the ovary itself. The spermatozoa of *cardium pygmæum* were distinctly seen to penetrate, in succession, the outer envelopes of the ova, and arrive at the vitellus, when they disappeared. With respect to the "germinal vesicle;" according to Barry, it first approaches the inner surface of the vitelline membrane, in order to receive the influence of the spermatozoa; it then retires to the centre of the yolk, and undergoes a series of spontaneous subdivisions. In M. Lovén's account, it is said to "burst" and par-

Up to this point nearly the same appearances are presented by the eggs of all classes of animals,—they manifest, so far, a complete "unity of organization." In the next stage, the development of an organ, fringed with stronger *cilia*, and serving both for locomotion and respiration, shews that the embryo is a *molluscous animal;* and the changes which follow soon point out the particular *class* to which it belongs. The rudimentary *head* is early distinguishable, by the black eye-specks; and the *heart*, by its pulsations. The digestive and other organs are first "sketched out," then become more distinct, and are seen to be covered with a transparent shell. By this time the embryo is able to move by its own muscular contractions, and to swallow food; is is therefore "hatched," or escapes from the egg.

The embryo tunicary quits the egg in the cloacal cavity of its parent, and is at this time provided with a swimming instrument, like the tail of the tadpole, and with processes by which it attaches itself as soon as it finds a suitable situation.

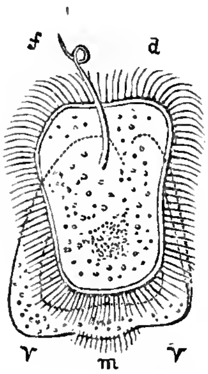


Fig. 30.*

The young bivalves also are hatched before they leave their parent, either in the gill cavity or in a special sac attached to the gills (as in *cyclas*), or in the interspaces of the external branchial laminæ (as in *unio*). At first they have a swimming disk, fringed with long *cilia*, and armed with a slender tentacular filament (*flagellum*). At a later period this disk disappears progressively, as the labial palpi are developed; and they acquire a foot, and with it the power of spinning a byssus. They now

tially dissolve, whilst the egg remains in the ovary, and before impregnation; it then passes to the centre of the yolk, and undergoes the changes described by Barry, along with the yolk, whilst the *nucleus* of the germinal vesicle, or some body exactly resembling it, is seen occupying a small prominence on the surface of the vitelline membrane, until the metamorphosis of the yolk is completed, when it disappears, in some unobserved manner, without fulfilling any recognized purpose.

* Fig. 30. Very young fry of *crenella marmorata*, Forbes, highly magnified; *d*, disk, bordered with cilia: *f*, flagellum; *v v*, valves; *m*, ciliated mantle.

have a pair of eyes, situated near the labial tentacles (fig. 30*, *e*), which are lost at a further stage, or replaced by numerous rudimentary organs placed more favourably for vision, on the border of the mantle.

Most of the aquatic *gasteropoda* are very minute when hatched, and they enter life under the same form,—that which

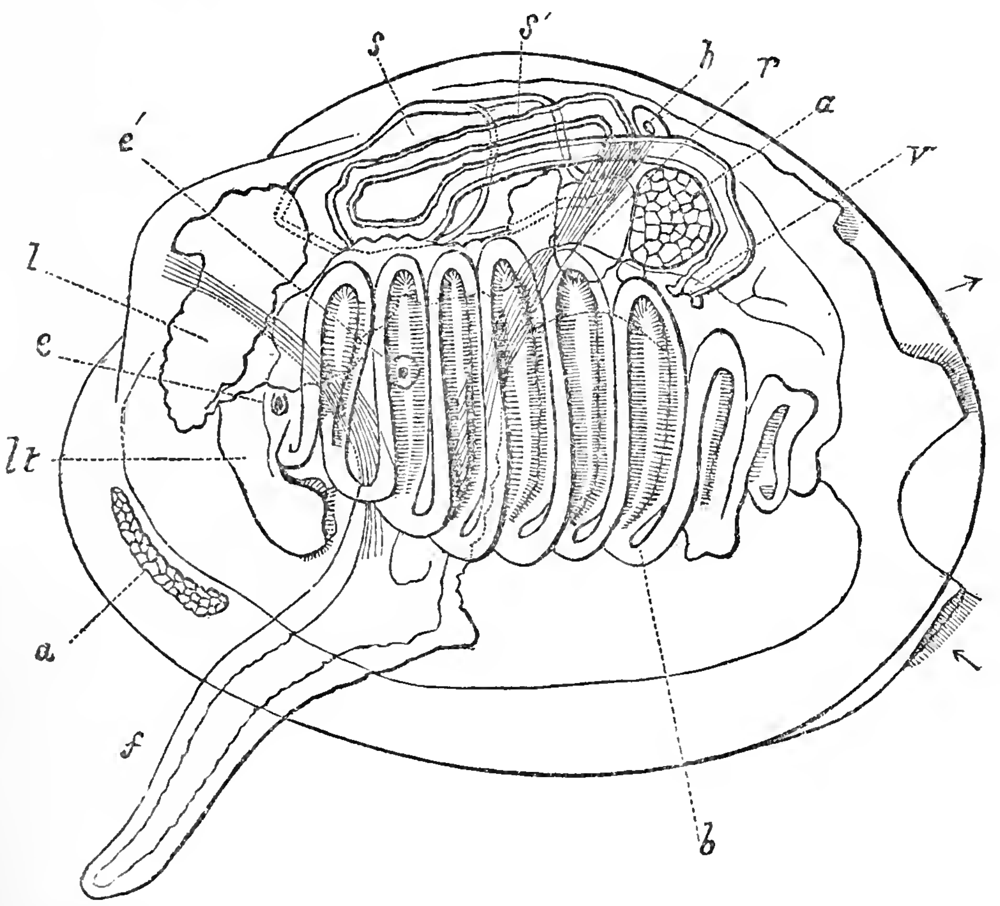


Fig. 30*. *Fry of the Mussel.**

has been already referred to as permanently characteristic of the *pteropoda*. (Fig. 60.)

The *Pulmonifera* and *Cephalopoda* produce large eggs, con-

* Fig. 30*. Fry of *mytilus edulis*, after Lovén. *e*, eye; *e′*, auditory capsule; *l t*, labial tentacles; *s s′*, the stomach; *b*, branchiæ; *h*, heart; *v*, vent; *l*, liver; *r*, renal organ; *a*, anterior adductor; *a′*, posterior adductor; *f*, foot. The arrows indicate the incurrent and excurrent openings; between which the margins of the mantle are united in the fry.

taining sufficient nutriment to support the *embryo* until it has attained considerable size and development; thus, the newly-born cuttle-fish has a shell half an inch long, consisting of several layers, and the *bulimus ovatus* has a shell an inch in length when hatched. (Fig. 31.) These are said to undergo no transformation, because their larval stage is concealed in the egg. The embryonic development of the cuttle-fishes has not been observed; it is probable that they would reveal more curious changes than occur in any other class.

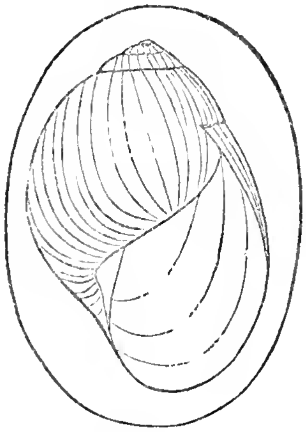


Fig. 31.*

The researches of *John Hunter*† into the embryonic condition of animals, led him to the conclusion that *each stage* in the development of the highest animals corresponded to the *permanent form* of some one of the inferior orders. This grand generalisation has since been more exactly defined and established by a larger induction of facts, some of which we have already described, and may now be stated thus:—

In the earliest period of existence all animals display one uniform condition; but after the first appearance of special development, uniformity is only met with amongst the members of the same primary division, and with each succeeding step it is more and more restricted. From that first step, the members of each primary group assume forms and pass through phases which have no parallels, except in the division to which each belongs. The mammal exhibits no likeness, at any period, to the *adult* mollusk, the insect, or the star-fish; but only to the

* Egg and young of *bulimus ovatus*, Mull. sp., Brazil, from specimens in the collection of Hugh Cuming, Esq.

† "In his printed works the finest elements of system seem evermore to flit before him, twice or thrice only to have been seized, and after a momentary detention to have been again suffered to escape. At length, in the astonishing preparations for his museum, he constructed it, for the scientific apprehension, out of the unspoken alphabet of nature." (*Coleridge.*)

ovarian stage of the invertebrata, and to more advanced stages of the classes formed upon its own type. And so also with the highest organized *mollusca;* after their first stage they resemble the simpler orders of their own sub-kingdom, but not those of any other group.

These are the views of Professor Owen—the successor of Hunter—by whom it has been most clearly shewn and steadfastly maintained, that the "unity of organization" manifested by the animal world results from the design of a Supreme Intelligence, and cannot be ascribed to the operation of a mechanical "law."

Chapter V.

CLASSIFICATION.

The objects of classification are, *first,* the convenient and intelligible arrangement of the species;* and, *secondly,* to afford a summary, or condensed exposition, of all that is known respecting their structure and relations.

In studying the shell-fish, we find resemblances of two kinds. First, agreements of structure, form, and habits; and, secondly, resemblances of form and habits without agreement of structure. The first are termed relations of *affinity;* the second of *analogy.*

Affinities may be near, or remote. There is some amount of affinity common to all animals; but, like relationships amongst men, they are recognized only when tolerably close. Resemblances of structure which subsist from a very early age are presumed to imply original relationship; they have been termed

* At least 12,000 recent, and 15,000 fossil species of molluscous animals are known.

genetic (or *histological*), and are of the highest importance. Those which are superinduced at a later period, are of less consequence.

Analogies. Modifications relating only to peculiar habits are called *adaptive;* or *teleological,* from their relation to final causes.* A second class of analogical resemblances are purely external and illusive; they have been termed *mimetic* (*Strickland*), and, by their frequency, almost justify the notion that a certain set of forms and colours are repeated, or represented in every class and family. In all artificial arrangements, these mimetic resemblances have led to the association of widely different animals in the same groups.† Particular forms are also *represented* geographically‡ and geologically,§ as well as systematically.

In all attempts to characterise groups of animals, we find, that in advancing from the smaller to the larger combinations, many of the most obvious external features become of less avail, and we are compelled to seek for more constant and comprehensive signs in the phases of embryonic development, and the condition of the circulating, respiratory, and nervous systems.

Species. All the specimens, or individuals, which are so much alike that we may reasonably believe them to have descended from a common stock, constitute a *species.* It is a particular provision for preventing the blending of species, that *hybrids* are always barren; and it is certain, in the case of shells, that a great many kinds have not changed in form, from the tertiary

* For example, the paper nautilus, from its resemblance to *carinaria,* was long supposed to be the shell of a nucleobranche, parasitically occupied by the "*ocythoë.*"

† E.g. Aporrhaïs with strombus, and ancylus with patella.

‡ Monoceros imbricatum and buccinum antarcticum take the place, in South America, of our common whelk and purple, and solen gladiolus and solen americanus of our solen siliqua and ensis.

§ The frequent recurrence of similar species in successive strata may lead beginners to attribute too much to the influence of time and external circumstances; but such impressions disappear with further experience.

period to the present day,—a lapse of many thousand years,—and through countless generations. When individuals of the same brood differ in any respect, they are termed *varieties;* for example, one may be more exposed to the light, and become brighter coloured; or it may find more abundant food, and grow larger than the rest. Should these peculiarities become permanent at any place, or period,—should all the specimens on a particular island or mountain, or in one sea, or geological formation, differ from those found elsewhere,—such permanent variety is termed a *race;* just as, in the human species, there are white and coloured races. The species of some genera are less subject to variation than others; the *nuculæ*, for example, although very numerous, are always distinguishable by good characters. Other genera, like *ammonites*, *terebratula*, and *tellina*, present a most perplexing amount of variation, resulting from age, sex, supply of food, variety of depth, and of saltness in the water. And further, whilst in some genera every possible variety of form seems to have been called into existence, in others only a few, strikingly distinct forms, are known.

Genera are groups of species, related by community of structure in all essential respects. The genera of bivalves have been characterised by the number and position of their hinge-teeth; those of the spiral univalves, by the form of their apertures; but these technical characters are only valuable so far as they indicate differences in the animals themselves.

Families are groups of genera, which agree in some more general characters than those which unite species into genera. Those which we have employed are mostly modifications of the artificial families framed by Lamarck, a plan which seemed more desirable, in the present state of our knowledge, than a subdivision into very numerous families, without assignable characters.

The *orders and classes* of mollusca have already been referred to; those now in use are all extremely natural.

It has been sometimes asserted that these groups are only scientific contrivances, and do not *really* exist in nature; but this is a false as well as a degrading view of the matter. The labours of the most eminent systematists have been directed to the discovery of the subordinate value of the characters derivable from every part of the animal organization; and, as far as their information enabled them, they have made their systems expressive "of all the highest facts, or generalisations, in natural history." (*Owen.*)

M. Milne Edwards has remarked, that the actual appearance of the animal kingdom is not like a well-regulated army, but like the starry heavens, over which constellations of various magnitude are scattered, with here and there a solitary star which cannot be included in any neighbouring group.

This is exceedingly true; we cannot expect our systematic groups to have equal numerical values,* but they ought to be of equal structural importance; and they will thus possess a *symmetry* of order, which is superior to mere numerical regularity.

All the most philosophic naturalists have entertained a belief that the development of animal forms has proceeded upon some regular plan, and have directed their researches to the discovery of that "reflection of the divine mind." Some have fancied that they have discovered it in a mystic number, and have accordingly converted all the groups into *fives.*† We do not undervalue these speculations, yet we think it better to describe things so far only as we know them.

Great difficulty has always been found in placing groups according to their affinities. This cannot be effected in—the way in which we are compelled to describe them—a single series; for each group is related to *all* the rest; and if we extend the representation of the affinities to very small groups, any arrange-

* The numerical development of groups is *inversely proportional to the bulk of the individuals composing them.* (*Waterhouse.*)

† The *quinarians* make out five molluscous classes, by excluding the *tunicata;* the same end would be attained in a more satisfactory manner by reducing the pteropods to the rank of an order, which might be placed next to the *opistho-branches.*

ment on a plane surface would fail, for the affinities radiate in all directions, and the "net-work" to which Fabricius likened them, is as insufficient a comparison as the "chain" of older writers.*

Chapter VI.

NOMENCLATURE.

The practice of using two names—generic and specific—for each animal, or plant, originated with Linnæus; therefore no scientific names date further back than his works. In the construction of these names, the Greek and Latin languages are preferred, by the common consent of all countries.

Synonyms. It often happens that a species is named, or a genus established, by more than one person, at different times, and in ignorance of each other's labours. Such duplicate names are called *synonyms;* they have multiplied amazingly of late, and are a stumbling-block and an opprobium in all branches of natural history.†

* The quinary arrangement of the molluscous classes reminds us of the eastern emblem of eternity—the serpent holding its tail in its mouth.

The following diagram is offered as an improved *circular system:*—

[Fishes.]
Di-branchiata.
Nucleo- Tetra-
Opistho- Proso-
Aporo- Pulmo-
Pallio- Lamelli-
Hetero-branchiata.
[Zoophytes.]

† In Pfeiffer's *Monograph of the Helicidæ*, a family containing seventeen genera, no less than 330 *generic synonyms* are enumerated; to this list, Dr. Albers, of Berlin, has lately added *another hundred* of his own invention!

One very common estuary shell rejoices in the following variety of titles:—

Scrobicularia piperata (*Gmelin sp*).
Trigonella plana (*Da Costa*).
Mactra Listeri (*Auct*).
Mya Hispanica (*Chemnitz*).
Venus borealis (*Pennant*).
Lutraria compressa (*Lamarck*).
Arenaria plana (*Megerle*).

As regards *specific* names, the earliest ought certainly to be adopted,—with, however, the following exceptions:—

1. MS. names; which are only admitted by courtesy.
2. Names given by writers antecedent to Linnæus.
3. Names unaccompanied by a description or figure.
4. Barbarisms; or names involving error or absurdity,*

It is also very desirable that names having a general (European) acceptation, should not be changed, on the discovery of earlier names in obscure publications.

With respect to *genera,*—those who believe in their real existence, as "ideas of the creating mind," will be disposed to set aside many random appellations, given to particular shells without any clear enunciation of their characters; and to adopt later names, if bestowed with an accurate perception of the grounds which entitle them to generic distinction.†

Authority for specific names. The multiplication of synonyms having made it desirable to place the *authority* after each

* This subject was investigated, and reported upon, by a committee of the British Association, in 1842; but the report was not sufficiently circulated.

† Several bad practices—against which there is, unhappily, no law—should be strongly discountenanced. First, the employment of names already in familiar use for other objects; such as *cidaris* (the title of a well-known genus of sea-urchins), for a group of spiral shells; and *arenaria* (a property of the botanists), for a bivalve. Secondly, the conversion of *specific* into *generic* titles, a process which has caused endless confusion; it has arisen out of the vain desire of giving new designations to old and familiar objects, and thus obtaining a questionable sort of fame.

name, another source of evil has arisen; for several naturalists (fancying that the *genus-maker*, and not the *species-maker*, should enjoy this privilege) have altered or divided almost every genus, and placed their signatures as the authorities for names given half a century or a century before, by LINNÆUS or BRUGUIERE.* British naturalists have disowned this practice, and agreed to distinguish, by the addition of "sp.," the authorities for those specific names whose generic appellations have been changed.

Types. The type of each genus *should be* that species in which the characters of its group are best exhibited, and most evenly balanced. (*Waterhouse.*) It has, however, been customary to take as the type, that species which the genus-maker placed first on his list; although by so doing there is risk of adopting an *aberrant* form, or one which very feebly represents the group, of which it is an obscure member.

* The authorities appended to specific names, are supposed to indicate an amount of work done in the determination and description of the species; when, therefore, the real author's name is suppressed, and a spurious one substituted, the case looks very like an attempt to obtain credit under false pretences.

ABBREVIATIONS.

Etym., etymology. *Syn.*, synonym. *Distr.*, distribution.
M.S., manuscript, i. e., *unpublished*.
Sp., species. Brit. M., (in the) British Museum.
Distr., Norway—New Zealand; including all intermediate seas.
Fossil, lias—chalk; implies that the genus existed in these, and all intervening strata. Chalk —; means that the genus commenced in the chalk, and has existed ever since.
Depth; — 50 fms.; genus found at all depths between low-water and 50 fathoms. A fathom is six feet.

$\frac{1}{4}$ one-fourth the real size; $\frac{4}{1}$ magnified four times.
Lat., breadth. *Long.*, length. *Alt.*, height or thickness.
Unc., (uncia) an inch. *Lin.*, (linea) a line, the $\frac{1}{12}$ of an inch.
Mill., millimetre, the twenty-fifth part of an inch.

MANUAL OF THE MOLLUSCA.

CLASS I. CEPHALOPODA.

The cuttle-fishes, though excluded by dealers from the list of shell-fish, are the most remarkable, and, rightly considered, the most interesting of any; whilst their relatives, the *nautili* and *ammonites,* are unmatched for the symmetry and wondrous architecture of their pearly shells.

The principal locomotive organs of the *cephalopods,* are attached to the head, in the form of muscular arms or tentacles;* in addition to which, many have fins; and all can propel themselves by the forcible expulsion of water from their respiratory chamber.

Unlike most of the *mollusca,* they are symmetrical animals, having their right and left sides equally developed; and their shell is usually straight, or coiled in a vertical plane. The nautilus and argonaut alone (of the living tribes) have external shells; the rest are termed "naked cephalopods," because the shell is internal. They have powerful jaws, acting vertically, like the mandibles of birds; the tongue is large and fleshy, and part of its surface is sentient, whilst the rest is armed with recurved spines; their eyes are large, and placed on the sides of the head; their senses appear to be very acute. All are marine; and predatory, living on shell-fish, crabs, and fishes.

The nervous system is more concentrated than in the other *mollusca;* and the brain is protected by a cartilage. The respiratory organs consist of two or four plume-like gills, placed symmetrically on the sides of the body, in a large branchial cavity, opening forwards on the *under*† side of the head; in the middle of this opening is placed the *siphon* or *funnel.* The sexes are always distinct; but the males are much less numerous than the females, and in many species, at present unknown. They are divided into two orders, the names of which are derived from the number of the *branchiæ.*

ORDER I. Dibranchiata, Owen.

Animal swimming; naked. *Head* distinct. *Eyes* sessile, prominent. *Mandibles* horny (Pl. I., fig. 2). *Arms* 8 or 10, provided with suckers. *Body* round or elongated, usually with a pair of *fins; branchiæ* two, fur-

* M. Schultze compares the arms of the cephalopods to the oral filaments of *myxine.*

† According to the established usage, we designate that the *under* or *ventral* side of the body, on which the funnel is placed. But if the cuttle fishes are compared with the nucleobranches, or the nautilus with the holostomatous gasteropods, their external analogies seem to favour an opposite conclusion.

nished with muscular ventricles; *ink-gland* always present; *parietes* of the *funnel* entire.

Shell internal (except in *argonauta*), horny or shelly, with or without air-chambers.

The typical forms of the cuttle-fishes were well described by Aristotle, and have been repeatedly examined by modern naturalists; yet, until Professor Owen demonstrated the existence of a second order of cephalopods, departing from all the abovementioned characters, it was not clearly understood how inseparably the organisation of the cuttle-fishes was connected with their condition as *swimming mollusca,* breathing by *two* gills.

The characters which co-exist with the two gills, are the internal rudimentary shell, and the substitution of other means of escape and defence, than those which an external shell would have afforded; viz.: powerful arms, furnished with suckers; the secretion of an inky fluid, with which to cloud the water and conceal retreat; more perfect organs of vision; and superadded branchial hearts, which render the circulation more vigorous.*

The *suckers* (*antlia* or *acetabula*), form a single or double series, on the inner surface of the arms. From the margin of each cup, the muscular fibres converge to the centre, where they leave a circular cavity, occupied by a soft *caruncle,* rising from it like the piston of a syringe, and capable of retraction when the sucker is applied to any surface. So perfect is this mechanism for effecting adhesion, that while the muscular fibres continue retracted, it is easier to tear away the limb than to detach it from its hold.† In the decapods, the base of the *piston* is surrounded by a horny dentated hoop; which in the uncinated calamaries, is folded, and produced into a long sharp claw.

The *ink-bag* (fig. 33), is tough and fibrous, with a thin silvery outer coat; it discharges its contents through a duct which opens near the base of the funnel. The ink was formerly used for writing (*Cicero*), and in the preparation of *sepia*;‡ and from its indestructible nature, is often found in a fossil state.

* In a few species, which have no fins, the arms are webbed. In the only kind which has an external shell, it is confined to the female sex, and is secreted by the membranes of the arms. It is now quite certain that such shells as those of the fossil *ammonites* and *orthocerata* would be incompatible with *dibranchiate* organization.

† "The complex, irritable mechanism, of all these suckers, is under the complete control of the animal. Mr. Broderip informs me that he has attempted, with a hand-net, to catch an *octopus* that was floating by with its long and flexible arms entwined round a fish, which it was tearing with its sharp hawk's bill; it allowed the net to approach within a short distance before it relinquished its prey, when, in an instant, it relaxed its thousand suckers, exploded its inky ammunition, and rapidly retreated under cover of the cloud which it had occasioned, by rapid and vigorous strokes of its circular web." (*Owen.*)

‡ Indian ink and sepia are now made of lamp-smoke, or of prepared charcoal.

The skin of the naked cephalopods is remarkable for its variously coloured vesicles, or pigment-cells. In *sepia* they are black and brown; in the calamary, yellow, red, and brown; and in the argonaut, and some octopods, there are blue cells besides. These cells alternately contract and expand, by which the colouring matter is condensed or dispersed, or perhaps driven into the deeper part of the skin. The colour accumulates, like a blush, when the skin is irritated, even several hours after separation from the body. During life, these changes are under the control of the animal, and give it the power of changing its hue, like the chameleon. In fresh specimens, the *sclerotic plates* of the eyes have a pearly lustre; they are sometimes preserved in a fossil state.

The *aquiferous pores* are situated on the back and sides of the head, on the arms (*brachial*), or at their bases (*buccal pores*).

The *mantle* is usually connected with the back of the head by a broad ("*nuchal*") muscular band; but its margin is sometimes free all round, and it is supported only by cartilaginous ridges, fitting into corresponding grooves,* and allowing considerable freedom of motion.

The cuttle-fishes are nocturnal, or crepuscular animals, concealing themselves during the day, or retiring to a lower region of the water. They inhabit every zone, and are met with equally near the shore, and in the open sea, hundreds of miles from land. They attain occasionally a much greater size than any other mollusca. MM. Quoy and Gaimard found a dead cuttle-fish in the Atlantic, under the equator, which must have weighed 2 cwt. when perfect; it was floating on the surface, and was partly devoured by birds. Banks and Solander, also met with one under similar circumstances, in the Pacific, which was estimated to have measured six feet in length. (*Owen.*) The arms of the octopods are sometimes two feet long.† From their habits, it is difficult to capture some species alive, but they are frequently obtained, uninjured, from the stomachs of dolphins, and other fishes which prey upon them.

SECTION A. OCTOPODA.

Arms 8; suckers sessile. *Eyes* fixed, incapable of rotation. *Body* united to the head by a broad cervical band. *Branchial chamber* divided longitudinally by a muscular partition. *Oviduct* double; no distinct nidamental gland. *Shell* external and one-celled (*mono-thalamous*), or internal and rudimentary.

The Octopods differ from the typical cuttle-fishes in having only eight arms, without the addition of tentacles; their bodies are round, and they sel-

* Termed the "apparatus of resistance," by D'Orbigny.

† *Denys Montfort*, having represented a "kraken octopod," in the act of scuttling a three-master, told M. Defrance, that if this were "swallowed," he would in his next edition represent the monster embracing the Straits of Gibraltar, or capsizing a whole squadron of ships. (*D'Orbigny.*)

dom have fins. They are the most eccentric or "aberrant" mollusks, superior in organization to all the rest, but manifesting some remarkable and unexpected analogies with the lowest classes of animals.

The males of some species of *octopus* and *eledone*, are similar to the females, but are comparatively scarce. Only the females of many others are known, and every specimen of the argonaut hitherto examined (amounting to many hundreds), has been of that sex. Dr. Albert Kölliker has suggested that the real males of the argonaut, and also of *octopus granulatus* and *tremoctopus violaceus* are the *hectocotyles*, previously mistaken for *parasitic worms*.

The *hectocotyle* of *octopus granulatus* was described by Cuvier,* who obtained several specimens from octopods captured in the Mediterranean. It is five inches in length, and resembles a detached arm of the octopus, its under surface being bordered with 40 or 50 pairs of alternate suckers.

The *hectocotyle* of *tremoctopus* was discovered by Dr. Kölliker, at Messina, in 1842, adhering to the interior of the gill-chamber and funnel of the poulpe; it is represented in Pl. I., fig. 3. The body is worm-like, with two rows of suckers on the ventral surface, and an oval appendage at the posterior end. The anterior part of the back is fringed with a double series of branchial filaments (250 on each side). Between the branchiæ are two rows of brown or violet *spots*, like the pigment cells of the *tremoctopus*. The suckers (40 on each side) closely resemble those of the *tremoctopus*, in miniature. Between the suckers are four or five series of *pores*, the openings of minute canals, passing into the abdominal cavity. The *mouth* is at the anterior extremity, and is minute and simple; the alimentary canal runs straight through the body, nearly filling it. The *heart* is in the middle of the back, between the branchiæ; it consists of an auricle and a ventricle, and gives origin to two large vessels. There is also an artery and vein on each side, giving branches to the branchial filaments. A *nerve* extends along the intestine, and one ganglion has been observed. The *oval sac* incloses a small but very long convoluted tube, ending in a muscular *vas deferens*; it contains innumerable *spermatozoa*.

The *hectocotyle* of the argonaut was discovered by *Chiaje*, who considered it a parasitic worm, and described it under the name of *trichocephalus acetabularis*; it was again described by *Costa*,† who regarded it as "a spermatophore of singular shape;" and lastly by Dr. Kölliker.‡

It is similar in form to the others, but is only seven lines in length, and has a filiform appendage in front, six lines long. It has two rows of alternate

* An. Sc. Nat. 1 Series, t. 18. p. 147. 1829.

† An. Sc. Nat. 2 Series, 7. p. 173.

‡ Lin. Trans. Vol. 20, pt. 1, p. 9; and in his own zootomical *berichte*, where it is figured.

suckers, 45 on each side; but no *branchiæ*; the skin contains numerous changeable spots of red or violet, like that of the argonaut.*

According to the observations of Madame Power, "the newly hatched *argonaut* has no shell, and is quite unlike what it afterwards becomes; it is a sort of little worm, having two rows of suckers along its length, with a filiform appendage at one extremity, and a small swelling at the other. It might be supposed to represent an *extremely small brachial appendage*, from which the other parts were afterwards to be developed."† (*Kölliker.*)

FAMILY I. ARGONAUTIDÆ.

Dorsal arms (of the female) webbed at the extremity, secreting a symmetrical involuted shell. *Mantle* supported in front by a single ridge on the funnel.

Genus Argonauta, Lin. Argonaut or paper sailor.

Etymology, *argonautai*, sailors of the ship Argo.

Synonyms, ocythoë (Rafinesque). Nautilus (Aristotle and Pliny).

Example, A. hians, Soland, pl. II., fig. 1. China.

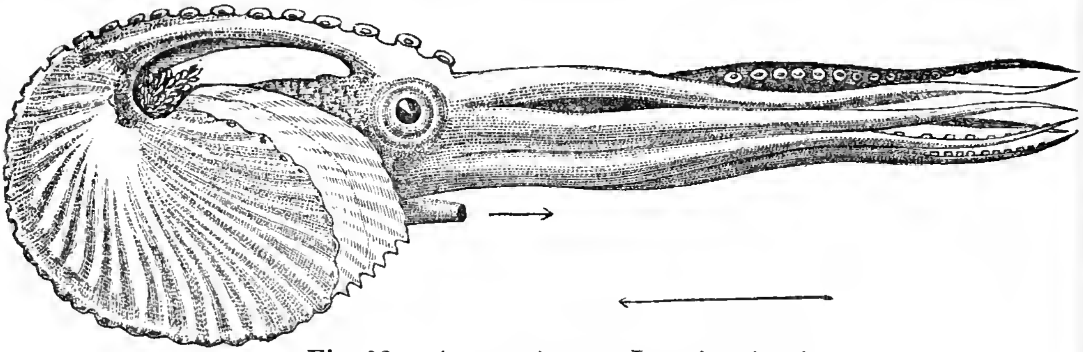


Fig. 32. *Argonauta argo L. swimming.*‡

The *shell* of the argonaut is thin and translucent; it is not moulded on the body of the animal, nor is it attached by shell-muscles; and the unoccupied hollow of the spire serves as a receptacle for the minute clustered eggs. The argonaut sits in its boat with its siphon turned towards the keel,§ and its sail-shaped (dorsal) arms closely applied to the sides of the shell, as in fig. 32, where, however, they are represented as partially withdrawn, in order to show the margin of the aperture. It swims only by ejecting water from its fun-

* Similar instances of a permanently rudimentary condition of the male sex, occur amongst the lowest organized parasitic crustaceans; the males of *achtheres*, *lernæopoda*, *tracheliaster*, *&c.*, are frequently a thousand times smaller than the female, upon whom they live, and from whom they differ both in form and structure. Mr. Gosse has described a similar disparity of the sexes in *asplanchna*.

† An. Sc. Nat. 2 Series, vol. 16, p. 185.

‡ From a copy of Rang's figure, in Charlesworth's Magazine; one-fourth the natural size; the small arrow indicates the current from the *funnel*, the large arrow the direction in which the "sailor" is driven by the recoil.

§ Poli has represented it sitting the opposite way; the writer had once an argonaut shell with the nucleus *reversed*, implying that the animal had *turned quite round* in its shell, and remained in that position. The specimen is now in the York Museum.

nel, and crawls in a reversed position, carrying its shell over its back like a snail. (*Madame Power and M. Rang.*)

It was the *nautilus* (*primus*) of Aristotle, who described it as floating on the surface of the sea, in fine weather, and holding out its sail-shaped arms to the breeze; a pretty fable, which poets have repeated ever since.

Distribution: 4 species of argonaut are known; they inhabit the open sea throughout the warmer parts of the world. Captain King took several from the stomach of a dolphin, caught upwards of 600 leagues from any land.

Fossil: A. hians is found in the sub-apennine tertiaries of Piedmont. This species is still living in the Chinese seas, but not in the Mediterranean.

FAMILY II. OCTOPODIDÆ.

Arms similar, elongated, united at the base by a web. *Shell* represented by two short styles, encysted in the substance of the mantle. (*Owen.*)

Octopus, Cuvier. Poulpe.

Etym., *octo*, eight, *pous* (*poda*) feet.

Syn., *cistopus*. (*Gray.*)

Ex., O. tuberculatus Bl., pl. I., figs. 1 and 2 (mandibles).

Body oval, warty or cirrose, without fins; *arms* long, unequal; *suckers* in two rows; *mantle* supported in front by the branchial septum.

The octopods are the "polypi" of Homer and Aristotle; they are solitary animals, frequenting rocky shores, and are very active and voracious; the females oviposit on sea-weeds, or in the cavities of empty shells. In the markets of Smyrna and Naples, and the bazaars of India, they are regularly exposed for sale. "Although common (at St. Jago) in the pools of water left by the retiring tide, they are not very easily caught. By means of their long arms and suckers they can drag their bodies into very narrow crevices, and when thus fixed it requires great force to remove them. At other times they dart tail first, with the rapidity of an arrow, from one side of the pool to the other, at the same instant discolouring the water with a dark chesnut-brown ink. They also escape detection by varying their tints, according to the nature of the ground over which they pass. In the dark they are slightly phosphorescent." (*Darwin.*)*

Professor E. Forbes has observed that the octopus, when resting, coils its dorsal arms over its back, and seems to shadow forth the argonaut's shell.

Distr., universally found on the coasts of the temperate and tropical zones; 46 species are known; when adult they vary in length from 1 inch to 2 feet, according to the species.

Pinnoctopus, D'Orb. Finned octopus.

Body with lateral fins, united behind.

* Journal of a Voyage round the World. The most fascinating volume of travels published since Defoe's fiction.

The only known species, *P. cordiformis,* was diseovered by MM. Quoy and Gaimard, on the eoast of New Zealand; it exceeds 3 feet in length.

ELEDONE. (Aristotle.) Leaeh.

Type, E. oetopodia, L.

Suckers forming a single series on eaeh arm; length 6 to 18 inches. *E. moschata* emits a musky smell.

Distr., 2 sp. Coasts of Norway, Britain, and the Mediterranean.

CIRROTEUTHIS, Esehricht. 1836.

Etym., cirrus, a filament, and *teuthis* a euttle-fish.

Body with two transverse fins; *arms* united by a web, nearly to their tips; *suckers* in a single row, alternating with *cirri.* Length 10 inehes. Colour violet. The only species (*C. Mülleri Esch.*) inhabits the coast of Greenland.

PHILONEXIS, D'Orb.

Etym., philos, an adept in *nexis,* swimming.

Type, P. atlantieus, D'Orb.

Arms free; suekers in two rows; *mantle* supported by two ridges on the funnel. Total length, 1 to 3 inehes.

Distr., 6 sp. Atlantic and Medit. Gregarious in the open sea; feeding on floating *mollusca.*

Sub-genus. Tremoctopus (Chiaje), pl. I., fig. 3.

Name from two large aquiferous pores (*tremata*) on the back of the head.

Arms partly, or all webbed half-way up.

Distr., 2 sp. T. quoyanus and violaeeus. Atlantic and Medit.

SECTION B. DECAPODA.

Arms 8. *Tentacles* 2, elongated, eylindrieal, with expanded ends. *Suckers* peduneulated, armed with a horny ring. *Mouth* surrounded by a buceal membrane, sometimes lobed and funished with suekers. *Eyes* moveable in their orbits. *Body* oblong or elongated, always provided with a pair of fins. *Funnel* usually furnished with an internal valve. *Oviduct* single. *Nidamental gland* largely developed. *Shell* internal; lodged loosely in the middle of the dorsal aspeet of the mantle.

The arms of the deeapods are comparatively shorter than those of the octopods; the dorsal pair is usually shortest, the ventral longest. The tentacles originate within the eirele of the arms, between the third and fourth pairs; they are usually mueh longer than the arms, and in *cheiroteuthis* are six times as long as the animal itself. They are eompletely retractile into large sub-oeular pouehes in *sepia, sepiola,* and *rossia;* partly retraetile in *loligo* and *sepioteuthis;* non-retractile in *cheiroteuthis.* They serve to seize prey whieh may be beyond the reaeh of the ordinary arms, or to moor the animal in safety during the agitation of a stormy sea.

The *shell* of the living decapods is either a horny "pen" (*gladius*) or a calcarious "bone" (*sepion*); not attached to the animal by muscles, but so loose as to fall out when the cyst which contains it is opened. In the genus *spirula*, it is a delicate spiral tube, divided into air-chambers by a series of partitions (*septa*). In the fossil genus *spirulirostra*, a similar shell forms the apex of a cuttle-bone; in the fossil *conoteuthis* a chambered shell is combined with a *pen;* and the *belemnite* unites all these modifications.

The decapods chiefly frequent the open sea, appearing periodically like fishes, in great shoals, on the coasts and banks. (*Owen, D'Orb.*)

FAMILY III. TEUTHIDÆ. Calamaries, or Squids.

Body, elongated; *fins* short, broad, and mostly terminal.

Shell, (gladius or *pen*) horny, consisting of three parts,—a shaft, and two lateral expansions or wings.

Sub-family A. *Myopsidæ*, D'Orb. *Eyes* covered by the skin.

Loligo. (*Pliny*) Lamarck. Calamary.

Syn., *teuthis* (Aristotle) Gray.

Type, L. vulgaris (sepia loligo L.) Fig. 1. Pl. I., fig. 6 (pen).

Pen, lanceolate, with the shaft produced in front; it is multiplied by age, several being found packed closely, one behind another, in old specimens. (Owen.)

Body tapering behind, much elongated in the males. *Fins* terminal, united, rhombic. *Mantle* supported by a cervical ridge, and by two grooves in the base of the funnel. *Suckers* in two rows, with horny, dentated hoops. *Tentacular club* with four rows of suckers. Length (excluding tentacles) from 3 inches to 2½ feet.

The calamaries are good swimmers; they also crawl, head-downwards, on their oral disk. The common species is used for bait, by fishermen, on the Cornish coast (Couch). Shells have been found in its stomach, and more rarely sea-weed (Dr. Johnston). Their egg-clusters have been estimated to contain nearly 40,000 eggs (Bohadsch).

Distr., 21 sp. in all seas. Norway—New Zealand.

Sub-genus. *Teudopsis*, Deslongchamps, 1835.

Etym., *teuthis*, a calamary and *opsis* like.

Type, T. Bunellii, Desl.

Pen, like *loligo*, but dilated and spatulate behind.

Fossil, 5 sp. Upper Lias, France, and Wurtemberg.

Gonatus, Gray.

Animal and *pen* like *loligo* in most respects. *Arms* with 4 series of cups, *tentacular club* with numerous small cups, and a single large sessile cup armed with a hook; funnel valveless.

Distr., a single species (*G. amœna*, Moller sp.) is found on the coast of Greenland.

SEPIOTEUTHIS, Blainville.

Type, S. sepioïdea, Bl. *Animal* like *loligo; fins* lateral, as long as the body. Length from 4 inches to 3 feet.

Distr., 13 sp., West Indies, Cape, Red Sea, Java, Australia.

BELOTEUTHIS, Münster.

Etym., *belos*, a dart and *teuthis*.

Type, B. subcostata, Münst. Pl. II., fig. 8., U. Lias, Wurtemberg.

Pen, horny, lanceolate; with a very broad shaft, pointed at each end, and small lateral wings.

Distr., 6 sp. described by Münster, considered varieties (differing in age and sex), by M. D'Orbigny.

GEOTEUTHIS, Münster.

Etym., *ge*, the earth (*i. e.* fossil) and *teuthis*.

Syn., belemnosepia (Agassiz.) belopeltis (Voltz) loligosepia (Quenstedt.)*

Pen broad, pointed behind; shaft broad, truncated in front; lateral wings shorter than the shaft.

Fossil, 9 sp. U. Lias, Wurtemberg; Calvados; Lyme Regis. Several undescribed sp. in the Oxf. clay, Chippenham.

Besides the *pens* of this calamary the *ink-bag*, the muscular mantle, and the bases of the arms, are preserved in the Oxford clay. Some of the ink-bags found in the Lias are nearly a foot in length, and are invested with a brilliant nacreous layer; the ink forms excellent *sepia*. It is difficult to understand how these were preserved, as the recent calamaries "spill their ink" on the slightest alarm. (*Buckland*).

LEPTOTEUTHIS, Meyer.

Etym., *Leptos* thin, and *teuthis*.

Type, L. gigas Meyer, Oxford clay, Solenhofen.

Pen very broad and rounded in front, pointed behind; with obscure diverging ribs.

CRANCHIA, Leach, 1817.

Named in honour of Mr. J. Cranch, naturalist to the Congo expedition.

Type, C. scabra, Leach.

Body large, ventricose; fins small, terminal; mantle supported in front by a branchial septum. Length 2 inches. *Head* very small. *Eyes* fixed. *Buccal* membrane large, 8-lobed. *Arms* short, suckers in two rows. *Tentacular* clubs finned behind, cups in 4 rows. *Funnel* valved.

Pen long and narrow.

* These names must be set aside, being incorrect in themselves, and founded on a total misapprehension of the nature of the fossils.

Distr., 2 sp. W. Afriea. In the open sea.

This genus makes the nearest approaeh to the oetopods.

SEPIOLA. (Rondelet) Leach, 1817.

Ex., S. atlantica (D'Orb.) Pl. I., fig. 4.

Body short, purse-like; mantle supported by a broad eervieal band, and a ridge fitting a groove in the funnel. *Fins* dorsal, rounded, eontraeted at the base. *Suckers* in 2 rows, or erowded, on the arms, in 4 rows on the tentaeles. Length 2 to 4 inches.

Pen, half as long as the baek. *S. stenodactyla* (sepioloidea, D'Orb.) has no pen.

Distr., 6 sp. Coasts of Norway, Britain, Medit., Mauritius, Japan, Australia.

Sub-genus. Rossia, Owen (*Fidenas?* Gray). *Mantle* supported by a eervieal ridge and groove. *Suckers* in 2 rows on the tentaeles. Length 3 to 5 inehes.

Distr., 6 sp. Regent Inlet, Britain, Medit., Manilla.

Sub-family B. *Oigopsidæ*, D'Orb.

Eyes naked. *Fins* always terminal, and united, forming a rhomb.

LOLIGOPSIS, Lam. 1811.

Etym., loligo, and *opsis*, like.

Type, L. pavo (Lesueur).

Body elongated, mantle supported in front by a branehial septum. *Arms* short. *Cups* in 2 rows. *Tentacles* slender, often mutilated. *Funnel* valveless.

Pen slender, with a minute eonieal appendix. Length from 6 to 12 inches.

Distr., pelagie. 8 sp. N. Sea, Atlantie, Medit., India, Japan, S. Sea.

CHEIROTEUTHIS, D'Orb.

Etym., *cheir*, the hand, and *teuthis*.

Type, C. veranii, Fér.

Mantle supported in front by ridges. *Funnel* valveless. *Ventral arms* very long. *Tentacles* extremely elongated, slender, with distant sessile cups on the peduncles, and 4 rows of pedunculated claws on their expanded ends.

Pen slender, slightly winged at each end. Length of the body 2 inehes; to the tips of the arms 8 inches; to the ends of the tentacles 3 feet.

Distr., 2 sp. Atlantie, Medit. On gulf-weed, in the open sea.

HISTIOTEUTHIS, D'Orb.

Etym., *histion*, a veil; and *teuthis*.

Type, H. bonelliana, Fér. Length 16 inehes.

Body short. *Fins* terminal, rounded. *Mantle* supported in front by ridges and grooves. *Buccal* membrane 6-lobed. *Arms* (exeept the ventral pair), webbed high up. *Tentacles* long, outside the web, with 6 rows of dentated eups on their ends.

Pen short and broad.

Distr., 2 sp. Mediterranean; in the open sea.

ONYCHOTEUTHIS, Lichtenstein. Uncinated calamary.

Etym., *onyx*, a claw, and *teuthis*.

Type, O. banksii, Leach. (= bartlingii?) Pl. I., fig. 7 and fig. 8 (*pen*)

Syn., ancistroteuthis (Gray). Onychia (Lesueur).

Pen narrow, with hollow, conical apex.

Arms with 2 rows of suckers. *Tentacles* long and powerful, armed with a double series of hooks; and usually having a small group of suckers at the base of each club, which they are supposed to unite, and thus use their tentacles in conjunction.* Length 4 inches to 2 feet.

The uncinated calamaries are solitary animals, frequenting the open sea, and especially the banks of gulf-weed (*sargasso*). O. banksii ranges from Norway to the Cape and Indian ocean; the rest are confined to warm seas. *O. dussumieri* has been taken swimming in the open sea, 200 leagues north of the Mauritius.

Distr., 6 sp. Atlantic, Indian ocean, Pacific.

ENOPLOTEUTHIS, D'Orb. Armed calamary.

Etym., *enoplos*, armed, and *teuthis*.

Type, E. smithii, Leach.

Syn., ancistrochirus and abralia (Gray), octopodoteuthis (Ruppell), verania (Krohn).

Pen lanceolate. *Arms* provided with a double series of horny hooks, concealed by retractile webs. *Tentacles* long and feeble, with small hooks at the end. Length (excluding the tentacles) from 2 inches to 1 foot; but some species attain a larger size. In the museum of the College of Surgeons there is an arm of the specimen of E. unguiculata, found by Banks and Solander in Cook's first voyage (mentioned at p. 64) supposed to have been 6 feet long when perfect. The natives of the Polynesian Islands, who dive for shell-fish, have a well-founded dread of these formidable creatures. (*Owen.*)

Distr., 10 sp. Medit., Pacific.

OMMASTREPHES, D'Orb. Sagittated calamary.

Etym., *omma*, the eyes, and *strepho*, to turn.

Type, O. sagittatus, Lam.

Body cylindrical; terminal fins large and rhombic. *Arms* with 2 rows of suckers, and sometimes an internal membranous fringe. *Tentacles* short and strong, with 4 rows of cups.

Pen, consisting of a shaft with three diverging ribs, and a hollow conical appendix. Length from 1 inch to nearly 4 feet.

* The obstetric forceps of Professor Simpson were suggested by the suckers of the calamary.

The sagittated calamaries are gregarious, and frequent the open sea in all climates. They are extensively used in the cod-fishery off Newfoundland, and are the principal food of the dolphins and cachalots, as well as of the albatross and larger petrels. The sailors call them "sea-arrows" or "flying squids," from their habit of leaping out of the water, often to such a height as to fall on the decks of vessels. They leave their eggs in long clusters floating at the surface.

Distr., 14 recent sp.; similar *pens* (4 sp.) have been found fossil in the Oxford clay, Solenhofen; it may, however, be doubted whether they are generically identical.

FAMILY IV. BELEMNITIDÆ.

Shell consisting of a *pen*, terminating posteriorly in a chambered cone, sometimes invested with a fibrous *guard*. The air-cells of the *phragmo-cone* are connected by a *siphuncle*, close to the ventral side.

BELEMNITES, Lamarck. 1801.

Etym., *belemnon*, a dart.*

Ex., B. puzosianus, pl. II., fig. 5.

Phragmocone horny, slightly nacreous, with a minute globular nucleus at its apex; divided internally by numerous concave *septa*. *Pen* represented by two nacreous bands on the dorsal side of the phragmocone, and produced beyond its rim, in the form of sword-shaped processes (pl. II., fig. 5).† *Guard*, fibrous, often elongated and cylindrical; becoming very thin in front, where it invests the phragmocone.‡

Nearly 100 species of belemnites have been found in a fossil state, ranging from the lias to the gault, and distributed over all Europe. The *phragmocone* of the belemnite, which represents the terminal appendix of the calamaries, is

* The termination *ites* (from *lithos*, a stone) was formerly given to all *fossil* genera.

† The most perfect specimens known are in the cabinet of Dr. Mantell, and the British Museum; they were obtained by William Buy in the Oxford clay of Christian Malford, Wilts. The *last chamber* of a lias belemnite in the British Museum is 6 inches long, and 2½ inches across at the smaller end; a fracture near the siphuncle shows the *ink-bag*. The *phragmocone* of a specimen corresponding to this in size, measures 7½ inches in length.

‡ The specific gravity of the guard is identical with that of the shell of the recent pinna, and its structure is the same. Parkinson and others have supposed that it was originally a light and porous structure, like the cuttle-bone; but the *mucro* of the sepiostaire, with which alone it is homologous, is quite as dense as the belemnite. We are indebted to Mr. Alex. Williams, M.R.C.S., for the following specific gravities of recent and fossil shells, compared with water as 1,000:—

Belemnites puzosianus, Oxford clay	2,674
Belemnitella mucronata, chalk	2,677
Pinna, recent, from the Mediterranean	2,607
Trichites plottii, from the inferior oolite	2,670
Conus monile, recent	2,910
Conus ponderosus, Miocene, Touraine	2,713

divided into air-chambers, connected by a small tube (*siphuncle*), like the shell of the pearly nautilus. It is exceedingly delicate, and usually owes its preservation to the infiltration of calc. spar; specimens frequently occur in the lias, with the meniscus-shaped casts of the air-chambers loose, like a pile of watch-glasses. It is usually eccentric, its apex being nearest to the ventral side of the guard. The *guard* is very variable in its proportions, being sometimes only half an inch longer than the phragmocone, at others one or two feet in length. These variations probably depend to some extent on age and sex; M. D'Orbigny believes that the shells of the males are always (comparatively) long and slender; those of the females are at first short, but afterwards growing only at the points, they become as long in proportion as the others. The guard always exhibits (internally) concentric lines of growth; in *B. irregularis* its apex is hollow. The belemnites have been divided into groups by the presence and position of furrows in the surface of the guard.

SECTION I. ACŒLI (Bronn.) without dorsal or ventral grooves.

Sub-section 1. *Acuarii*, without lateral furrows, but often channelled at the extreme point.

Type., b. acuarius. 20 sp. Lias—Neocomian.

Sub-section 2. *Clavati*, with lateral furrows.

Type, b. clavatus. 3 sp. Lias.

SECTION II. GASTROCŒLI (D'Orb.) Ventral groove distinct.

Sub-section 1. *Canaliculati*, no lateral furrows.

Type, b. canaliculatus. 5 sp. Inf. oolite—Gt. oolite.

Sub-section 2. *Hastati*, lateral furrows distinct.

Type, b. hastatus. 19 sp. U. lias—Gault.

SECTION III. NOTOCŒLI (D'Orb.) with a dorsal groove, and furrowed on each side.

Type, b. dilatatus. 9 sp. Neocomian.

The belemnites appear to have been gregarious, from the exceeding abundance of their remains in many localities, as in some of the marlstone quarries of the central counties, and the lias cliffs of Dorsetshire. It is also probable that they lived in a moderate depth of water, and preferred a muddy bottom to rocks or coral-reefs, with which they would be apt to come in perilous collision. Belemnites injured in the life-time of the animal have been frequently noticed.

BELEMNITELLA, D'Orb.

Syn., actinocamax, Miller (founded on a mistake.)

Type, B. mucronata, Sby. Pl. II., fig. 6.

Distr., Europe; N. America. 5 sp. U. greensand and chalk.

The *guard* of the belemnitella has a straight fissure on the ventral side of its alveolar border; its surface exhibits distinct vascular impressions. The *phragmocone* is never preserved, but casts of the alveolus show that it was chambered, that it had a single dorsal ridge, a ventral process passing into the fissure of the guard, and an apical nucleus.

ACANTHOTEUTHIS (Wagner), Münster.

Etym., *acantha*, a spine, and *teuthis.*

Syn., Kelæno (Munster.) Belemnoteuthis?

Type, A. prisca, Ruppell.

Founded on the fossil hooks of a calamary, preserved in the Oxford clay of Solenhofen. These show that the animal had 10, nearly equal arms, all furnished with a double series of horny claws, throughout their length. A *pen* like that of the *ommastrephes* has been hypothetically ascribed to these arms, which may, however, have belonged to the *belemnite* or the *belemnoteuthis.*

BELEMNOTEUTHIS (Miller), Pearce, 1842.

Type, B. antiquus (Cunnington), fig. 33.

Shell consisting of a *phragmocone*, like that of the belemnite; a horny dorsal *pen* with obscure lateral bands; and a thin fibrous *guard*, with two diverging ridges on the dorsal side.

Animal provided with *arms* and *tentacles* of nearly equal length, furnished with a double alternating series of horny hooks, from 20 to 40 pairs on each arm; *mantle* free all round; *fins* large, medio-dorsal (much larger than in fig. 33).

Fossil in the Oxford clay of Chippenham. Similar horny claws have been found in the lias of Watchett; and a *guard* equally thin is figured in Buckland's Bridgewater Treatise, t. 44, fig. 14.

In the fossil calamary of Chippenham, the shell is preserved along with the muscular mantle, fins, ink-bag, funnel, eyes, and tentacles with their horny hooks; all the specimens were discovered, and developed with unexampled skill, by William Buy, of Sutton, near Chippenham.

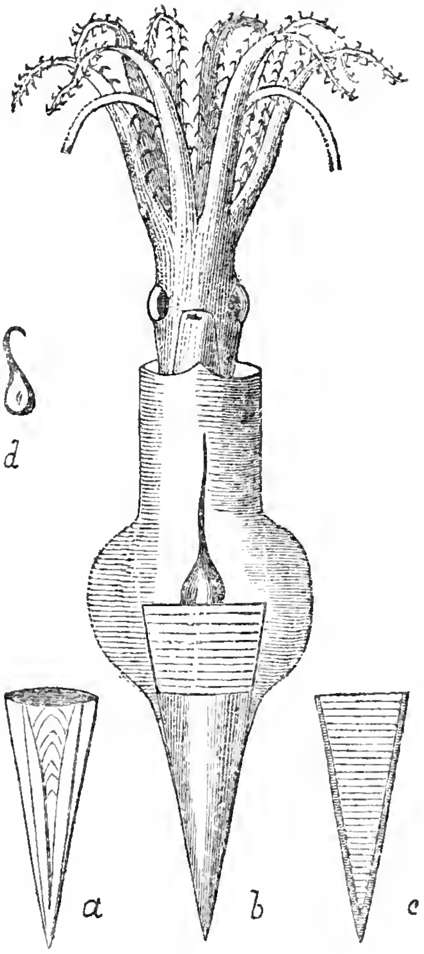


Fig. 33. *Belemnoteuthis.**

* Fig. 33. *Belemnoteuthis antiquus*, ¼, ventral side, from a specimen in the cabinet of William Cunnington, Esq., of Devizes. The last chamber of the phragmocone is preserved in this specimen. *a*, represents the dorsal side of an uncompressed phragmocone from the Kelloway rock, in the cabinet of J. G. Lowe, Esq.; *c*, is an ideal section of the same. Since this woodcut was executed, a more complete specimen has

CONOTEUTHIS, D'Orb.

Type, C. Dupinianus, D'Orb. Pl. II., fig. 9. *Neocomian,* France.

Phragmocone slightly curved. *Pen* elongated, very slender.

This shell, which is like the pen of an ommastrephe, with a chambered cone, connects the ordinary calamaries with the belemnites.

FAMILY V. SEPIADÆ.

Shell (cuttle-bone or *sepiostaire*) calcarious; consisting of a broad laminated plate, terminating behind in a hollow, imperfectly chambered apex (*mucro*). *Animal* with elongated tentacles, expanded at their ends.

SEPIA (Pliny), Linnæus.

Type, S. officinalis, L. Pl. I., fig. 5.

Syn., belosepia, Voltz. (B. sepioïdea, pl. II., fig. 3, mucro only.)

Body oblong, with lateral fins as long as itself. *Arms* with 4 rows of suckers. *Mantle* supported by tubercles fitting into sockets on the neck and funnel. Length 3 to 28 inches.

Shell as wide and long as the body; very thick in front, concave internally behind; terminating in a prominent *mucro.* The thickened part is composed of numerous plates, separated by vertical fibres, which render it very light and porous. T. Orbignyana, pl. II., fig. 2.

The cuttle-bone was formerly employed as an antacid by apothecaries; it is now only used as "pounce," or in casting counterfeits. The bone of a Chinese species attains the length of 1½ feet. (*Adams.*)

The cuttle-fishes live near shore, and the *mucro* of their shell seems intended to protect them in the frequent collisions they are exposed to in swimming backwards. (*D'Orb.*)

Distr., 30 sp. World-wide.

Fossil, 5 sp. Oxf. clay, Solenhofen. Several species have been founded on *mucrones* from the Eocene of London and Paris. Pl. II., fig. 3.

SPIRULIROSTRA, D'Orb.

Type, S. Bellardii (D'Orb.) Pl. II., fig. 4. Miocene, Turin.

Shell, mucro only known; chambered internally; chambers connected by a ventral *siphuncle;* external spathose layer produced beyond the *phragmocone* into a long pointed beak.

BELOPTERA (Blainville) Deshayes.

Etym., belos, a dart, and *pteron,* a wing.

Type, B. belemnitoïdes, Bl. Pl. II., fig. 7.

been obtained for the British Museum; the *tentacles* are not longer than the ordinary arms, owing, perhaps, to their partial retraction; this specimen will be figured in Dr. Mantell's "Petrifactions and their Teachings." *d,* is a single hook, natural size; the specimens belonging to Mr. Cunnington and the late Mr. C. Pearce, show the large acetabular bases of the hooks.

Shell, mucro (only known) chambered and siphuncled; winged externally.

Fossil, 2 sp. *Eocene.* Paris; Bracklesham

Belemnosis, Edwards.

Type, B. anomalus, Sby. sp. Eocene. Highgate (unique.)

Shell, mucro, chambered and siphuncled; without lateral wings or elongated beak.

FAMILY VI. Spirulidæ.

Shell entirely naercous; discoidal; whirls separate, chambered (*polythalamous,*) with a ventral siphuncle.

Spirula, Lam., 1801.

Syn., lituus, Gray.

Ex., S. lævis (Gray.) Pl. I., fig. 9.

Body oblong, with minute terminal fins. *Mantle* supported by a cervical and 2 ventral ridges and grooves. *Arms* with 6 rows of very minute cups *Tentacles* elongated. *Funnel* valved.

Shell placed vertically in the posterior part of the body, with the involute spire towards the ventral side. The last chamber is not larger in proportion than the rest; its margin is organically connected; it contains the ink-bag.

The delicate shell of the spirula is scattered by thousands on the shores of New Zealand; it abounds on the Atlantic coasts, and a few specimens are yearly brought by the Gulf-stream, and strewed upon the shores of Devon and Cornwall. But the animal is only known by a few fragments, and one perfect specimen, obtained by Mr. Percy Earl on the coast of New Zealand.

Distr., 3 sp. All the warmer seas.

ORDER II. Tetrabranchiata.

Animal creeping; protected by an external shell.

Head retractile within the mantle. *Eyes* pedunculated. *Mandibles* calcarious. *Arms* very numerous. *Body* attached to the shell by adductor muscles, and by a continuous horny girdle. *Branchiæ* four. *Funnel* formed by the folding of a muscular lobe.

Shell external, camerated (poly-thalamous) and siphuncled; the inner layers and septa naercous; outer layers porcellanous.*

It was long ago remarked by Dillwynn, that shells of the carnivorous gasteropods were almost, or altogether, wanting in the palæozoic and secondary strata; and that the office of these animals appeared to have been performed, in the ancient seas, by an order of cephalopods, now nearly extinct. Above 1,400 fossil species belonging to this order are now known by their shells; whilst their only living representative is the *nautilus pompilius,*

* The Chinese carve a variety of patterns in the outer opaque layer of the nautilus shell, relieved by the pearly ground beneath.

of which several specimens have been brought to Europe within the last few years.*

The shell of the tetrabranchiate cephalopods is an extremely elongated cone, and is either straight, or variously folded, or coiled.

It is *straight* in	orthoceras .	baculites.
bent on itself in	ascoceras .	ptychoceras.
curved in	cyrtoceras .	toxoceras.
spiral in	trochoceras .	turrilites.
discoidal in	gyroceras .	crioceras.
discoidal and produced in .	lituites . .	ancyloceras.
involute in	nautilus . .	ammonites.

Internally, the shell is divided into cells or chambers, by a series of partitions (*septa*), connected by a tube or *siphuncle*. The last chamber is occupied by the animal, the rest are empty during life, but in fossil specimens they are often filled with spar. When the outer shell is removed (as often happens to fossils,) the edges of the *septa* are seen (as in Pl. III., figs. 1, 2.) Sometimes they form curved lines, as in *nautilus* and *orthoceras*, or they are *zig-zag*, as in *goniatites* (fig. 53,) or *foliaceous*, as in the ammonite, fig. 34.

Fig. 34. *Suture of an ammonite.*†

The outlines of the *septa* are termed *sutures*;‡ when they are folded the elevations are called *saddles*, and the intervening depressions *lobes*. In *ceratites* (fig. 54) the *saddles* are round, the lobes *dentated;* in *ammonites* both lobes and saddles are extremely complicated. Broken fossils show that the *septa* are nearly flat in the middle, and folded round the edge (like a shirt-frill), where they abut against the outer shell-wall (fig. 37).

The *siphuncle* of the recent *nautilus* is a membranous tube, with a very thin nacreous investment; in most of the fossils it consists of a succession of funnel-shaped, or bead-like tubes. In some of the oldest fossil genera, *actinoceras*, *gyroceras*, and *phragmoceras*, the siphuncle is large, and contains in-

* The *frontispiece*, copied from Professor Owen's Memoir, represents the animal of the first nautilus, captured off the New Hebrides, and brought to England by Mr. Bennett; it is drawn as if lying in the section of a shell, without concealing any part of it. The woodcut, fig. 43, is taken from a more perfect specimen, lately acquired by the British Museum, in which the relation of the animal to its shell is accurately shown.

† *A. heterophyllus*, Sby., from the lias, Lyme Regis. British Museum. Only one side is represented; the arrow indicates the dorsal saddle.

‡ From their resemblance to the sutures of the skull.

its centre a smaller tube, the space between the two being filled up with radiating plates, like the lamellæ of a coral. The position of the siphuncle is very variable; in the *ammonitidæ* it is *external*, or close to the outer margin of the shell (fig. 37). In the *nautilidæ* it is usually *central* (fig. 35), or *internal* (fig. 36).

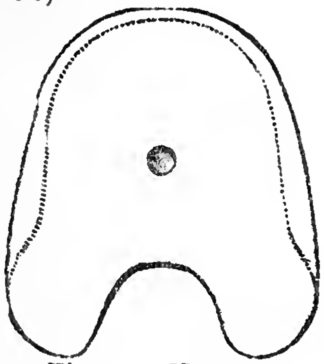


Fig. 35. *Nautilus*.

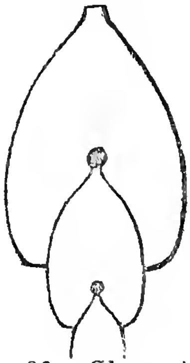


Fig. 36. *Clymeniæ*.

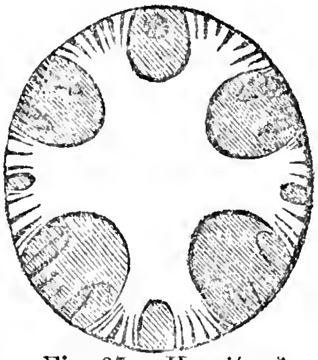


Fig. 37. *Hamites*.*

The *air-chambers* of the recent nautilus are lined by a very thin, living membrane; those of the fossil *orthocerata* retain indications of a thick vascular lining, connected with the animal by spaces between the beads of the siphuncle.†

The *body-chamber* is always very capacious; in the recent nautilus its cavity is twice as large as the whole series of air-cells; in the *goniatite* (fig. 39), it occupies a whole whirl, and has a considerable lateral extension; and in *ammonites communis* it occupies more than a whirl.

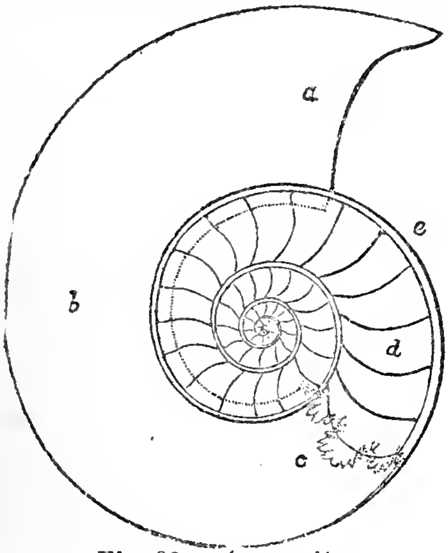


Fig. 38. *Ammonites*.

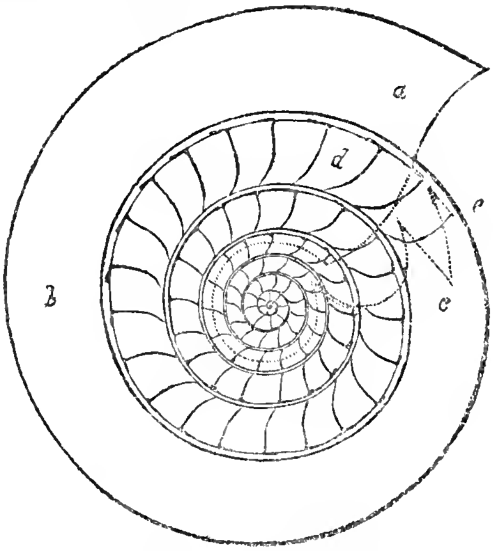


Fig. 39. *Goniatites*.‡

* Fig. 35. Nautilus pompilius, L. Fig. 36. Clymenia striata, Münst., see pl. II., fig. 16. Fig. 37. Hamites cylindraceus Defr., see fig. 58.

† The apocryphal genus *spongarium*, was founded on detached septa of an *orthoceras*, from the Upper Ludlow rock, in which the vascular markings distinctly radiate from the siphuncle. Mr. Jones, warden of Clun Hospital, has several of these in apposition.

‡ Fig. 38. Section of *ammonites obtusus*, Sby. lias, Lyme Regis; from a very young specimen. Fig. 39. Section of *goniatites sphæricus*, Sby. carb. limestone, Bolland (in the cabinet of Mr. Tennant.) The dotted lines indicate the *lateral extent* of the body-chamber.

The *margin of the aperture* is quite simple in the recent nautilus, and affords no clue to the many curious modifications observable in the fossil forms. In the *ammonites* we frequently find a dorsal process, or lateral projections, developed periodically, or only in the adult (fig. 55, and pl. III., fig. 5).

In *phragmoceras* and *gomphoceras* (figs. 40, 41) the aperture is so much contracted that it is obvious the animal could not have withdrawn its head into the shell like the nautilus.

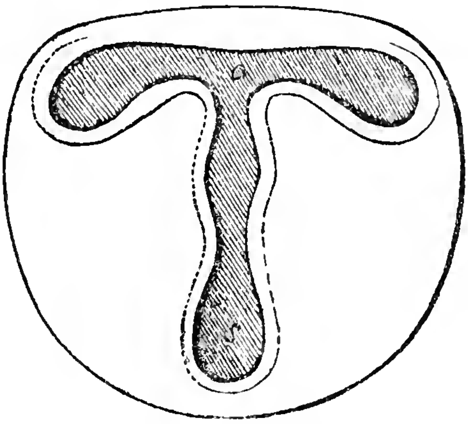


Fig. 40. *Gomphoceras.*

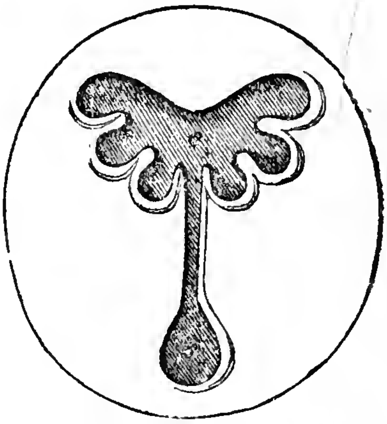


Fig. 41. *Phragmoceras.**

M. Barrande, from whose great work on the Silurian Formations of Bohemia these figures are taken, suggests that the lower part of the aperture (*s s*) which is almost isolated, may have served for the passage of the funnel, whilst the upper and larger space (*c c*) was occupied by the neck; the lobes probably indicate the position of the external arms.

The aperture of the pearly nautilus is closed by a disk or hood (fig. 43, *h*), formed by the union of the two dorsal arms, which correspond to the shell-secreting sails of the argonaut.

In the extinct *ammonites* we have evidence that the aperture was guarded still more effectively by a horny, or shelly *operculum*, secreted, in all probability, by these dorsal arms. In one group (*arietes*,) the operculum consists of a single piece, and is horny and flexible.† In the *round-backed* ammonites the operculum is shelly, and divided into two plates by a straight median suture (fig. 42). They were described in 1811, by Parkinson, who called them *trigonellites*, and pointed out the resemblance of their

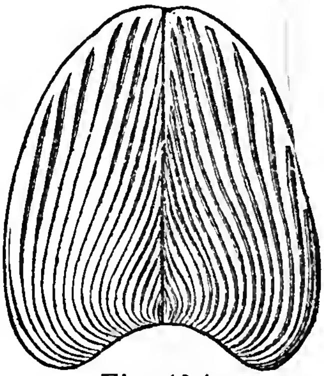


Fig. 42.‡

* Fig. 40. *Gomphoceras Bohemicum* (Barrande), reduced view of the aperture; *s*, the siphonal opening. Fig. 41. *phragmoceras callistoma* (Barr.) both from the U. Silurian, Bohemia.

† This form was discovered by the late Miss Mary Anning, the indefatigable collector of the lias fossils of Lyme Regis, and described by Mr. Strickland, Geol. Journal, vol. I., p. 232. Also by M. Voltz, Mem. de l'Institute, 1837, p. 48.

‡ *Trigonellites lamellosus*, Park. Oxford clay, Solenhofen (and Chippenham,) associated with ammonites lingulatus, Quenstedt. (= A. Brightii, Pratt). From a specimen in the cabinet of Charles Stokes, Esq.

internal structure to the cancellated tissue of bones. Their external surface is smooth or sculptured; the inner side is marked by lines of growth. Forty-five kinds are enumerated by Bronn; they occur in all the strata in which ammonites are found, and a single specimen has been figured by M. D'Archiac, from the Devonian rocks of the Eifel, where it was associated with *goniatites.**

Calcarious mandibles or *rhyncholites* (F. Biguet) have been obtained from all the strata in which *nautili* occur; and from their rarity, their large size and close resemblance to the mandibles of the recent nautilus, it is probable that they belonged only to that genus.† In the Muschelkalk of Bavaria one nautilus (*N. arietis*, Reinecke, = N. bidorsatus, Schlotheim,) is found, and two kinds of *rhyncholite;* one sort, corresponding with the upper mandible of the recent nautilus, has been called "rhyncholites hirundo" (pl. II., fig. 11), the other, which appears to be only the lower mandible of the same species, has been described under the name of "conchorhynchus avirostris."‡

In studying the fossil *tetrabranchiata*, it is necessary to take into consideration the varying circumstances under which they have been preserved. In some strata (as the lias of Watchett) the outer layer of the shell has disappeared, whilst the inner nacreous layer is preserved. More frequently only the outer layer remains; and in the chalk formation the whole shell has perished. In the calcarious grit of Berkshire and Wiltshire the ammonites have lost their shells; but perfect casts of the chambers, formed of calcarious spar, remain.§

Fossil *orthocerata* and *ammonites* are evidently in many instances *dead shells*, being overgrown with corals, serpulæ, or oysters; every cabinet affords such examples. In others the animal has apparently occupied its shell, and prevented the ingress of mud, which has hardened all around it; after this it has decomposed, and contributed to form those phosphates and sulphurets commonly present in the body-chamber of fossil shells, and by which the sediment around them is so often formed into a hard concretion.‖ In this state they are

* The *trigonellites* have been described by Meyer as bivalve shells, under the generic name of *aptychus;* by Deslongchamps under the name of *Munsteria*. M. D'Orbigny regards them as cirripedes! M. Deshayes believes them to be *gizzards* of the ammonites. M. Coquand compares them with *teudopsis;* an analogy evidently suggested by some of the membranous and elongated forms. such as *T. sanguinolarius*, found with *am. depressus*, in the lias of Boll. Ruppell, Voltz, Quenstedt, and Zieten, regard the trigonellites as the *opercula of ammonites*, an opinion also entertained by many of the most experienced fossil collectors in England.

† M. D'Orbigny has manufactured *two genera of calamaries* out of these nautilus beaks! (*rhynchoteuthis* and *palæoteuthis*). In the innumerable sections of *ammonites* which have been made, no traces of the mandibles have ever been discovered.

‡ *Lepas avirostris* (Schlotheim), described by Blainville as the beak of a brachiopod!

§ Called *spondylolites* by old writers.

‖ In the alum-shale of Whitby, innumerable *concretions* are found, which, when struck with the hammer, split open, and disclose an *ammonite*. See Dr. Mantell's "Thoughts on a Pebble," p. 21.

permeated by mineral water, which slowly deposits calcarious spar, in crystals, on their walls; or by acidulous water, which removès every trace of the shell, leaving a cavity, which at some future time may again become filled with spar, having the form of the shell, but not its structure. In some sections of *orthocerata*, it is evident that the mud has gained access to the air-cells, along the course of the blood-vessels; but the chambers are not entirely filled, because their lining membrane has contracted, leaving a space between itself and certain portions of the walls, which correspond in each chamber.

With respect to the purpose of the *air-chambers*, much ingenuity has been exercised in devising an explanation of their assumed *hydrostatic* function, whereby the nautilus can rise at will to the surface, or sink, on the approach of storms to the quiet recesses of the deep. Unfortunately for such poetical speculations, the nautilus appears on the surface, only *when driven up by storms*, and its sphere of action is on the *bed* of the sea, where it creeps like a snail, or perhaps lies in wait for unwary crabs and shell-fish, like some gigantic "sea-anemone," with outspread tentacles.

The tetrabranchs could undoubtedly swim, by their respiratory jets; but the discoidal nautili and ammonites are not well calculated, by their forms, for swimming; and the straight-shelled *orthocerata* and *baculites* must have held a nearly vertical position, head-downwards, on account of the buoyancy of their shells. The use of the air-chambers, is to render the whole animal (and shell) of nearly the same specific gravity with the water.* The object of the numerous partitions is not so much to sustain the pressure of the water, as to guard against the *collisions* to which the shell is exposed. They are most complicated in the *ammonites*, whose general form possesses least strength.† The purpose of the siphunele (as suggested by Mr. Searles Wood) is to maintain the *vitality* of the shell, during the long life which these animals certainly enjoyed. Mr. Forbes has suggested that the inner courses of the *hamites*, broke off, as the outer ones were formed. But this was not the case with the *orthocerata*, whose long straight shells were particularly exposed to danger; in these the preservation of the shell was provided for by the increased size and strength of the siphuncle, and its increased vascularity. In *endoceras* we find the siphuncle thickened by *internal* deposits, until (in some of the very cylindrical species) it forms an almost solid axis.

The *nucleus* of the shell is rather large in the *nautili*, and causes an

* A *nautilus pompilius* (in the cabinet of Mr. Morris) weighs 1lb., and when the siphuncle is secured, it floats with a ½lb weight in its aperture. The animal would have displaced 2 pints (= 2½lbs) of water, and therefore, if it weighed 3lbs., the specific gravity of the animal and shell would scarcely exceed that of salt water.

† The siphuncle and lobed septa did not hold the animal in its shell, as Von Buch imagined: that was secured by the shell-muscles. The complicated sutures perhaps indicate lobed ovaries; they occur in genera, which must have produced very small eggs.

opening to remain through the shell, until the *umbilicus* is filled up with a callous deposit; several fossil species have always a hole through the centre.

In the *ammonites*, the *nucleus* is exceedingly small, and the whirls compact from the first.

It has been stated that the *septa* are formed periodically; but it must not be supposed that the shell-muscles ever become detached, or that the animal moves the distance of a chamber all at once. It is most likely that the *adductors* grow only in front, and that a constant waste takes place behind, so that they are always moving onward, except when a new septum is to be formed; the *septa* indicate periodic *rests*.

The consideration of this fact, that the nautilus must so frequently have an air-cavity between it and its shell, is alone sufficient to convince us, that the chambered cephalopods could not exist in very deep water. They were probably limited to a depth of 20 or 30 fathoms at the utmost.*

It is certain that the sexes were distinct in the *tetrabranchiata*, but since only the female of the living nautilus is known, we are left to conjecture how ar the differences observable in the shells, are dependant on sex. M. D'Orbigny, having noticed that there are two varieties of almost every kind of ammonite, —one compressed, the other inflated—naturally assumed that the first were the shells of male individuals (♂), the second of females (♀). Dr. Melville has made a similar suggestion with respect to the nautili; namely, that the umbilicated specimens are the males, the imperforated shells, females. This is rendered probable by the circumstance, that all the known specimens of *N. pompilius* were female, and that the supposed male (*N. macromphalus*) is very rare, as we have noticed amongst the male *dibranchiata*. Of the other recent species, both the presumed sexes (*N. umbilicatus* ♂ and *N. stenomphalus* ♀) are comparatively rare.

FAMILY I. Nautilidæ.

Shell. *Body-chamber* capacious. *Aperture* simple. *Sutures* simple. *Siphuncle* central, or internal. (Figs. 35, 36.)

Nautilus, Breynius, 1732.

Shell involute or discoidal, few-whirled. *Siphuncle* central.

In the recent nautili, the shell is smooth, but in many fossil species it is corrugated, like the patent iron-roofing, so remarkable for its strength and lightness. (*Buckland.*) See pl. II., fig. 10.

* By *deep water*, naturalists and dredgers seldom mean more than 25 fathoms, a comparatively small depth, only found near coasts and islands. At 100 fathoms the pressure exceeds 265lbs. to the square inch. Empty bottles, securely corked, and sunk with weights beyond 100 fathoms, are always crushed, If filled with liquid, the cork is driven in, and the liquid replaced by salt water; and in drawing the bottle up again, the cork is returned to the neck of the bottle, generally in a reversed position. (*Sir F. Beaufort.*)

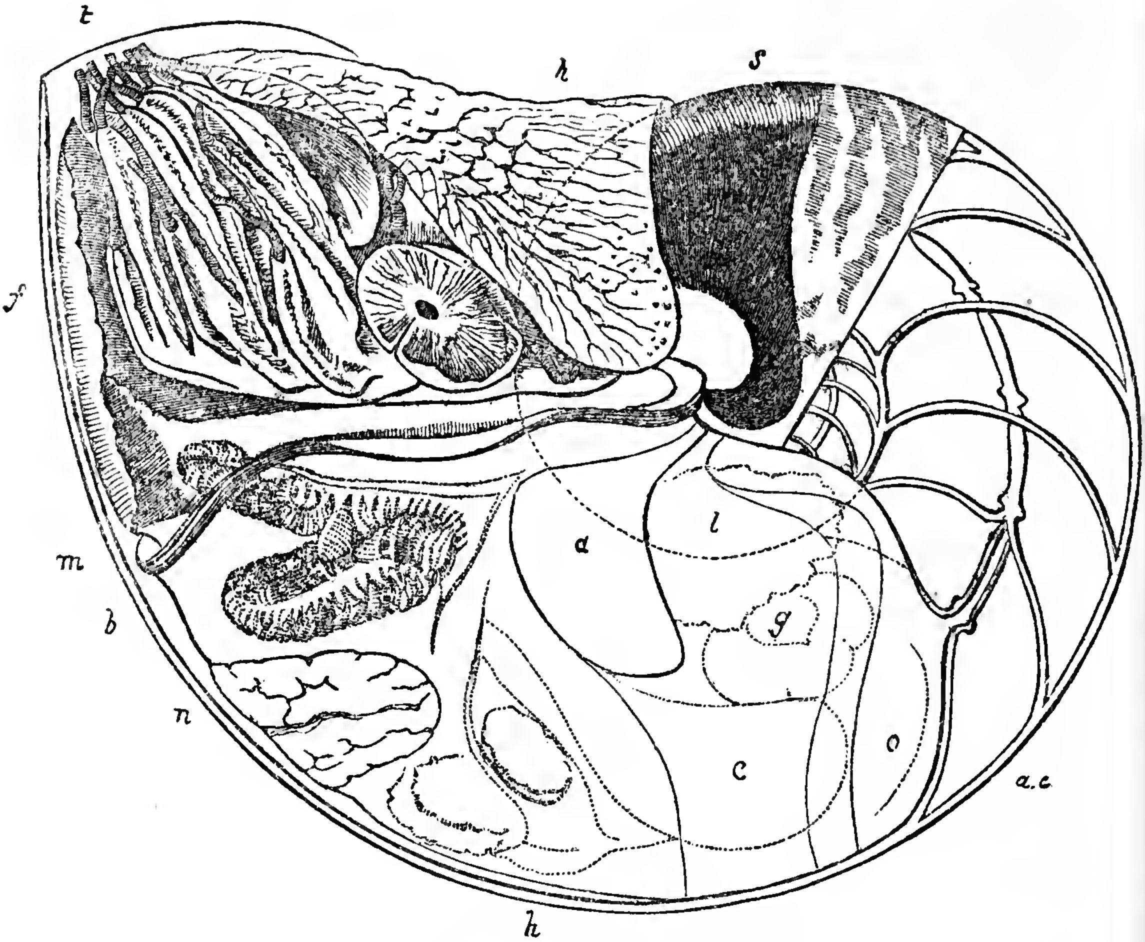


Fig. 43. *Nautilus pompilius in its shell.**

The *umbilicus* is small or obsolete in the typical nautili, and the whirls enlarge rapidly. In the palæozoic species, the whirls increase slowly, and are sometimes scarcely in contact. The last *air-cell* is frequently shallower in proportion than the rest.

Animal. In the recent nautilus, the *mandibles* are horny, but calcified to a considerable extent; they are surrounded by a circular fleshy lip, external to which are four groups of *labial tentacles*, 12 or 13 in each group, they appear to answer to the *buccal membrane* of the calamary (fig. 1). Beyond these, on each side of the head, is a double series of arms, or *brachial tentacles*, 36 in number; the dorsal pair are expanded and united to form the hood, which closes the aperture of the shell, except for a small space on each side, which is filled by the second pair of arms. The *tentacles* are lamellated

* This woodcut and 18 others illustrating the *tetrabranchiata*, are the property of Mr. Gray, to whom we are indebted for their use. Fig. 43 represents the recent nautilus, as it appears on the removal of part of the outer shell-wall (from the specimen in the British Museum). The *eye* is seen in the centre, covered by the hood (*h*); *t*, tentacles, nearly concealed in their sheaths; *f*, funnel; *m*, margin of the mantle, very much contracted; *n*, nidamental gland; *a*, *c*, air-cells and siphuncle; *s*, portion of the shell; *a*, shell-muscle. The internal organs are indicated by dotted lines; *b*, branchiæ; *h*, heart and renal glands; *c*, crop; *g*, gizzard; *l*, liver; *o*, ovary.

on their inner surface, and are retractile within sheaths, or "digitations," which correspond to the eight ordinary arms of the cuttle-fishes; their superiority in number being indicative of a lower grade of organization. Besides these there are four *ocular tentacles,* one behind and one in front of each eye; they seem to be instruments of sensation, and resemble the tentacles of *doris* and *aplysia* (*Owen*). On the side of each eye is a hollow plicated process, which is not tentaculiferous. The *respiratory funnel* is formed by the folding of a very thick muscular lobe, which is prolonged laterally on each side of the head, with its free edge directed backwards, into the branchial cavity; behind the *hood* it is directed forwards, forming a lobe which lies against the black-stained spire of the shell (fig. 43 *s*.)* Inside the funnel is a valve-like fold (fig. 44 *s*). The margin of the mantle is entire, and extends as far as the edge of the shell; its substance is firm and muscular, as far back as the line of the shell-muscles and horny girdle, beyond which it is thin and transparent. The *shell-muscles* are united by a narrow tract, across the hollow occupied by the involute spire of the shell; and are thus rendered horse-shoe shaped. The *siphuncle* is vascular; it opens into the cavity containing the heart (*pericardium*), and is most probably filled with fluid from that cavity. (*Owen.*)

Respecting the habits of the nautilus, very little is known, the specimen dissected by Professor Owen had it crop filled with fragments of a small crab, and its mandibles seem well adapted for breaking shells. The statement that it visits the surface of the sea of its own accord, is at present unconfirmed by observation, although the air cells would doubtless enable the animal to rise by a very small amount of muscular exertion.

Professor Owen gives the following passage, from the old Dutch naturalist, Rumphius, who wrote in 1705, an account of the rarities of Amboina. "When the nautilus floats on the water, he puts out his head and all his tentacles, and spreads them upon the water, with the poop of the shell above water; but at the bottom he creeps in the reverse position, with his boat above him, and with his head and tentacles upon the ground, making a tolerably quick progress. He keeps himself chiefly upon the ground, creeping also sometimes into the nets of the fishermen; but after a storm, as the weather becomes calm, they are seen in troops, floating on the water, *being driven up by the agitation of the waves.* This sailing, however, is not of long continuance;

* The *funnel* is considered the homologue of the foot of the gasteropods, by Loven, a conclusion to which we cannot agree. The cephalopods ought to be compared with the *larval* gasteropods, in which the foot only serves to support an operculum;—or with the floating tribes in which the foot is obsolete, or serves only to secrete a nidamental raft (*ianthina*). However, on examining the nautilus preserved in the British Museum, and finding that the funnel was only part of a muscular collar, which extends all round the neck of the animal, we could not avoid noticing its resemblance to the siphonal lappets of *paludina*, and to that series of lappets (including the *operculigerous lobe*) which surrounds the *trochus* (fig. 87).

for having taking in all their tentacles, they upset their boat, and so return to the bottom."

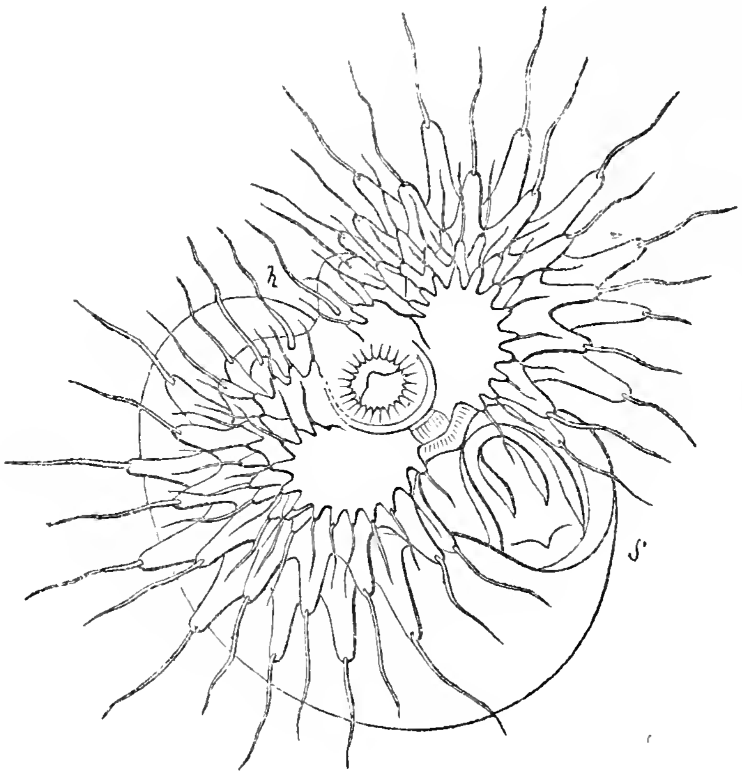


Fig. 44. *Nautilus expanded.**

Distr., 2 or 4 sp. Chinese seas, Indian ocean, Persian gulf.

Fossil, about 100 sp. In all strata, S. and N. America (Chile). Europe, India (Pondicherry).

Sub-genus. Aturia (Bronn), = Megasiphonia D'Orb.

Type, N. zic-zac Sby. Pl. II., fig. 12, London clay, Highgate.

Shell, sutures, with a deep lateral lobe; siphuncle nearly internal, large, continuous, resembling a succession of funnels.

Fossil, 4 sp. Eocene, N. America, Europe, India.

Sub-genus? Discites, McCoy. *Whirls* all exposed; the last chamber sometimes produced. L. silurian.—Carb: limestone.

Temnocheilus, McCoy. Founded on the carinated sp. of the Carb. limestone.

Cryptoceras, D'Orb. Founded on *N. dorsalis* Phil. and one other species, in which the siphuncle is nearly external.

* Ideal representation of the nautilus, when expanded, by Professor Lovén, who appears to have taken the details from M. Valenciennes memoir in the *Archives du Museum*, vol. 2, p. 257. *h*, hood. *s*, siphon. It is just possible, that when the nautilus issues from its shell, the gas contained in the last, incomplete, air-chamber, may expand; but this could not happen under any great pressure of water.

LITUITES, Breynius.

Etym., *lituus*, a trumpet.

Syn., Hortolus, Montf. (whirls separate.) Trocholites, Conrad.

Ex., L. convolvans, Schl. L. lituus, Hisinger.

Shell, discoidal; whirls close, or separate; last chamber produced in a straight line; siphuncle central.

Fossil, 15 sp. Silurian, N. America, Europe.

TROCHÓCERAS, Barrande, 1848.

Ex., T. trochoides, Bar.

Shell, nautiloid, spiral, depressed.

Fossil, 16 sp. U. Silurian, Bohemia.

Some of the species are nearly flat, and having the last chamber produced would formerly have been considered Lituites.

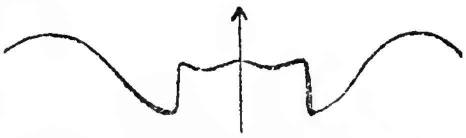


Fig. 45. *Clymenia striata, Munst.**

Fig. 46. *C. linearis, Munst.*

CLYMENIA, Munster, 1832.

Etym., clymene, a sea-nymph.

Syn. Endosiphonites, Ansted. Sub-clymenia, D'Orb.

Ex., C. striata, pl. II., fig. 16 (Mus. Tennant).

Shell, discoidal; septa simple or slightly lobed; siphuncle internal.

Fossil, 43 sp. Devonian, N. America, Europe.

FAMILY II. ORTHOCERATIDÆ.

Shell, straight, curved, or discoidal; *body chamber* small; *aperture* contracted, sometimes extremely narrow (figs. 40, 41); siphuncle complicated.

It seems probable that the cephalopods of this family were not able to withdraw themselves completely into their shells, like the pearly nautilus; this was certainly the case with some of them, as M. Barrande has stated, for the siphonal aperture is almost isolated from the cephalic opening. The shell appears to have been often less calcified, but connected with more vascular parts than in the nautilus; and the siphuncle often attains an enormous development. In all this, there is nothing to suggest a doubt of their being *tetrabranchiate;* and the chevron-shaped coloured bands preserved on the *orthoceras anguliferus*,† sufficiently prove that the shell was essentially external.

* Fig. 45. Sutures of two species of Clymenia from Phillips' Pal. Fos., Devonshire.

† Figured by D'Archiac and Verneuil, Geol. Trans.

Orthoceras, Breyn.

Etym., *orthos*, straight, and *ceras*, a horn.

Syn., cycloceras, McCoy. Gonioceras, Hall.*

Ex. O. giganteum (diagram of a longitudinal section), pl. II, fig. 14.

Shell, straight; siphuncle central; aperture sometimes contracted.

Fossil, 125 typical sp. (D'Orb).† L. Silurian—Trias; N. America, Australia, and Europe.

The *orthocerata* are the most abundant and wide spread shells of the old rocks, and attained a larger size than any other fossil shell. A fragment of *O. giganteum*, in the collection of Mr. Tate of Alnwick, is a yard long, and 1 foot in diameter, its original length must have been 6 feet. Other species, 2 feet in length, are only 1 inch in diameter, at the aperture.

Sub-genus I. *Cameroceras*, Conrad (= melia and thoracoceras, Fischer ?).

Siphuncle lateral, sometimes very large (*simple ?*).

Casts of these large siphuncles were called *hyolites* by Eichwald.

27 sp. L. Silurian—Trias ? N. America and Europe.

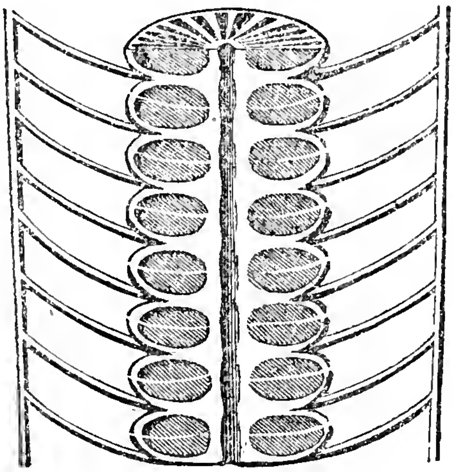


Fig. 47. *Actinoceras*.‡

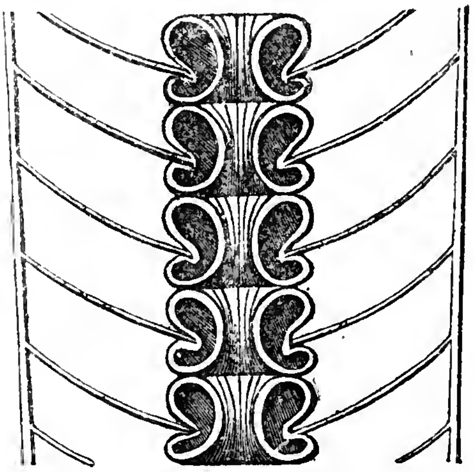


Fig. 48. *Ormoceras*.

2. *Actinoceras* (Bronn), Stokes. Siphuncle very large, inflated between the chambers, and connected with a slender central tube by radiating plates. 6 sp. L. Silurian—Carb, N. America, Baltic, and Brit.

3. *Ormoceras*, Stokes. Siphuncular beads constricted in the middle (making the septa appear as if united to the centre of each). 3 sp. L. Silurian, N. America.

4. *Huronia*, Stokes. *Shell* extremely thin, membraneous or horny ? Siphuncle very large, central, the upper part of each joint inflated, connected

* *Theca* and *Tentaculites* are provisionally placed with the *Pteropoda*, they probably belong here.

† M Barrande has discovered 100 new species in the Upper Silurian rocks of Bohemia.

‡ Fig. 47. *Actinoceras Richardsoni*, Stokes. Lake Winipeg (diagram, reduced ½). Fig. 48. *Ormoceras, Bayfieldi*, Stokes. Drummond Island, (from Mr. Stokes' paper, Geol. Trans.)

with a small central tube by radiating plates. 3 sp. L. Silurian. Drummond Island, Lake Huron.

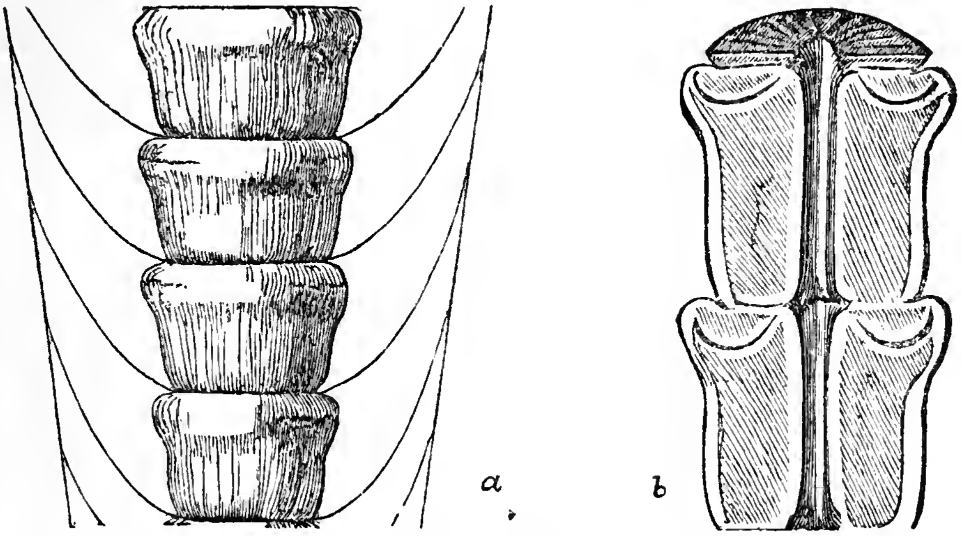


Fig. 49. *Huronia vertebralis.**

Numerous examples of this curious fossil were collected by Dr. Bigsby (in 1822), and by the officers of the regiments formerly stationed on Drummond Island. Specimens have also been brought home by the officers of many of the Artic expeditions. But with the exception of one formerly in the possession of Lieut. Gibson, 68., and another in the cabinet of Mr. Stokes, the siphuncle only is preserved, and *not a trace* remains of septa or shell wall. Some of those seen by Dr. Bigsby in the limestone cliffs, were 6 feet in length.

5. *Endoceras*, Hall (Cono-tubularia *Troost*). Shell extremely elongated, drical. Siphuncle very large, cylindrical, lateral; thickened internally by repeated layers of shell, or partitioned off by funnel-shaped diaphragms. 12 sp. Lower Silurian, New York.

6. Shell perforated by two distinct siphuncles? O. bisiphonatum Sby, Caradoc sandstone, Brit.

"Orthocerata with two siphuncles have been observed, but there has always appeared something doubtful about them. In the present instance, however, this structure cannot be questioned." (J. Sowerby.)

Small orthocerata of various species, are frequenlly found in the body chamber and open siphuncle of large specimens.† The *endoceras gemelliparum* and *proteiforme* of Hall, appear to be examples of this kind.

GOMPHOCERAS, J. Sby, 1839.

Etym., *gomphos*, a club, and *ceras*, a horn.

* Fig. 49. *Huronia vertebralis*, Stokes. *a*, from a specimen in the Brit. M., presented by Dr. Bigsby. The septa are added from Dr. Bigsby's drawing; they were only indicated in the specimen by "colourless lines on the brown limestone," *b*. represents a weathered section, presented to the Brit. Mus. by Captain Kellett and Lieutenant Wood of H.M.S. Pandora. The figures are reduced ½.

† Shells of *Bellerophon* and *Murchisonia* are found under the same circumstances.

Syn., Apioceras (Fischer). Poterioceras (McCoy).
Type, G. pyriforme, Sby., fig. 51, and G. Bohemicum, Bar. fig. 40.

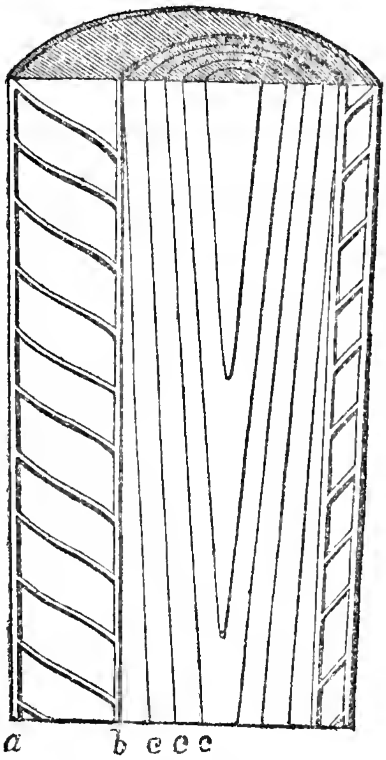


Fig. 50. *Endoceras.**

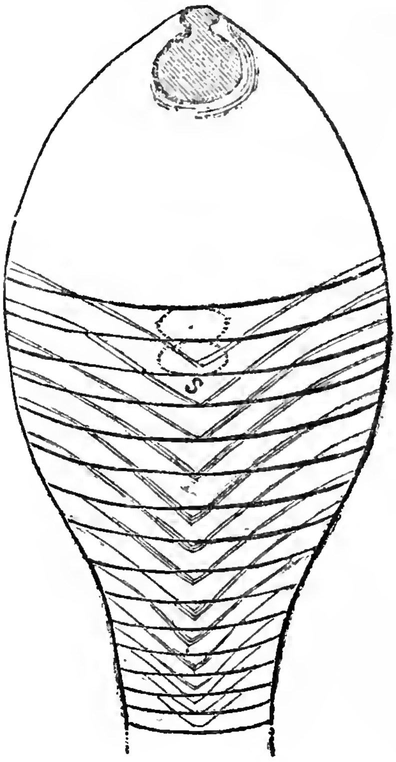


Fig. 51. *Gomphoceras.*†

Shell, fusiform or globular, with a tapering apex; aperture contracted in the middle; siphuncle moniliform, sub-central.

Distr., 10 sp. Silurian—Carb; N. America, Europe.

ONCOCERAS, Hall.

Etym., *oncos*, a protuberance.
Type, O. constrictum, Hall. Trenton limestone.
Shell, like a curved *gomphoceras*; siphuncle external.
Distr., 3 sp. Silurian, New York.

PHRAGMÓCERAS, Broderip.

Etym., *phragmos*, a partition, and *ceras*, a horn.
Type, P. ventricosum (Steininger sp.), pl. II., fig. 15.
Shell curved, laterally compressed; *aperture* contracted in the middle *siphuncle*, ventral, radiated. Ex., P. callistoma, Bar., fig. 41.
Distr., 8 sp. U. Silurian—Devonian, Brit., Germany.

* Fig. 50. Diagram of an *endoceras* (after Hall), *a*, shell-wall. *b*. Wall of siphuncle. *c c c*. Diaphragms ("embryo-tubes" of Hall).

† Fig. 51. *Gomphoceras pyriforme*. L. Ludlow rock, Mochtre hill, Herefordshire (from Murch, Silur, syst., reduced ½). *s*. Beaded siphuncle.

Cyrtóceras, Goldf. 1833.

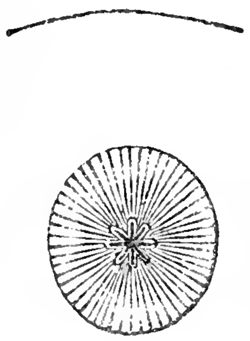
Etym., *curtos*, curved, *ceras*, horn.

Syn., Campulites, Desh. 1832 (including gyroceras). Aploceras, D'Orb. Campyloceras and trigonoceras, McCoy.

Ex., C. hybridum, volborthi and beaumonti (Barrande).

Shell, curved; *siphuncle* small, internal, or sub-central.

Distr., 36 sp. L. Silurian, Carb—N. America, and Europe.



b

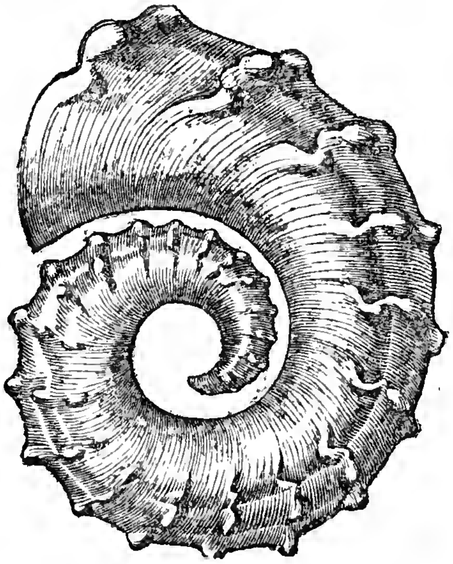


Fig. 52.*

Gyróceras, Meyer, 1829.

Etym., *gyros*, a circle, and *ceras*.

Syn., Nautiloceras, D'Orb.

Ex., G. eifeliense, D'Arch., pl. II., fig. 13. Devonian, Eifel.

Shell, nautiloid; whirls separate; siphuncle excentric, radiated.

Fossil, 17 sp. U. Silurian—Trias? N. America, and Europe.

Ascoceras, Barrande, 1848.†

Etym., *ascos*, a leather bottle.

Shell, bent upon itself, like *ptychoceras*.

Distr., 7 sp. U. Silurian, Bohemia.

FAMILY III. Ammonitidæ.

Shell. *Body-chamber* elongated; *aperture* guarded by processes, and closed by an operculum; *sutures* angulated, or lobed and foliated; *siphuncle* external (dorsal, as regards the shell).

The shell of the *ammonitidæ* has essentially the same structure with the nautilus. It consists of an external porcellanous‡ layer, formed by the *collar*

* Fig. 52. *Gyroceras goldfussii* (= ornatum Goldf). *b*. Siphuncle of *G. depressum*, Goldf. sp. Devonian. Eifel. From M.M. D'Archiac and Verneuil.

† In Haidinger's Berichte.

‡ Its microscopic structure has not been satisfactorily examined; Prof. Forbes detected a punctate structure in one species.

of the mantle only; and of an internal nacreous lining, deposited by the whole extent of its visceral surface. There is an *ammonite* in the British Museum, evidently broken and repaired during the life of the animal,* which shews that the shell was deposited *from within.* In some species of ammonites the collar of the mantle forms prominent spines on the shell, which are too deep for the visceral mantle to enter; they are therefore *partitioned off* (as in *A. armatus*, Lias) from the body whirl and air cells, and not exhibited in *casts.*

The baculites, and ammonites of the section *cristati*, acquire when adult a process projecting from the outer margin of their shell. Certain other ammonites (the *ornati*, *coronati*, &c.) form two *lateral* processes before they cease to grow (pl. III., fig. 5). As these processes are often developed in very small specimens, it has been supposed that they are formed repeatedly in the life of the animal (at each periodic rest), and are again removed when growth recommences. These small specimens, however, may be only dwarfs. In one ammonite, from the inferior oolite of Normandy, the ends of these lateral processes meet, "forming an arch over the aperture, and dividing it into two outlets, one corresponding with that above the hood of the nautilus, which gives passage to the dorsal fold of the mantle; the other with that below the hood, whence issue the tentacles, mouth, and funnel; such a modification, we may presume, could not take place before the termination of the growth of the individual."† (Owen.)

M. D'Orbigny has figured several examples of deformed *ammonites*, in which one side of the shell is scarcely developed, and the keel is consequently lateral. Such specimens probably indicate the partial atrophy of the branchiæ on one side. In the British Museum there are deformed specimens of *Am. obtusus, amaltheus, and tuberculatus.*

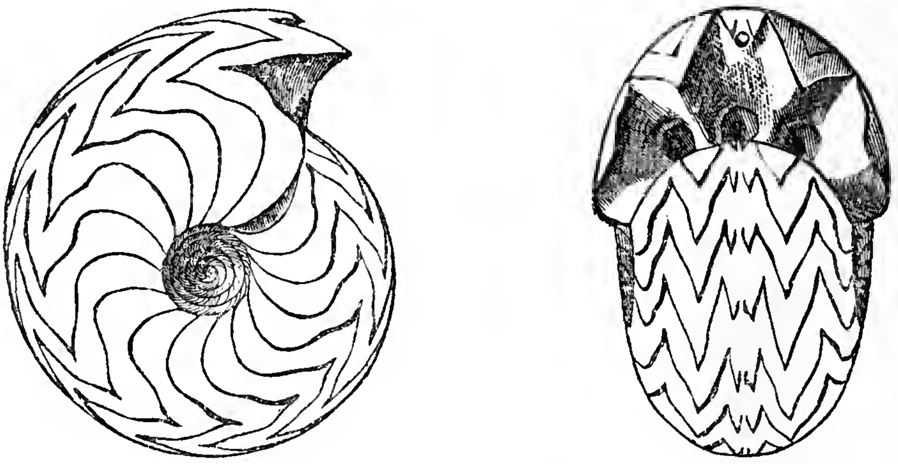


Fig. 53.‡

* *A serpentinus* Schloth, U. Lias, Wellingboro. Rev. A. W. Griesbach.

† This unique and abnormal specimen is in the cabinet of S. P. Pratt, Esq.

‡ Fig. 53. *Goniatites sphericus*, Sby. Front and side views of a specimen from the carb limestone of Derbyshire, in the cabinet of Mr. J. Tennant; the body-chamber and shell-wall have been removed artificially.

GONIATITES, De Haan.

Etym., *gonia*, angles (should be written gonialites ?).

Syn., *aganides*, Montf.

Examples, G. Henslowi, pl. III., fig. 1., G. sphericus, fig. 53, and 39.

Shell, discoidal; sutures lobed; siphuncle dorsal.

Distr. 150 sp. Devonian—Trias, Europe.

BACTRITES, Sandberger (= stenoceras, D'Orb ?).

Shell, straight; sutures lobed. *Type*, B. subconicus, Sbger.

Distr., 2 sp. Devonian—Germany.

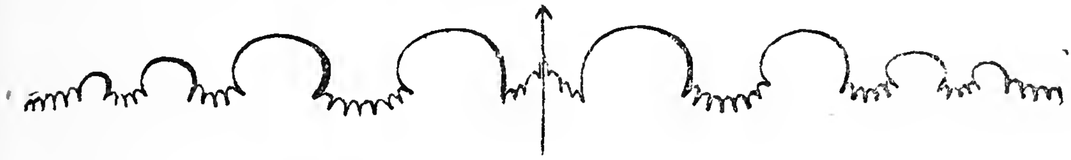


Fig. 54.*

CERATITES, De Haan.

Type, C. nodosus, pl. III., fig. 2.

Shell, discoidal; sutures lobed, the lobes crenulated. Fig. 54.

Distr., muschelkalk, 8 sp. Germany, France, Russia, Siberia.

Salt-marls (Keuper). 17 sp. S. Cassian, Tyrol.

M. D'Orbigny describes 5 shells from the gault and U. greensand as *ceratites;* but many ammonites have equally simple sutures, when young.

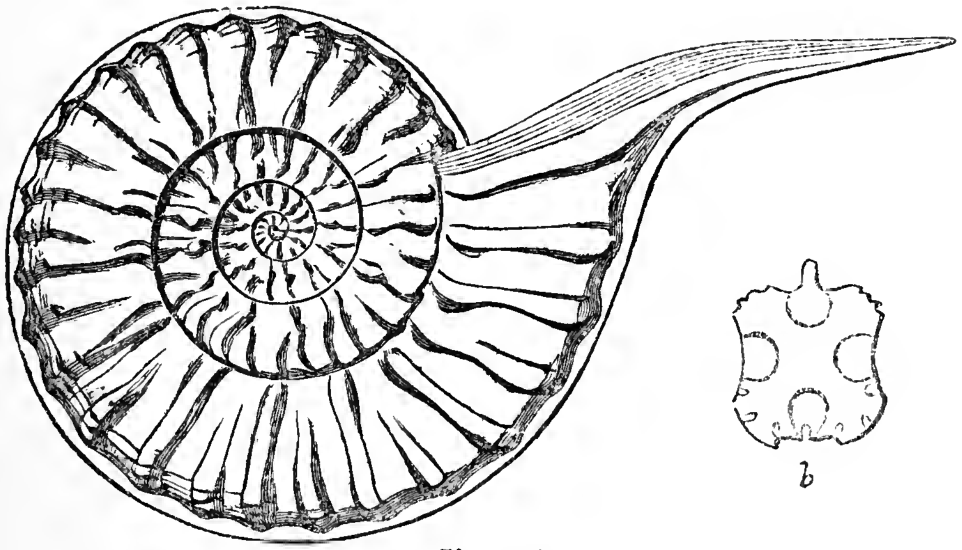


Fig. 55.†

AMMONITES, Bruguiere.

Etym., *ammon*, a name of Jupiter, worshipped in Libya under the form of a ram. The ammonite is the *cornu ammonis* of old authors.

* Fig. 54. Suture of *ceratites nodosus* (Brug). The arrow in the dorsal lobe points towards the aperture.

† Fig. 55. *Ammonites rostratus*, Sby. From the U. green-sand of Devizes, in the cabinet of W. Cunnington, Esq. *b*, front view of one of its partitions.

Syn., orbulites Lam. planulites, Montf.

Shell, discoidal; inner whirls more or less concealed; septa undulated; sutures lobed and foliated; siphuncle dorsal.

Distr., 530 sp. Trias—chalk. Coast of Chili (D'Orb.) Santa Fe de Bogota (Hopkins), New Jersey, Europe, and S. India.

Capt. Alexander Gerard discovered ammonites similar to our L. oolitic species, in the high passes of the Himalaya, 16,200 feet above the sea.

Section A. *Back, with an entire keel.*

1. *Arietes,*	L. oolites,	A. bifrons (pl. III., fig. 6), bisulcatus (pl. III., fig. 7).
2. *Falciferi,*	L. oolites,	A. serpentinus, radians, hecticus.
3. *Cristati,*	cretaceous,	A. cristatus, rostratus (fig. 55), varians.

B. *Back crenated.*

4. *Amalthei,*	ool.	A. amaltheus, cordatus, excavatus.
5. *Rhothomagenses,*	cret.	A. rhothomagensis (pl. III., fig. 4).

C. *Back sharp.*

6. *Disci.,*	oolitic,	A. discus, clypeiformis.

D. *Back channelled.*

7. *Dentati,*	cret.	A. dentatus, lautus.
	ool.	A. Parkinsoni, anguliferus.

E. *Back squared.*

8. *Armati,*	L. ool.	A. armatus, athletus, perarmatus.
9. *Capricorni,*	L. ool.	A. capricornus, planicostatus.
10. *Ornati,*	ool.	A. Duncani, Jason (pl. III., fig. 5).

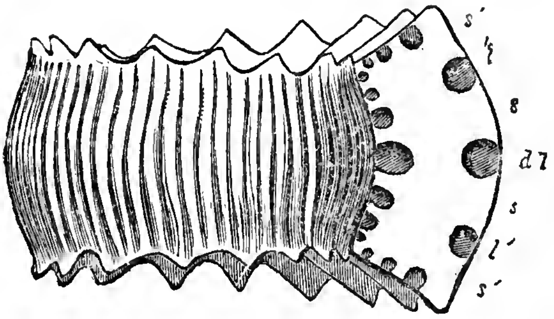


Fig. 56. *Ammonites coronatus.**

F. *Back round, convex.*

11. *Heterophylli,*	L. ool.	A. heterophyllus (fig. 34).
12. *Ligati,*	cret.	A. planulatus (pl. III., fig. 3).
13. *Annulati,*	ool.	A. annulatus, biplex, giganteus.
14. *Coronati,*	ool.	A. coronatus (fig. 56), sublævis.
15. *Fimbriati,*	ool.	A. fimbriatus, lineatus, hircinus.

* Fig. 56. Profile of ammonites coronatus, Brug. (reduced ½ from D'Orbigny) Kelloway rock, France. *d l*, dorsal lobe; *s s*, dorsal saddles; *l' l'*, lateral lobes; *s' s'*, lateral saddles; accessory and ventral lobes. The number of accessory lobes increases with age.

16. *Cassiani*, 36 sp. of very variable form, and remarkable for the number and complexity of their lobes. Trias, Austrian Alps.

Fig. 57.*

Ex., A. Maximiliani (fig. 57), A. Metternichii.

CRIOCERAS, Leveille.

Etym., *krios*, a ram, and *ceras*, a horn.

Syn., tropæum, Sby.

Ex., C. cristatum, D'Orb. (pl. III., fig. 8).

Shell, discoidal; whirls separate.

Distr., 9 sp. Neocomian—Gault; Brit., France.

TOXOCERAS, D'Orb.

Etym., *toxon*, a bow, *ceras*, a horn.

Ex., T. annulare, D'Orb. (pl. III., fig. 12.)

Shell, bow-shaped; like an ammonite uncoiled.

Distr., 19 sp. Neocomian. Between this and *crioceras* and *ancyloceras* there are numerous intermediate forms.

ANCYLOCERAS, D'Orb.

Etym., *anculos*, incurved.

Ex., A. spinigerum (pl. III., fig. 10).

Shell, at first discoidal, with separate whirls; afterwards produced at a tangent and bent back again, like a hook or crosier.

Distr., 38 sp. Inf. oolite—chalk. S. America (Chile and Bogota), Europe.

SCAPHITES, Parkinson.

Etym., *scaphe*, a boat.

Ex., S. equalis (pl. III., fig. 9).

Shell, at first discoidal, with close whirls; last chamber detached and recurved.

Distr., 17 sp. Neocomian—chalk. Europe.

HELICOCERAS, D'Orb.

Etym., *helix* (*helicos*), a spiral, and *ceras*, horn.

Ex., H. rotundum, Sby, sp. pl. III., fig. 11 (diagram).

* Fig. 57. Am. Maximiliani Klipstein. (= A. bicarinatus Münst). Trias, Hallstadt (copied from Quenstedt). A, Profile shewing the numerous lobes and saddles. B, suture of one side; *v*, dorsal saddle.

Shell, spiral, sinistral; whirls separate.

Distr., 11 sp. Inf. oolite?—chalk. Europe.

TURRILITES, Lam.

Etym., turris, a tower, and *lithos,* a stone.

Shell, spiral, sinistral; aperture often irregular.

Distr., 27 sp. (Bronn). Gault—chalk. Europe.

The turrilite was perhaps *di-branchiate,* by the atrophy of the respiratory organs of one side. M. D'Orbigny includes in this genus particular specimens of certain *Lias ammonites* which are very slightly unsymmetrical; the same species occur with both sides alike. He also makes a genus (*heteroceras*) of two turrilites, in which the last chamber is somewhat produced and recurved. *T. reflexus* (Quenstedt, T. 20, fig. 16) has its apex inflected and concealed.

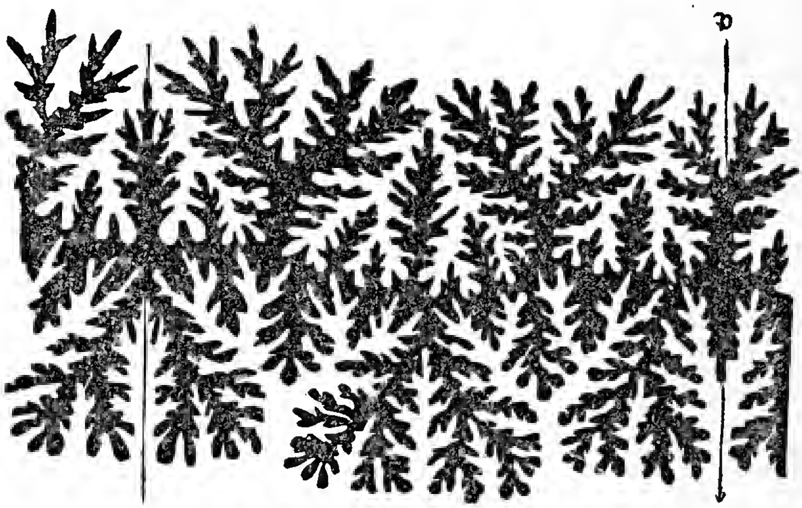


Fig. 58. *Sutures of hamites cylindraceus, Defr.**

HAMITES, Parkinson.

Etym., hamus, a hook.

Ex., H. attenuatus, pl. III., fig. 15.

Shell, hook-shaped, or bent upon itself more than once, the courses separate.

Distr., 58 sp. Neocomian—chalk. S. America (Tierra del Fuego)—Europe.

The inner courses of this shell probably break away or are "decollated" in the progress of its growth (Forbes). M. D'Orbigny has proposed a new genus, *hamulina,* for the 20 neocomian species.

PTYCHOCERAS, D'Orb.

Etym., ptyche, a fold.

Ex., P. emericianum, D'Orb., pl. III., fig. 14.

* Fig. 58. Space between two consecutive sutures of the right side, from a specimen in the Brit. Mus. *a.* dorsal line. *b.* ventral. Baculite limestone, Fresville.

Shell, bent once upon itself; the two straight portions in contact.
Distr., 7 sp. Neocomian—chalk. Brit. France.

BACULITES, Lamarck.

Etym., *baculus*, a staff.
Ex., B. anceps. Pl. III., fig. 13.
Shell, straight, elongated; aperture guarded by a dorsal process.
Distr., 11 sp. Neocomian—chalk. Europe, S. America (Chile).

Baculina, D'Orb. B. Rouyana. Neoc., France. Sutures not foliated.

The chalk of Normandy has received the name of *baculite limestone*, from the abundance of this fossil.

CLASS II. GASTEROPODA.

The gasteropods, including land-snails, sea-snails, whelks, limpets, and the like, are the types of the *mollusca;* that is to say, they present all the leading features of molluscous organization in the most prominent degree, and make less approach to the appearance and condition of fishes than the cephalopods, and less to the crustaceans and zoophytes than the bivalves.

Their ordinary and characteristic mode of locomotion is exemplified by the common garden-snail, which creeps by the successive expansion and contraction of its broad muscular foot. These muscular movements may be seen following each other in rapid waves when a snail is climbing a pane of glass.

The *nucleobranches* are "aberrant" gasteropods, having the foot thin and vertical; they swim near the surface of the sea, in a reversed position, or adhere to floating sea-weed.

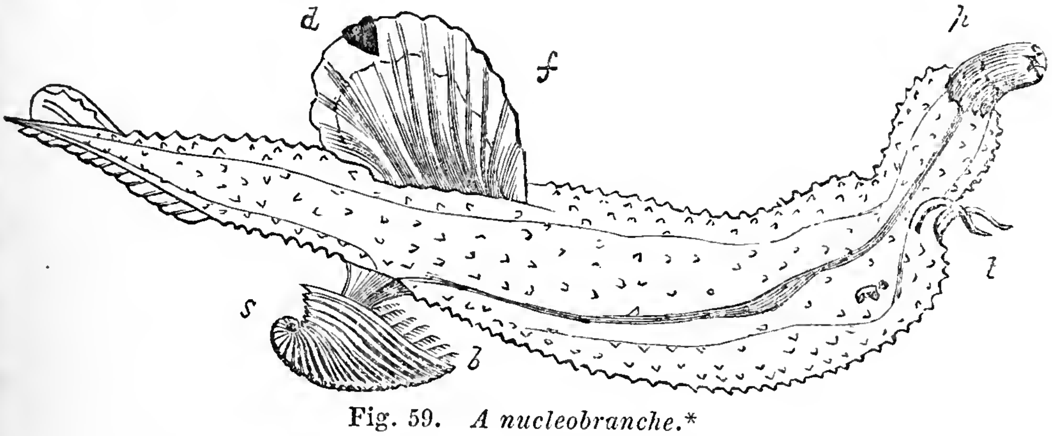


Fig. 59. *A nucleobranche.**

The gasteropods are nearly all unsymmetrical, the body being coiled up spirally, and the respiratory organs of the left side being usually atrophied. In *chiton* and *dentalium* the *branchiæ* and reproductive organs are repeated on each side.

* Fig. 59. *Carinaria cymbium*, L. sp. (after Blainville), Mediterranean; *p*, proboscis; *t*, tentacles; *b*, branchiæ; *s*, shell; *f*, foot; *d*, disk.

A few species of *cymba, litorina, paludina,* and *helix,* are viviparous; the rest are oviparous.

When first hatched the young are always provided with a shell, though in many families it becomes concealed by a fold of the mantle, or it is speedily and wholly lost.*

The gasteropods form two natural groups; one breathing air (*pulmonifera*), the other water (*branchifera*). The air-breathers undergo no apparent metamorphosis; when born, they differ from their parents in size only. The water-breathers have at first a small nautiloid shell, capable of concealing them entirely, and closed by an operculum. Instead of creeping, they swim with a pair of ciliated fins springing from the sides of the head; and by this means are often more widely dispersed than we should be led to expect from their adult habits; thus some sedentary species of *calyptræa* and *chiton* have a greater range than the "paper-sailor," or the ever-drifting oceanic-snail.

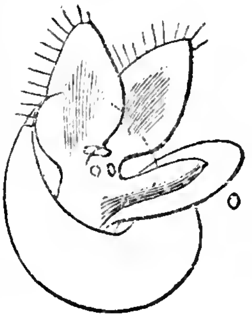


Fig. 60.†

At this stage, which may fairly be compared with the larval condition of insects, there is scarcely any difference between the young of *eolis* and *aplysia,* or *buccinum* and *vermetus.* (M. Edw.)

The development of the branchiferous gasteropods may be observed with much facility in the common river-snails (*paludina*); which are viviparous, and whose oviducts in early summer contain young in all stages of growth; some being a quarter of an inch in diameter.

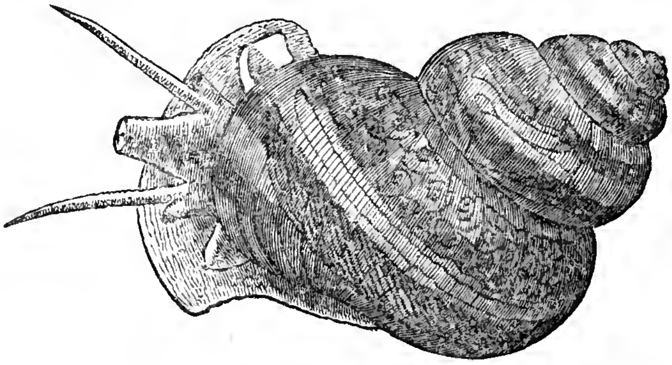


Fig. 61. *Paludina vivipara.*‡

Embryos scarcely visible to the naked eye have a well-formed shell, ornamented with epidermal fringes; a foot and operculum; and the head has long delicate tentacula, and very distinct black eyes.

* M. Lovén believes that the embryo shell of the nudibranches falls off at the time they acquire a locomotive foot.

† Fig. 60. Fry of Eolis (from Alder and Hancock); *o*, the operculum; the original is not larger than the letter o.

‡ Fig. 61. *Paludina vivipara L.* (original); the internal organs are represented as if seen through the shell. The ovary, distended with eggs and embryos, occupies the right side of the body whirl; the gill is seen on the left; and between them the termination of the alimentary canal. Surrey Docks, June, 1850.

The development of the pulmoniferous embryo is best seen in the transparent eggs of the fresh-water limneïds; these are not hatched until the young have passed the larval condition, and their ciliated head-lobes (or veil), are superseded by the creeping disk, or foot.

The *shell* of the gasteropods is usually *spiral*, and univalve; more rarely *tubular*, or *conical*, and in one genus it is *multivalve*. The following are its principal modifications:

A. Regularly spiral,
  a. elongated or turreted; *terebra, turritella.*
  b. cylindrical; *megaspira, pupa.*
  c. short; *buccinum.*
  d. globular; *natica, helix.*
  e. depressed; *solarium.*
  f. discoidal; *planorbis.*
  g. convolute; aperture as long as the shell; *cypræa, bulla.*
  h. fusiform; tapering to each end, like *fusus.*
  i. trochi-form; conical, with a flat base, like *trochus.*
  k. turbinated; conical, with a round base, like *turbo.*
  l. few-whirled; *helix hæmastoma.* Pl. XII., fig. 1.
  m. many-whirled; *helix polygyrata.* Pl. XII., fig. 2.
  n. ear-shaped; *haliotis.*
B. Irregularly spiral; *siliquaria, vermetus.*
C. Tubular; *dentalium.*
D. Shield-shaped; *umbrella, parmophorus.*
E. Boat-shaped; *navicella.*
F. Conical or limpet-shaped; *patella.*
G. Multivalve and imbricated; *chiton.*

The only symmetrical shells are those of *carinaria, atlanta, dentalium*, and the limpets.*

Nearly all the spiral shells are *dextral*, or right-handed; a few are constantly *sinistral*, like *clausilia;* reversed varieties of many shells, both dextral and sinistral, have been met with.

The cavity of the shell is a single conical or spiral chamber; no gasteropod has a multilocular shell like the nautilus, but spurious chambers are formed by particular species, such as *triton corrugatus* (fig. 62), and *euomphalus pentangulatus;* or under special circumstances, as when the upper part of the spire is destroyed.

Some spiral shells are complete tubes, with the whirls separate, or scarcely

* The curve of the spiral shells and their opercula, and also of the Nautilus, is *a logarithmic spiral;* so that to each particular species may be annexed a number, indicating the ratio of the geometrical progression of the dimensions of its whirls. Rev. H. Moseley, "On geometrical forms of turbinated and discoid shells." *Phil. Trans. Lond.* 1838. *Pt.* 2, *p.* 351.

in contact, as *scalaria, cyclostoma,* and *valvata;* but more commonly the inner side of the spiral tube is formed by the pre-existing whirls (fig. 62).

The axis of the shell, around which the whirls are coiled, is sometimes open or hollow; in which case the shell is said to be perforated, or *umbilicated* (e. g. *solarium*). The perforation may be a mere chink, or fissure (*riam*), as in *lacuna;* or it may be filled up by a shelly deposit, as in many *naticas.* In other shells, like the *triton,* the whirls are closely coiled, leaving only a pillar of shell, or *columella,* in the centre; such shells are said to be *imperforate.*

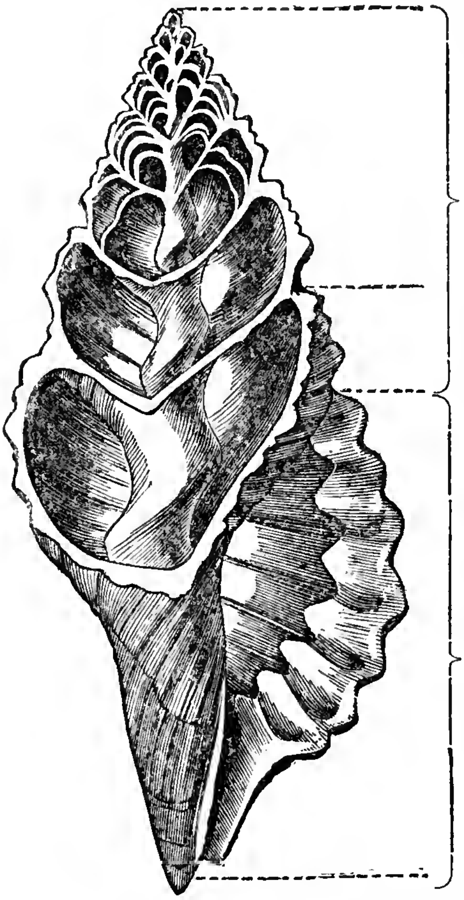


Fig. 62. *Section of a spiral univalve.**

The *apex* of the shell presents important characters, as it was the *nucleus* or part formed in the egg; it is sinistral in the *pyramidellidæ,* oblique and spiral in the *nucleobranches* and *emarginulæ,* and mammillated in *turbinella pyrum* and *fusus antiquus.*

The apex is directed backwards in all except some of the *patellidæ,* in which it is turned forwards, over the animal's head. In the adult condition of some shells the apex is always truncated (or *decollated*), as in *cylindrella* and *bulimus decollatus;* in others it is only truncated when the animals have lived

* Fig. 62. Longitudinal section of *triton corrugatus,* Lam., from a specimen in the cabinet of Mr. Gray. The upper part of the spire has been partitioned off many times successively.

in acidulous waters (e. g. *cerithidea* and *pirena*), and specimens may be obtained from more favorable situations with the points perfect.

The line or channel formed by the junction of the whirls is termed the *suture.*

The last turn of the shell, or *body-whirl,* is usually very capacious; in the females of some species the whirls enlarge more rapidly than in the males (e. g. *buccinum undatum*). The "base" of the shell is the opposite end to the apex, and is usually the front of the aperture.

The *aperture is entire* in most of the vegetable feeders (*holostomata*), but notched or produced into a *canal,* in the carnivorous families (*siphonostomata*); this canal, or siphon, is respiratory in its office, and does not necessarily indicate the nature of the food. Sometimes there is a posterior channel or canal, which is excurrent, or anal, in its function (e. g. *strombidæ* and *ovulum volva*); it is represented by the slit in *scissurella,* the tube of *typhis,* the perforation in *fissurella,* and the series of holes in *haliotis.*

The margin of the aperture is termed the *peristome;* sometimes it is continuous (*cyclostoma*), or becomes continuous in the adult (*carocolla*); very frequently it is "interrupted," the left side of the aperture being formed only by the body-whirl. The right side of the aperture is formed by the outer lip (*labrum*), the left side by the inner or columellar lip (*labium*), or partly by the body-whirl (termed the "wall of the aperture" by Pfeiffer).

The outer lip is usually thin and sharp in immature shells, and in some adults (e. g. *helicella* and *bulimulus*); but more frequently it is thickened; or reflected; or curled inwards (*inflected*), as in *cypræa;* or expanded as in pteroceras; or fringed with spines as in *murex.* When these fringes or expansions of the outer lip are formed periodically they are termed *varices.*

Lines of colour, or sculpture, running from the apex to the aperture are spiral or longitudinal, and others which coincide with the lines of growth are "transverse," as regards the whirls; but stripes of colour extending from the apex across the whirls are often described as "longitudinal" or "radiating," with respect to the entire shell.

Shells which are always concealed by the mantle are colourless, like *limax* and *parmophorus;* and those which are covered by the mantle-lobes when the animal expands, acquire a glazed or enamelled surface, like the cowries; when the shell is deeply immersed in the foot of the animal it becomes partly glazed, as in *cymba.* In all other shells there is an epidermis, although it is sometimes very thin and transparent.

In the interior of the shell the muscular impression is horse-shoe shaped, or divided into two scars; the horns of the crescent are turned towards the head of the animal.

The *operculum* with which many of the gasteropods close the aperture of their shell, presents modifications of structure which are so characteristic of the sub-genera, as to be worthy of particular notice. It consists of a horny layer, sometimes strengthened by the addition of calcarious matter on its exterior, and in its mode of growth it presents some resemblance to the shell itself. Its inner surface is marked by a muscular scar, whose lines bear no relation to the external lines of growth, and its form is unlike the muscular scar in the shell. It is developed in the embyro, within the egg, and the point from which it commences is termed the nucleus; many of the spiral and concentric forms fit the aperture of the shell with accuracy, the others only close the entrance partially, and in many genera, especially those with large apertures (e. g. *dolium, cassidaria, harpa, navicella*), it is quite rudimentary or obsolete.

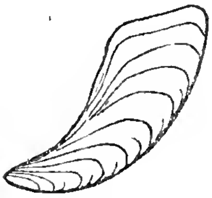


Fig. 63.

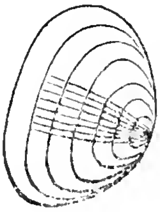


Fig. 64.

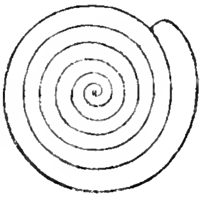


Fig. 65.

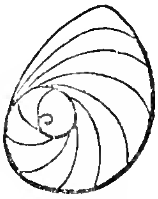


Fig. 66.

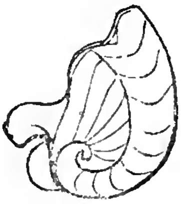


Fig. 67.

The operculum is described as—

Concentric, when it increases equally all round, and the nucleus is central or sub-central, as in *paludina* and *ampullaria* (pl. IX., fig. 26).

Imbricated or lamellar (fig. 64), when it grows only on one side, and the nucleus is marginal, as in *purpura, phorus,* and *paludomus.*

Claw-shaped, or unguiculate, (fig. 63, with the nucleus apical or in front), as in *turbinellus* and *fusus;* it is claw-shaped and serrated in *strombus* (fig. 69).

Spiral, when it grows only on one edge, and revolves as it grows; it is always *sinistral* in dextral shells.

Paucispiral, or few-whirled (fig. 66), as in *litorina.*

Sub-spiral, or scarcely spiral, in *melania.* Pl. VIII., fig. 25*.

Multispiral or many-whirled (fig. 65) as in *trochus,* where they sometimes amount to 20; the number of turns which the operculum makes is not determined by the number of whirls in the shell, but by the curvature of the opening, and the necessity that the operculum should revolve fast enough to fit it constantly (*Moseley*).

It is said to be *articulated* when it has a projection, as in nerita (fig. 67).

Too much importance, however, must not be attached to this very variable plate, as an aid to classification; it is present in some species of *voluta, oliva, conus, mitra,* and *cancellaria,* but absent in others; it is (indifferently) horny or shelly in the species of *ampullaria* and *natica;* in *paludina* it is concentric, in *paludomus lamellar,* in *valvata* spiral; in *solarium* and *cerithium,* it is *multispiral* or *paucispiral.*

Some of the gasteropoda can suspend themselves by glutinous threads, like *litiopa* and *rissoa parva*, which anchor themselves to sea-weeds (Gray), and *cerithidea* (fig. 68), which frequently leaves its proper element, and is found hanging in the air (Adams). A West India land-snail (*cyclostoma suspensum*) also suspends itself (Guilding). The origin of these threads has not been explained; but some of the *limaces* lower themselves to the ground by a thread which is not secreted by any particular gland, but derived from the exudation over the general surface of the body (Lister; D'Orbigny).

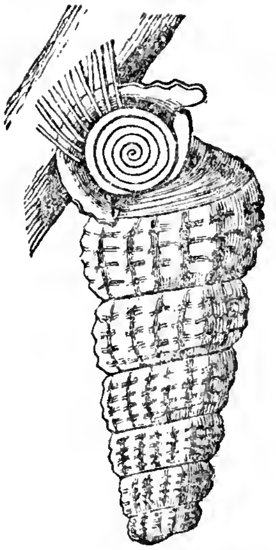


Fig. 68.

The division of this extensive class into orders and families, has engaged the attention of many naturalists, and a variety of methods have been proposed. Cuvier's classification was the first that possessed much merit, and several of his orders have since been united with advantage.

System of Cuvier.	System now adopted.
Class. GASTEROPODA.	
Order 1. Pectinibranchiata	Ord. *Prosobranchiata*, M. Edw.
2. Scutibranchiata	
3. Cyclobranchiata	
4. Tubulibranchiata	
5. Pulmonata	Ord. *Pulmonifera.*
6. Tectibranchiata	Ord. *Opisthobranchiata*, M. Edw.
7. Inferobranchiata	
8. Nudibranchiata	
Class. HETEROPODA.	Ord. *Nucleobranchiata*. Bl.

ORDER I. PRÓSOBRANCHIÁTA.

Abdomen well developed, and protected by a shell, into which the whole animal can usually retire. *Mantle* forming a vaulted chamber over the back of the head, in which are placed the excretory orifices, and in which the branchiæ are almost always lodged. *Branchiæ* pectinated, or plume-like, situated (*proson*) in advance of the heart. *Sexes* distinct. (M. Edwards.)

SECTION A. SIPHONOSTÓMATA. Carnivorous Gasteropods.

Shell spiral, usually imperforate; aperture notched or produced into a canal in front. *Operculum* horny, lamellar.

Animal provided with a retractile proboscis; eye-pedicels connate with the tentacles; margin of the mantle prolonged into a siphon, by which water is conveyed into the branchial chamber; gills 1 or 2, comb-like, placed obliquely over the back. Species all marine.

FAMILY I. Strómbidæ. Wing-shells.

Shell with an expanded lip, deeply notched near the canal. *Operculum* claw-shaped, serrated on the outer edge.

Animal furnished with large eyes, placed on thick pedicels; tentacles slender, rising from the middle of the eye-pedicels. Foot narrow, ill adapted for creeping. Lingual teeth single; uncini, three on each side.

The strombs are carrion feeders, and, for molluscous animals, very active; they progress by a sort of leaping movement, turning their heavy shell from side to side. Their eyes are more perfect than those of the other gasteropods, or of many fishes.

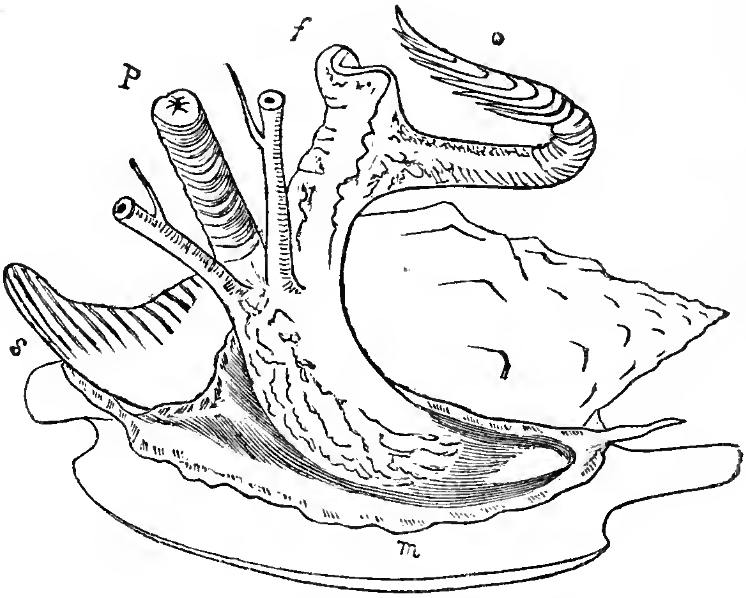


Fig. 69.*

Strombus, L. Stromb.

Etym., *strombos*, a top.

Type, S. pugilis. Pl. IV., fig. 1.

Shell rather ventricose, tubercular or spiny; spire short; aperture long, with a short canal above, and truncated below; outer lip expanded, lobed above, and sinuated near the notch of the anterior canal. Lingual teeth (*S. floridus*) 7 cusped; uncini, 1 tri-dentate, 2, 3 claw-shaped, simple.†

Distr., 60 species. West Indies, Mediterranean, Red Sea, India, Mau-

* Fig. 69. Strombus auris-Dianæ, L. (after Quoy and Gaimard), Amboina. *p*, proboscis, between the eye-pedicels; *f*, foot, folded up; *o*, operculum; *m*, border of the mantle; *s*, respiratory siphon.

† The lingual dentition of *strombus* resembles that of aporrhais, and is unlike that of the whelks; but it is more probable that aporrhais is the *representative* of strombus, than that it is very closely allied.

ritius, China, New Zealand, Pacific, West America. On reefs, at low water, and ranging to 10 fathoms.

Fossil, 5 cretaceous species ; 3 sp. Miocene—. South Europe. There is a group of small shells in the eocene tertiary strata of England and France, nearly related to the living *S. fissurellus* L., some of which have been placed with *rostellaria,* because the notch in the outer lip is small, or obsolete. They probably constitute a sub-genus, to which Swainson's name *strombidia,* might be applied. *Example,* S. Bartonensis. Pl. IV., fig. 2.

The fountain-shell of the West Indies, *S. gigas,* L., is one of the largest living shells, weighing sometimes four or five pounds; its apex and spines are filled up with solid shell as it becomes old. Immense quantities are annually imported from the Bahamas for the manufacture of cameos, and for the porcelain works; 300,000 were brought to Liverpool alone in the last year, 1850 (Mr. Archer).

PTERÓCERAS, Lam. Scorpion-shell.

Etym., pteron, a wing, and *ceras,* a horn.

Type, P. lambis. Pl. IV., fig. 3.

Shell like strombus when young; outer lip, of the adult, produced into several long claws, one of them close to the spire, and forming a posterior canal.

Distr., 10 sp. India, China.

Fossil, nearly 100 sp. are enumerated by D'Orbigny, ranging from the lias to the upper chalk; many of them are more nearly related to aporrhaïs (*cerithiadæ*).

ROSTELLARIA, Lam.

Etym., rostellum, a little beak.

Syn., fusus, Humphreys.

Example, R. curta. Pl. IV., fig. 4.

Shell with an elongated spire; whirls numerous, flat; canals long, the posterior one running up the spire; outer lip more or less expanded, with only one sinus, and that close to the beak.

Distr., 5 sp. Red Sea, India, Borneo, China. *Range,* 30 fathoms.

Fossil, 70 sp. Neocomian — chalk (=aporrhaïs ?). 6 sp. Eocene—. Britain, France, &c.

The older tertiary species have the outer lip enormously expanded, and smooth-edged; they constitute the section *hippochrenes* of Montfort (e. g. Rost. ampla, Solander. London clay).

Sub-genus? Spinigera, D'Orb. 1847. Shell like *rostellaria;* whirls keeled; keel developed into a slender spine on the outer lip, and two on each whirl, forming lateral fringes, as in *ranella.* Fossil, 5 sp. Inf. oolite—chalk. Britain, France.

SERAPHS, Montfort. (Terebellum, Lam.)

Etym., diminutive of *terebra*, an auger.

Type, S. terebellum (Linnæus sp.)=T. subulatum, Lam. Pl. IV., fig. 5.

Shell smooth, sub-cylindrical; spire short or none; aperture long and narrow, truncated below; outer lip thin.

Distr., 1 sp. China. Philippines, 8 fms. (Cuming.)

Fossil, 5 sp. Eocene—. London, Paris.

The animal of *terebellum* has an operculum like *strombus*; its eye-pedicels are simple, without tentacles (Adams). In one fossil species, *T. fusiforme*, there is a short posterior canal, as in *rostellaria*.

FAMILY II. MURICIDÆ.

Shell with a straight anterior canal; aperture entire behind.

Animal with a broad foot; eyes sessile on the tentacles, or at their base; branchial plumes 2. *Lingual ribbon* long, linear; *rachis* armed with a single series of dentated teeth; *uncini*, single. Predatory, on other *mollusca*.

MUREX (Pliny) L.

Types, M. palma-rosæ, Pl. IV., fig. 10. M. tenuispina, Pl. IV., fig. 9. M. haustellum, Pl. IV., fig. 8. M. radix, pinnatus.

Shell ornamented with three or more continuous longitudinal varices; aperture rounded; beak often very long; canal partly closed; *operculum* concentric, nucleus sub-apical (Pl. IV., fig. 10); lingual dentition (M. erinaceus), teeth single, 3 crested; uncini single, curved.

Distr., 180 sp. World-wide; most abundant on the W. coast of tropical America, in the Chinese Sea, West coast of Africa, West Indies; ranging from low water to 25 fathoms, rarely at 60 fathoms.

Fossil, 160 sp. Eocene—. Britain, France, &c.

A few of the species usually referred to this genus, belong to *pisania* and *trophon*.

The murices appear to form only one-third of a whirl annually, ending in a *varix;* some species form intermediate varices of less extent. *M. erinaceus* a very abundant species on the coasts of the channel, is called "sting-winkle" by fishermen, who say it makes round holes in the other shell-fish with its beak. See p. 27. The ancients obtained their purple dye from species of *murex;* the small shells were bruised in mortars, the animals of the larger ones taken out. (F. Col.) Heaps of broken shells of the *M. trunculus* and caldron-shaped holes in the rocks may still be seen on the Tyrian shore. (Wilde.) On the coast of the Morea, there is similar evidence of the employment of *M. brandaris* for the same purpose. (M. Boblaye.)

TYPHIS, Montfort.

Etym., *typhos*, smoke.

Type, T. pungens. Pl. IV.. fig. 11.

Shell like murex; but having tubular spines between the varices, of which the last is open, and occupied by the excurrent canal.

Distr., 8 sp. Medit., W. Africa, Cape, India, W. America. —50 fms.

Fossil, 8 sp. Eocene—. London, Paris.

Pisania, Bivon, 1832.

Etym., a native of (the coast near) *Pisa*, in Tuscany.

Syn., Pollia, Enzina, and Euthria (Gray).

Types, P. maculosa. Pl. IV., fig. 14 (Enzina) zonata. Pl. IV., fig. 15.

Shell with numerous indistinct varices, or smooth and spirally striated; canal short; inner lip wrinkled; outer lip crenulated.

Operculum ovate, acute; nucleus apical.

The *pisaniæ* have been usually confounded with *buccinum*, *murex*, and *ricinula*.

Distr., about 120 sp. W. Indies, Africa, India, Philippines, S. Seas, W America.

Fossil, ? sp. Eocene—. Brit., France, &c.

Ranella, Lam. Frog-shell.

Syn., Apollon, Montfort and Gray.

Types, R. granifera. Pl. IV., fig. 12. R. spinosa.

Shell with two rows of continuous varices, one on each side.

Operculum ovate, nucleus lateral.

Distr., 50 sp. Medit., Cape, India, China, Australia, Pacific, W. America. *Range*, low-water to 20 fms.

Fossil, 23 sp. Eocene—.

Triton. Lam.

Etym. *Triton*, a sea-deity. *Syn.*, persona (Montf. Gray).

Type, T. tritonis, L. sp. Pl. IV., fig. 13.

Shell with disconnected varices; canal prominent; lips denticulated.

Operculum ovate, sub-concentric.

Distr., 100 sp. W. Indies, Medit., Africa, India, China, Pacific, W. America. Ranging from low-water to 10 or 20 fathoms; one minute species has been dredged at 50 fathoms.

Fossil, 45 sp. Eocene—. Brit., France, &c. Chile.

The great triton (*T. tritonis*) is the conch blown by the Australian and Polynesian Islanders. A very similar sp. (*T. nodiferus*) is found in the Medit., and a third in the W. Indies.

Fasciolaria, Lam.

Etym., *fasciola*, a band.

Type, F. tulipa. Pl. V., fig. 1.

Shell fusiform, elongated; whirls round or angular; canal open; columellar lip tortuous, with several oblique folds. *Operc.* claw-shaped. F. gigantea of the S. Seas, attains a length of nearly two feet.

Distr., 16 sp. W. Indies, Medit., W. Africa, India, Australia, S. Pacific, W. America.

Fossil, 28 sp., U. chalk—. France.

TURBINELLA, Lam.

Etym., diminutive of *turbo*, a top.

Type, T. pyrum. Pl. V., fig. 2.

Shell thick; spire short; columella with several transverse folds. Operculum claw-shaped. Fig. 63. The shank-shell (*T. pyrum*) is carved by the Cingalese, and reversed varieties of it, from which the priests administer medicine, are held sacred.

Distr., 70 sp. W. Indies, S. America, Africa, Ceylon, Philippines, Pacific, W. America.

Fossil, 20 sp. Miocene—.

Sub-genera. Cynodonta (Schum.) T. cornigera. Pl. V., fig. 3.

Latirus (Montf.) T. gilbula. Pl. V., fig. 4.

Cuma (Humphr.) T. angulifera, inner lip with a single prominent fold operculum like *purpura*.

Lagena (Schum.) T. Smaragdula, L. sp. N. Australia.

CANCELLARIA, Lam.

Etym., *cancellatus*, cross-barred.

Type, C. reticulata. Pl. V., fig. 5.

Shell cancellated; aperture channelled in front: columella with several strong oblique folds; no operculum. The animals are vegetable feeders. (Desh.)*

Distr., 70 sp. W. Indies, Medit., W. Africa, India, China, California.

Fossil, 60 sp. Eocene—. Britain, France, &c.

TRICHOTROPIS, Broderip, 1829.

Etym., *Thrix*, (trichos) hair, and *tropis*, keel.

Type, T. borealis, Pl. VI., fig. 8. (= ? *Admete*, Phil., no operculum.)

Shell thin, umbilicated; spirally furrowed; the ridges with epidermal fringes; columella obliquely truncated; operc. lamellar, nucleus external.

Animal with a short broad head; tentacles distant, with eyes on the middle; proboscis long, retractile.

Lingual dentition similar to *strombus*; *teeth* single, hamate, denticulated; *uncini* 3: 1 denticulate 2 and 3 simple.

* *Cancellaria* and *trichotropis* form a small natural family connected with *cerithiadæ* and *strombidæ*.

Distr., 8 sp. Northern seas. U. States, Greenland, Melville Island, Behring's Straits, N. Brit. 15—80 fms.

Fossil, 1 sp. Miocene—. Brit.

PYRULA, Lam. Fig-shell.

Etym., diminutive of *pyrus*, a pear.

Syn., Ficula, Sw. Sycotypus, Br., Cassidula, Humph. Cochlidium, Gray.

Type, P. ficus. (Pl. V., fig. 6.)

Shell pear-shaped; spire short; outer lip thin; columella smooth: canal long, open. No operculum in the typical species.

Distr., 39 sp. W. Indies, Ceylon, Australia, China, W. America.

Fossil, 30 sp. Neocomian—. Europe, India. Chile.

Pyrula ficus has a broad foot, truncated and horned in front; the mantle forms lobes on the sides, which nearly meet over the back of the shell. Chinese seas, in 17—35 fms. water. (Adams.)

Sub-genera. Fulgur, Montf. P. perversa. (= *Pyrella*, Sw. P. spirillus.)

Rapana, Schum. P. bezoar, shell perforated. Operc. lamellar, nucleus external.

Myristica. Sw. P. melongena. Pl. V., fig. 7. Operc. pointed, curved.

FUSUS, Lam. Spindle-shell.

Syn., Colus, Humph. Leiotomus, Sw. Strepsidura, Sw.

Type, F. colus. Pl. V., fig. 8.

Shell fusiform; spire many-whirled; canal straight, long; operculum ovate, curved, nucleus apical. Pl. V., fig. 9*.

Distr., 100 sp. World-wide. The typical sp. are sub-tropical. Australia, New Zealand, China, Senegal, U. States, W. America, Pacific.

Fossil, 320 sp. Bath oolite? Gault—Eocene—. Brit. &c.

Sub-genera, Trophon, Montf. F. magellanicus, Pl. IV., fig. 16. 14 sp. Antarctic and Northern seas. Brit. coast. 5—70 fathoms. *Fossil*, Chile, Brit.

Clavella, Sw. (cyrtulus, Hinds) body-whirl ventricose, suddenly contracted in front; canal long and straight. Resembling a turbinella, without plaits. 2 sp. Marquesas, Panama. *Fossil*, Eocene. F. longævus (Solander), Barton, &c.

Chrysodomus, Sw. F. antiquus (var.) Pl. V., fig. 9. Canal short; apex papillary; lingual dentition like buccinum, 12 sp. Spitzbergen, Davis's Straits, Brit., Medit., Kamschatka, Oregon. Low water to 100 fms. *Fossil*, pliocene. Brit., Sicily.

Pusionella, Gray. F. pusio, L. sp. (=F. nifat, Lam.), columella keeled. Operc., nucleus internal, 7 sp. Africa, India. *Fossil*, tertiary. France.

Fusus colosseus and proboscidalis, Lam., are two of the largest living gasteropods. *Fusus* (*chrysodomus*) *antiquus*, called the red-whelk on the coasts of the channel, and "Buckie" in Scotland, is extensively dredged for the markets, being more esteemed than the *buccinum*. It is the "roaring buckie," in which the sound of the sea may always be heard. In the Zetland cottages it is suspended horizontally, and used for a lamp; the cavity containing the oil, and the canal the wick. (Fleming.) The reversed variety (F. contrarius, Sby) is found in the Medit., and on the coast of Spain; it abounds in the pliocene tertiary (crag) of Essex. The *fusus deformis*, a similar sp., found off Spitzbergen, is always reversed.

FAMILY III. BUCCINIDÆ.

Shell notched in front; or with the canal abruptly reflected, producing a kind of varix on the front of the shell.

Animal similar to *murex*; lingual ribbon long and linear, (fig. 16) rachidian teeth single, transverse, dentated in front; uncini single. Carnivorous.

BUCCINUM, L. Whelk.

Etym., *buccina*, a trumpet, or triton's-shell.

Type, B. undatum. Pl. V., fig. 10.

Shell few whirled; whirls ventricose; aperture large; canal very short, reflected; operculum lamellar, nucleus external. (See *pisania.*)

Distr., 20 typical species. Northern and Antarctic seas. Low water to 100 fms. (Forbes). (B? clathratum, 136 fms., off Cape.)

Fossil, 130 sp., including *pisania*, &c. Gault ?—Miocene—. Brit., France.

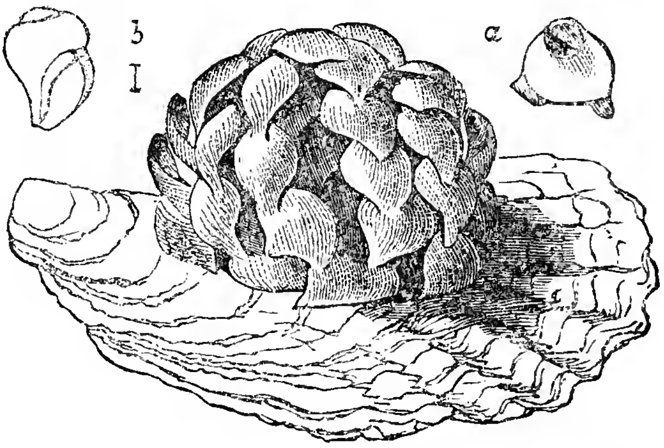


Fig. 70. *Nidamental capsules of the Whelk.**

The whelk is dredged for the market, or used as bait by fishermen; it may be taken in baskets, baited with dead fish. Its nidamental capsules are aggregated in roundish masses, which, when thrown ashore, and drifted by the wind resemble corallines. Each capsule contains five or six young, which, when hatched, are like fig. 70, *b*: *a*, represents the inner side of a single capsule, shewing the round hole, from which the fry have escaped.

* Fig. 70. From a small specimen, on an oyster-shell, in the cabinet of Albany Hancock, Esq. The line at *b*, represents the length of the young shell.

Sub-genus. Cominella, Gray. *Ex. B. limbosum, purpura maculosa*, &c. Operculum as in *fusus*. About 12 sp.

PSEUDOLIVA, Swainson.

Etym., named from its resemblance to *oliva*, in form.

Syn., sulco-buccinum, D'Orb. Gastridium (Gray), G. Sowerby.

Type, P. plumbea. Pl. V., fig. 12.

Shell globular, thick; with a deep spiral furrow near the front of the body-whirl, forming, as in *monoceros*, a small tooth on the outer lip; spire short, acute; suture channelled; inner lip callous; aperture notched in front; operculum? Animal unknown.

Distr., 6 sp.? W. America.

Fossil, 5 sp. Eocene. Brit., France, Chile.

? ANOLAX (Roissy), Conrad. Lea.

Etym., *an aulax*, without furrow.

Syn., buccinanops, D'Orb. Leiodomus, Sw. Bullia, Gray.

Types, A. gigantea, Lea. Buc. lævigatum, B. semiplicata, Pl. V., fig. 14.

Shell variable; like buccinum, pseudoliva, or terebra; sutures enamelled; inner lip callous.

Animal without eyes; foot very broad; tentacles long and slender; operculum pointed, nucleus apical.

Distr., 26 sp. Brazil, W. Africa, Ceylon, Pacific, W. America.

Fossil, 3 sp. Eocene—. N. America, France.

? HALIA, Risso.

Etym., *halios*, marine. *Syn.*, priamus, Beck.

Types, bulla helicoides (Brocchi). Miocene, Italy. Helix priamus (Meuschen). Coast of Guinea?

Shell like *achatina*; ventricose, smooth; apex regular, obtuse; operc.? The fossil species occurs with marine shells, and sometimes coated by a coral (*lepralia*).

TEREBRA, Lamarck. Auger-shell.

Syn., acus, Humph. Subula, Bl. Dorsanum, Gray.

Type, T. maculata. Pl. V., fig. 13.

Shell long, pointed, many-whirled; aperture small; canal short; operc. pointed, nucleus apical.

Animal blind, or with eyes near the summit of minute tentacles.

Distr., 109 sp., mostly tropical. Medit. (1 sp.) India, China, W. America.

Fossil, 24 sp. Eocene—. Brit., France, Chile.

EBURNA, Lamarck. Ivory-shell.

Etym., *ebur*, ivory. *Syn.*, latrunculus, Gray.

Type, E. spirata. Pl. V., fig. 11.

Shell umbilicated when young; inner lip callous, spreading and covering the umbilicus of the adult; *operculum* pointed, nucleus apical.

Distr., 9 sp. Red Sea, India, Cape, Japan, China, Australia. Solid, smooth shells, which have usually lost their epidermis, and are pure white, spotted with dark red; the animal is spotted like the shell. 14 fms. (Adams.)

Nassa, Lam. Dog-whelk.

Etym, *nassa*, a basket used for catching fish.

Syn., desmoulinsia and northia, Gray.

Type, N. arcularia. Pl. V., fig. 15.

Shell like buccinum; columellar lip callous, expanded, forming a tooth-like projection near the anterior canal. *Operc.* ovate, nucleus apical. Lingual teeth arched, pectinated; uncini, with a basal tooth.

The animal has a broad foot, with diverging horns in front, and two little tails behind. *N. obsoleta* (Say) lives within the influence of fresh water and becomes eroded. *N. reticulata, L.*, is common on the English shores, at low-water, and is called the dog-whelk by fishermen.

Distr., 68 sp. Low-water—50 fms. World-wide. Arctic, Tropical and Antarctic Seas.

Fossil, 19 sp. Eocene—. Brit., &c., N. America.

Sub-genus, *cyllene*, Gray. C. Oweni, Pl. V., fig. 17. Outer lip with a slight sinus near the canal; sutures channelled. W. Africa, Sooloo Islands, Borneo. *Fossil*, Miocene, Touraine.

Cyclonassa, Swainson. C. neritea, Pl. V., fig. 16.

Phos, Montfort.

Etym., *phos*, light. *Syn.*, rhinodomus, Sw.

Type, P. senticosus, Pl. V., fig. 18.

Shell like nassa; cancellated; outer lip striated internally, with a slight sinus near the canal; columella obliquely grooved.

The animal has slender tentacles, with the eyes near their tips.

Distr., 30 sp. (Cuming.) Red Sea, Ceylon, Philippines, Australia, W. America.

? Ringicula, Deshayes.

Etym., diminutive of *ringens*, from *ringo*, to grin.

Type, R. ringens, Pl. V., fig. 21.

Shell minute, ventricose, with a small spire; aperture notched, columella callous, deeply plaited; outer lip thickened and reflected.

Distr., 4 sp.? Medit., India, Philippines, Gallapagos.

Fossil, 9 sp., Miocene—. Brit., France. *Ringicula* is placed with *nassa* by Mr. Gray, and Mr. S. Wood; it appears to us very nearly allied to *cinulia* (=*avellana*, D'Orb.) in *tornatellidæ.*

Purpura (Adans), Lam. Purple.

Type, P. persica, Pl. VI., fig. 1.

Shell striated, imbricated or tuberculated; spire short; aperture large, slightly notched in front; inner lip much worn and flattened. Operc. lamellar, nucleus external. Pl. VI., fig. 2. Lingual dentition like murex erinaceus; teeth transverse, 3 crested; uncini small, simple.

Many of the *purpuræ* produce a fluid which gives a dull crimson dye; it may be obtained by pressing on the operculum. *P. lapillus* abounds on the British coast at low-water, amongst sea-weed; it is very destructive to mussel-beds (Fleming).

Distr., 140 sp. W. Indies, Brit., Africa, India, New Zealand, Pacific, Chile, California, Kamschatka. From low-water—25 fathoms.

Fossil, 30 sp. Miocene—. Brit., France, &c.

Sub-genus. Concholepas, Favan. C. lepas (Gmelin sp.) Pl. VI., fig. 3. Peru. The only sp. differs from purpura in the size of its aperture, and smallness of the spire.

? Purpurina (Lycett, 1847). D'Orb.

Shell, ventricose, coronated; spire, short; aperture, large, scarcely notched in front.

Fossil, 9 sp., Bath-oolite. Brit. France. The type, *P. rugosa*, somewhat resembles *purpura chocolatum* (Duclos), but the genus probably belongs to an extinct group.

Monoceros, Lam.

Etym., *monos*, one; *ceras*, horn.

Syn., acanthina, Fischer. Chorus, Gray.

Type, M. imbricatum. Pl. VI., fig. 4 (Buc. monoceros, Chemn).

Shell, like purpura; with a spiral groove on the whirls, ending in a prominent spine on the outer lip. This genus is retained on account of its geographical curiosity; it consists of sp. of *purpura*, *lagena*, *turbinella*, *pseudoliva*, &c.

Distr., 18 sp. W. coast of America.

Fossil, tertiary. Chile.

M. gigantens (chorus) has the canal produced like *fusus*. *M. cingulatum* is a *turbinella*, and several sp. belong more properly to *lagena*.

Pedicularia, Swainson.

Type, P. sicula. Pl. VI., fig. 5 (*thyreus, Phil.*).

Shell very small, limpet-like; with a large aperture, channelled in front, and a minute, lateral spire. *Lingual dentition* peculiar; teeth single, hooked, denticulated; *uncini*, 3; 1, four-cusped, 2, 3, elongated, three-spined.

Distr., 1 sp. Sicily, adhering to corals. Closely allied to *purpura madreporarum*, Sby. Chinese Sea.

Ricinula, Lam.

Etym., diminutive of *ricinus*, the (fruit of the) castor-oil plant.

Ex., R. arachnoïdes. Pl. VI., fig. 9 (=murex ricinus L.).

Shell, thick, tuberculated, or spiny; aperture contracted by callous projections on the lips. Operc. as in purpura.

Distr. 25 sp. India, China, Philippines, Australia, Pacific.

Fossil, 3 sp. Miocene—. France.

Planaxis, Lam.

Type, P. sulcata. Pl. VI., fig. 6. *Syn.*, quoyia and leucostoma.

Shell, turbinated; aperture notched in front; inner lip callous, channelled behind; operculum *subspiral* (quoyia) or semi-ovate. Pl. VI., fig. 7.

Distr., 11 sp. W. Indies, Red Sea, Bourbon, India, Pacific, and Peru.

Fossil, miocene?

Small coast shells, resembling periwinkles, with which Lamarck placed them.

Magilus, Montf., 1810.

Syn., campulote, Guettard, 1759. Leptoconchus, Rüppell.

Type, M. antiquus. Pl. V., figs. 19, 20.

Shell, when young, spiral, thin; aperture channelled in front; adult, prolonged into an irregular tube, solid behind; operculum lamellar.

Distr., 1 sp.? Red Sea. Mauritius.

The magilus lives fixed amongst corals, and grows upwards with the growth of the zoophytes in which it becomes immersed; it fills the cavity of its tube with solid shell, as it advances.

Cassis, Lam. Helmet-shell.

Syn., bezoardica, Schum. Levenia, Gray. Cypræcassis, Stutch.

Type, C. flammea. Pl. VI., fig. 14.

Shell, ventricose, with irregular varices; spire, short; aperture long, outer lip reflected, denticulated; inner lip spread over the body-whirl; canal sharply recurved. Operculum small, elongated; nucleus in the middle of the straight inner edge.

Distr., 34 sp. Tropical seas; in shallow water. W. Indies, Medit., Africa, China, Japan, Australia, New Zealand, Pacific, Mexico.

Fossil, 36 sp. Eocene—. Chile, France.

The queen-conch (C. madagascariensis) and other large species, are used in the manufacture of shell cameos, p. 46. The periodic mouths (*varices*) which are very prominent, are not absorbed internally as the animal grows.

Oniscia, Sowerby.

Etym., *oniscus*, a wood louse. *Syn.*, morum, Bolten.

Type, O. oniscus; O. cancellata, pl. VI., fig. 15.

Shell, with a short spire, and a long narrow aperture, slightly truncated in front; outer lip thickened, denticulated; inner lip granulated.

Distr., 6 sp. W. Indies, China, Gallapagos. (20 fms.)

Fossil, 3 sp. Miocene.

CITHARA, Schumacher.

Etym., *cithara*, a guitar. *Syn.*, mangelia, Reeve (not Leach).

Type, cancellaria citharella, Lam. (cithara striata, Schum.)

Shell, fusiform, polished, ornamented with regular longitudinal ribs; aperture linear, truncated in front, slightly notched behind; outer lip margined, denticulated within; inner lip finely striated. Operc.?

Distr., above 50 sp. of this pretty little genus were discovered by Mr. Cuming, in the Philippine Islands.

CASSIDARIA, Lam.

Etym., *cassida*, a helmet.

Syn., morio, Montf. Sconsia, Gray.

Type, C. echinophora. Pl. VI., fig. 13.

Shell, ventricose; canal produced, rather bent. No operculum.

Distr., 5 sp. Medit.

Fossil, 10 sp. Eocene—. Brit., France, &c.

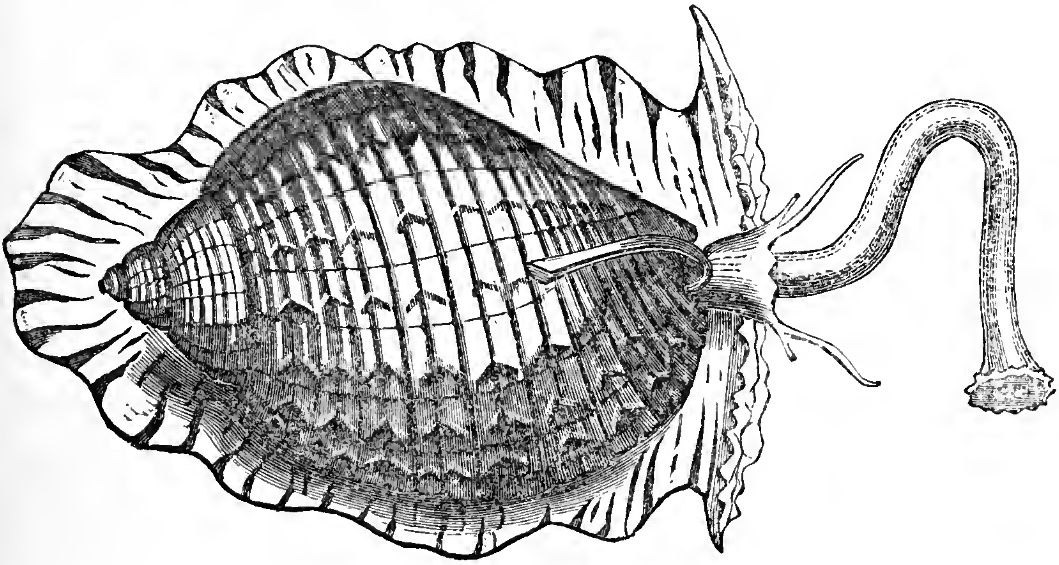


Fig. 71.*

DOLIUM, Lam. The tun.

Type, D. galea. Pl. VI., fig. 12.

Shell, ventricose, spirally furrowed; spire small; aperture very large; outer lip crenated. No operc.

Distr., 14 sp. Medit., Ceylon, China, Australia, Pacific.

* D. perdix, L. sp. ⅓ nat. size (after Quoy). Vanicoro, Pacific. The proboscis is exserted, and the siphon recurved over the front of the shell.

Fossil, 7 sp. (?Chalk. Brit.) Miocene—. S. Europe.

Sub-genus, malea, Valenc. (D. personatum) outer lip thickened and denticulated; inner lip with callous prominences.

HARPA, Lam. Harp-shell.

Type, H. ventricosa. Pl. VI., fig. 11. (=Buc. harpa, L.)

Shell, ventricose; with numerous ribs, at regular intervals; spire small; aperture large, notched in front. No operc.

The animal has a very large foot, with the front crescent-shaped, and divided by deep lateral fissures from the posterior part, which is said to separate spontaneously when the animal is irritated. Mostly obtained from deep-water, and soft bottoms.

Distr., 9 sp. Mauritius, Ceylon, Philippines, Pacific.

Fossil, 4 sp., Eocene—. France.

COLUMBELLA, Lam.

Etym., diminutive of *columba,* a dove.

Type, C. mercatoria. Pl. VI., fig. 10.

Shell, small; with a long narrow aperture; outer lip thickened (especially in the middle), dentated; inner lip crenulated. Operculum very small, lamellar.

Distr., 200 sp. Sub-tropical. W. Indies, Medit., India, Gallapagos, California. Small, prettily-marked shells; living in shallow water, on sandy flats, or congregating about stones. (Adams.)

Fossil, 8 sp. Miocene—. (The Brit. sp. are *pisaniæ*).

Sub-genus. Columbellina, D'Orb. 4 sp. Cretaceous. France, India.

OLIVA, Lam. Olive, rice-shell.

Type, O. porphyria. Pl. VI., fig. 16. *Syn.,* strephona, Brown.

Shell, cylindrical, polished; spire very short, suture channelled; aperture long, narrow, notched in front; columella callous, striated obliquely; body whirl furrowed near the base. No operc. in the typical sp.

Animal, with a very large foot, in which the shell is half immersed; mantle lobes large, meeting over the back of the shell, and giving off filaments which lie in the suture and furrow. The eyes are placed near the tips of the tentacles.

The olives are very active animals, and can turn over, when laid on their back; near low water they may be seen gliding about or burying in the sands as the tide retires; they may be taken with animal baits, attached to lines. They range downwards to 25 fms.

Distr., 117 sp. Sub-tropical, W. and E. America. W. Africa, India, China, Pacific.

Fossil, 20 sp. Eocene—. Brit., France, &c.

Sub-genera. *Olivella*, Sw. O. jaspidea, pl. VI., fig. 19.
Animal with small, acute frontal lobes. Operc. nucleus sub-apical.
Scaphula, Sw. O utriculus, pl. VI., fig. 18.
Frontal lobes large, rounded, operculate.
Agaronia, Gray. O. hiatula, pl. VI., fig. 17.
No eyes or tentacles. Frontal lobes moderate, acute.

ANCILLARIA, Lam.

Etym., *ancilla*, a maiden.

Types, A. subulata, pl. VI., fig. 20. A. glabrata, pl. VI. fig. 21.

Shell like oliva; spire produced, and entirely covered with shining enamel. Operc. minute, thin, pointed. Lingual teeth pectinated. Uncini simple, hooked.

Animal like oliva; said to use its mantle-lobes for swimming. (D'Orb.) In *A. glabrata*, a space resembling an umbilicus, is left between the callous inner lip and the body whirl.

Distr., 23 sp. Red Sea, India, Madagascar, Australia, Pacific.

Fossil, 21 sp. Eocene—. Brit., France, &c.

FAMILY IV. CONIDÆ, Cones.

Shell inversely conical; aperture long and narrow; outer lip notched at or near the suture; operculum minute, lamellar.

Animal, foot oblong, truncated in front; with a conspicuous (aquiferous?) pore in the middle. Head produced. Tentacles far apart. Eyes on the tentacles. Gills 2. Lingual teeth (*uncini?*) in pairs, elongate, subulate, or hastate.

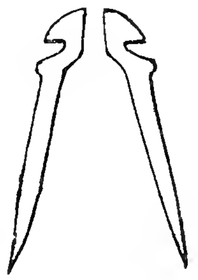


Fig. 72.*

CONUS, L. Cone-shell.

Types, C. marmoreus, pl. VII., fig. 1. C. geographicus, antediluvianus, &c.

Shell conical, tapering regularly; spire short, many-whirled; columella smooth, truncated in front; outer lip notched at the suture; operculum pointed, nucleus apical.

Distr., 269 sp. All tropical seas. Medit., 2; Africa, 23; Red Sea, 5; Asia, 124; Australia, 16; Pacific, 25; Gallapagos, 3; W. America, 20; W. Indies and Brazil, 21.

Fossil, 80 sp. Chalk—. Brit., France, India, &c.

The cones range northward as far as the Mediterranean, and southward to the Cape; but are most abundant and varied in equatorial seas. They inhabit fissures and holes of rocks, and the warm and shallow pools inside coral-reefs, ranging from low water to 30 and 40 fathoms; they move slowly, and sometimes (C. aulicus) bite when handled; they are all predatory. (Adams.)

Sub-genus. *Conorbis*, Sw. C. dormitor, Pl. VII., fig. 2. Eocene—. Brit., France.

* Fig. 72. Lingual teeth of bela turricula (after Lovén).

Pleurotoma, Lam.

Etym., *pleura*, the side, and *toma*, a notch. *Syn.*, *turris*, Humph.

Types, P. Babylonica, Pl. VII., fig. 3. P. mitræformis, &c.

Shell fusiform, spire elevated; canal long and straight; outer lip with a deep slit near the suture. Operculum pointed, nucleus apical.

Distr., 430 sp. World-wide. Greenland, Brit., 17; Medit., 19; Africa, 15; Red Sea and India, 6; China, 90; Australia, 15; Pacific, 0? W. America, 52; W. Indies and Brazil, 20. The typical sp. about 20 (China, 16; W. America, 4.) Low water to 100 fathoms.

Fossil, 300 sp. Chalk—. Brit., France, &c. Chile.

Sub-genera. *Drillia*, Gray. D. umbilicata, canal short.

Clavatula, Lam., canal short, operc. pointed, nucleus in the middle of the inner edge. C. mitra, Pl. VII., fig. 4.

Tomella, Sw., canal long; inner lip callous near suture. T. lineata.

? *Clionella*, Gray. C. sinuata, Born sp. (= P. buccinoides) freshwaters, Africa.

Mangelia, Leach, (not Reeve). Apertural slit at the suture; no operc., M. tæniata, Pl. VII., fig. 5. Greenland, Brit., Medit.

Bela, Leach. Operc. nucleus apical. B. turricula, Pl. VII., fig. 6.

Defrancia, Millet,* no operc. D. linearis, Pl. VII., fig. 7.

? *Lachesis*, Risso, L. minima, Pl. VII., fig. 8, apex mammillated; operc. claw-shaped. Medit., S. Brit. In shallow water.

Daphnella, Hinds. D. marmorata. New Guinea. (Buc. junceum. L. clay).

FAMILY V. Volutidæ.

Shell turreted, or convolute; aperture notched in front; columella obliquely plaited. No operculum.

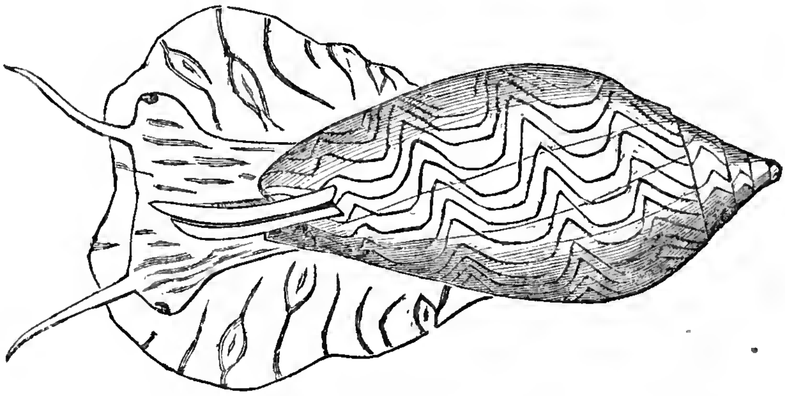


Fig. 73.†

Animal with a recurved siphon; foot very large partly hiding the shell;

* According to Mr. S. Hanley, *Defrancia* is synonymous with *Mangelia*.

† Fig. 73. V. undulata, Lam. ½ Australia (from Quoy and Gaimard),

mantle often lobed and reflected over the shell; eyes on the tentacles, or near their base. Lingual ribbon linear; *rachis* toothed; *pleuræ* unarmed.

VOLUTA, L. Volute.

Type, V. musica, Pl. VII., fig. 9.

Syn., cymbiola, harpula, Sw. Volutella, D'Orb. Scapha, &c., Gray.

Shell ventricose, thick; spire short, apex mammillated; aperture large, deeply notched in front; columella with several plaits. V. musica and a few others have a small operculum.

Animal, eyes on lobes at the base of the tentacles; siphon with a lobe on each side, at its base; lingual teeth 3 cusped.

V. vespertilio and *hebræa* fill the nuclei of their spires with solid shell. *V. brasiliana* forms nidamental capsules 3 inches long. (D'Orb.) In *V. angulata* the mantle is produced into a lobe on the left side, and overlaps the shell.

Distr., 70 sp. W. Indies, Cape Horn, W. Africa, Australia, Java, Chili.

Fossil, 80 sp. Chalk—. India, Brit., France, &c.

Sub-genera. *Volutilithes*, Sw. Spire pointed, many-whirled, columella plaits indistinct. V. spinosus, Pl. VII., fig. 10.

Living, 1 sp. (*V. abyssicola*), dredged at 132 fathoms; off the Cape. (Adams).

Fossil, Eocene. Brit., Paris.

Scaphella, Sw. Fusiform, smooth.

Ex., V. magellanica. *Fossil*, V. Lamberti, Crag, Suffolk.

Melo, Brod. Large, oval; spire short.

Type, M. diadema, Pl. VII., fig. 11. New Guinea, 8 sp.

CYMBA, Broderip. Boat-shell.

Syn., Yetus (Adans.) Gray.

Type, C. proboscidalis, Pl. VII., fig. 12, and fig. 74 (= V. cymbium, L.)

Shell like voluta; nucleus large and globular; whirls few, angular, forming a flat ledge round the nucleus.

The foot of the animal is very large, and deposits a thin enamel over the under side of the shell. It is ovo-viviparous, and the young animal is very large when born; the *nucleus* becomes partly concealed by the growth of the shell.

Distr., 10 sp. W. Africa, Lisbon.

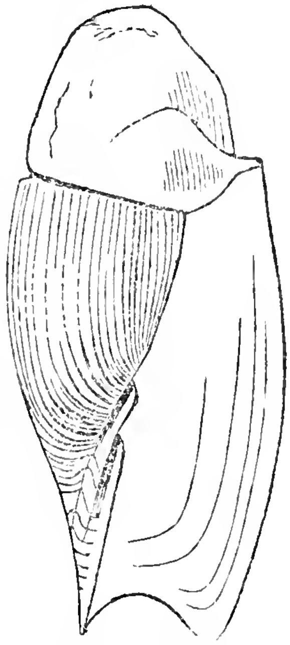


Fig. 74. *Cymba.*

MITRA, Lam. Mitre-shell.

Syn., turris, Montf. Zierliana, Gray. Tiara, Sw.

Types, M. episcopalis, Pl. VII., fig. 13. M. vulpecula, fig. 14.

Shell fusiform, thick; spire elevated, acute; aperture small, notched in front; columella obliquely plaited; operculum very small.

The animal has a very long proboscis; it emits a purple liquid, having a nauseous odour, when irritated. The eyes are placed on the tentacles, or at their base. Range, from low water to 15 fathoms, more rarely in 15—80 fathoms.

Distr., 350 sp. Philippines, India, Red Sea, Medit., W. Africa, Greenland (1 sp.), Pacific, W. America. The extra-tropical species are minute. M. Greenlandica and M. cornea (Medit. sp.) are found together in the latest British Tertiaries (Forbes.)

Fossil, 90 sp. Chalk—. India, Brit., France, &c.

Sub-genera. *Imbricaria*, Schum. (conœlix, Sw.)

Shell, cone-shaped. I. conica, Pl. VII., fig. 15.

Cylindra, Schum. (Mitrella, Sw.)

Shell, olive-shaped. C. crenulata, Pl. VII., fig. 16.

Volvaria, Lam.

Etym., *volva*, a wrapper.

Type, V. bulloïdes, Pl. VII., fig. 17.

Shell cylindrical, convolute; spire minute; aperture long and narrow; columella with 3 oblique plaits in front.

Fossil, 5 ? sp. Eocene. Brit., France.

Marginélla, Lam.

Etym., diminutive of *margo*, a rim.

Syn., porcellana (Adans.) Gray. Persicula, Schum.

Types, M. nubeculata, Pl. VII., fig. 18. M. persicula, fig. 19.

Shell, smooth, bright; spire short or concealed; aperture truncated in front; columella plaited; outer lip (of adult) with a thickened margin. *Animal* similar to cypræa.

Distr., 90 sp. Tropical, W. Indies, Brazil, Medit. (1 small sp.) W. Africa, China, Australia.

Fossil, 30 sp. Eocene—. France, &c.

Sub-genus. *Hyalina*, Schum. Outer lip scarcely thickened.

Type, voluta pallida, Mont., W. Indies.

FAMILY VI. Cypræidæ. Cowries.

Shell convolute, enamelled; spire concealed; aperture narrow, channelled at each end; outer lip (of adult) thickened, inflected. No operculum.

Animal with a broad foot, truncated in front; mantle expanded on each side, forming lobes, which meet over the back of the shell; these lobes are usually ornamented with tentacular filaments; eyes on the middle of the tentacles or near their base; branchial plume single. Lingual ribbon long, partly contained in the visceral cavity; *rachis* 1 toothed; *uncini* 3. The cowries inhabit shallow water, near shore, feeding on zoophytes.

CYPRÆA, L. Cowry.

Etym., Cypris, a name of Venus.

Types, C. tigris, C. mauritiana, Pl. VII., fig. 20.

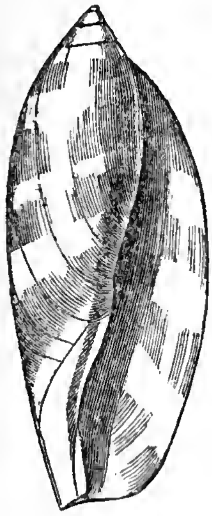


Fig. 75. *Cypræa, young.**

Shell ventricose, convolute, covered with shining enamel; spire concealed; aperture long and narrow, with a short canal at each end; inner lip crenulated; outer lip inflected and crenulated. (Lingual *uncini* similar).

The young shell has a thin and sharp outer lip, a prominent spire, and is covered with a thin epidermis, fig. 75. When full-grown the mantle lobes expand on each side, and deposit a shining enamel over the whole shell, by which the spire is entirely concealed. There is usually a line of paler colour which indicates where the mantle lobes met. *Cypræa annulus* is used by the Asiatic Islanders to adorn their dress, to weight their fishing-nets, and for barter. Specimens of it were found by Dr. Layard in the ruins of Nimroud. The money-cowrey (*C. moneta*) is also a native of the Pacific and Eastern seas; many tons weight of this little shell are annually imported into this country, and again exported for barter with the native tribes of Western Africa; in the year 1848 sixty tons of the money-cowry were imported into Liverpool; and in 1849 nearly three hundred tons were brought to the same place, according to the statement of Mr. Archer in the Industrial Exhibition. Mr. Adams observed the pteropodous fry of *C. annulus*, at Singapore, adhering in masses to the mantle of the parent, or swimming in rapid gyrations, or with abrupt jerking movements by means of their cephalic fins.

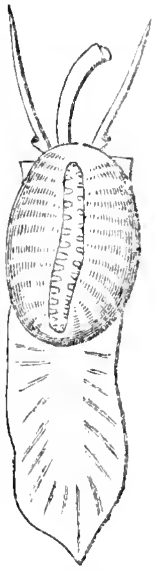


Fig. 76. *Trivia.*†

Distr., 150 sp. In all warm seas (except E. coast S. America?) but most abundant in those of the old world. On reefs and under rocks at low water.

Fossil, 78 sp. Chalk—. India, Brit., France, &c.

Sub-genera. Cyprovula, Gray. C. capensis, Pl. VII., fig. 21. Apertural plaits continued regularly over the margin of the canal.

Luponia, Gray. C. algoënsis, Pl. VII., fig. 22. Inner lip irregularly plaited in front.

* Fig. 75. Cypræa testudinaria, L., young, China.

† Fig. 76. Trivia europæa, Mont. From the "British Mollusca," by Messrs. Forbes and Hanley.

Trivia, Gray. C. europæa, Pl. VII., fig. 23; fig. 76, and 15, B. Small shells with striæ extending over the back. (*Uncini;* 1st denticulate 2, 3, simple.)

Distr., 30 sp. Greenland, Brit., W. Indies, Cape, Australia, Pacific, W. America.

Erato, Risso.

Etym., *Erato,* the muse of love-songs and mimicry. *Type,* E. lævis, Pl. VII., fig. 24.

Shell minute; like *marginella;* lips minutely crenulated. *Animal,* like *trivia.*

Distr., 8 sp. Brit., Medit., W. Indies, China.

Fossil, 2 sp. Miocene—. France, Brit. (Crag.)

Ovulum, Lam.

Etym., diminutive of *ovum,* an egg. *Syn.*, amphiceras, Gronov.

Types, O. ovum, pl. VII., fig. 25. O. gibbosa and verrucosa.

Shell, like *cypræa;* inner lip smooth.

Distr., 36 sp. Warm seas. W. Indies, Brit., Medit. China, W. America.

Fossil, 11 sp. Eocene—. France, &c.

Sub-genus, calpurna, Leach. O. volva ("The weaver's shuttle"). Aperture produced into a long canal at each end. Foot narrow, adapted for walking on the round stems of the *gorgoniæ,* &c., on which it feeds. C. patula inhabits the S. coast of Britain, it is very thin, and has a sharp outer lip.

SECTION B. Holostomata. Sea-Snails.

Shell, spiral or limpet shaped; rarely tubular or multivalve: margin of the aperture entire. *Operculum,* horny or shelly, usually spiral.

Animal with a short non-retractile muzzle; respiratory siphon wanting, or formed by a lobe developed from the neck (fig. 61), gills pectinated or plume-like, placed obliquely across the back, or attached to the right side of the neck; neck and sides frequently ornamented with lappets and tentacular filaments. Marine or fresh-water. Mostly phytophagous.*

FAMILY I. Naticidæ.

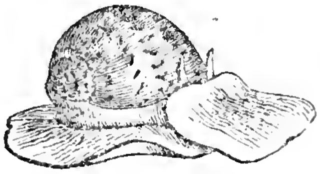
Shell, globular, few-whirled; spire small, obtuse; aperture, semi-lunar; lip, acute; pillar often callous.

Animal, with a long retractile proboscis; lingual ribbon linear; *rachis,* 1 toothed; *uncini,* 3 (similar to *trivia,* fig. 15, B.); foot very large; mantle-lobes largely developed, hiding more or less of the shell. Species all marine.

* These "sections" are not very satisfactory, but they are better than any others yet proposed, and they are convenient, on account of the great extent of the order *proso-branchiata.* *Natica* and *scalaria* have a retractile proboscis. *Pirena* has a notched aperture, and *aporrhais,* a canal.

NATICA (Adans.), Lamarck.

Syn., mammilla, Schm. Cepatia, Gray. Nacca, Risso.
Type, N. canrena, Pl. VIII., fig. 1.



Shell, thick, smooth; inner lip callous; umbilicus large, with a spiral callus; epidermis thin, polished; operculum sub-spiral.

Animal blind; tentacles connate with a head veil; front of the large foot provided with a fold (*mentum*), reflected upon and protecting the head; operc. lobe large, covering part of the shell; jaws horny; lingual ribbon short; branchial plume single.

The coloured markings of the naticæ are very indestructible; they are frequently preserved on fossils. The *naticæ* frequent sandy and gravelly bottoms, ranging from low water to 90 fathoms (Forbes). They are carnivorous, feeding on the smaller bivalves (Gould), and are themselves devoured by the cod and haddock. Their eggs are agglutinated into a broad and short spiral band, very slightly attached, and resting free on the sands.

Distr., 90 sp. Arctic seas, Brit., Medit., Caspian, India, Australia, China, Panama, W. Indies.

Fossil, 260 sp. Devonian—. S. America, N. America, Europe, India.

Sub-genera, naticopsis, M'Coy. N. Phillipsii. Shell imperforate; inner lip very thick, spreading. Operc. shelly (Brit. Mus.). Carb. limestone, 7 sp.

Operculum, horny.

Neverita, Risso. N. Alderi. Fig. 77.

Lunatia, Gray. N. Ampullaria. Perforation simple; epidermis dull, olivaceous. Northern seas.

Globulus, J. Sby. (Deshayesia,† Raulin; Ampullina, Desh. not Bl.) N. Sigaretina. Pl. VIII., fig. 2. Umbilicus narrow (rimate), lined by a thin callus. *Fossil*, eocene. Brit., Paris.

Polinices, Montf., (naticella Guild.) N. mammilla. Shell oblong; callus very large, filling the umbilicus.

Cernina, Gray. N. fluctuata. Pl. VIII., fig. 3. Globular, imperforate; inner-lip callous, covering part of the body whirl.

Naticella, Müller. 19 sp. *Fossil*, Trias, S. Cassian.

* Fig. 77. Natica Alderi, Forbes. From an original drawing, communicated by Joshua Alder, Esq.

† *Deshayesia* was founded on a specimen with prominences on the pillar.

SIGARETUS (Adans.), Lamarck.

Syn., cryptostoma, Bl. Stomatia, Browne.

Type, S. haliotoïdes. Pl. VIII., fig. 4.

Shell, striated; ear-shaped; spire minute; aperture very wide, oblique (not pearly). Operculum minute, horny, sub-spiral.

The flat species are entirely concealed by the mantle when living; the convex shells only partially, and they have a yellowish epidermis. The anterior foot lobe (*mentum*) is enormously developed.

Distr., 26 sp. W. Indies, India, China, Peru.

Fossil, 10 sp. Eocene—. Brit., France, S. America.

Sub-genus, naticina, Gray. N. papilla, pl. VIII., fig. 3. Shell ventricose, thin, perforated. W. Indies, Red Sea, China, N. Australia, Tasmania. *Eocene*, Paris.

LAMELLARIA, Montagu.

Etym., *lamella*, a thin plate.

Syn., marsenia, Leach. Coriocella, Bl.

Type, L. perspicua. Pl. VIII., fig. 6.

Shell ear-shaped; thin, pellucid, fragile; spire very small; aperture large, patulous; inner lip receding. No operc.

Animal much larger than the shell, which is entirely concealed by the reflected margins of the mantle; mantle non-retractile, notched in front; eyes at the outer bases of the tentacles. Lingual *uncini* 3, similar; or one very large.

Distr., 5 sp. Norway, Brit., Medit., New Zealand, Philippines.

Fossil, 2 sp. Miocene—. Brit. (Crag.)

NARICA, Recluz.

Syn., vanicoro, Quoy. Merria, Gray. Leucotis, Sw.

Type, N. cancellata. Pl. VIII., fig. 8.

Shell thin, white, with a velvety epidermis; ribbed irregularly, and spirally striated; axis perforated. Operc. very small, thin.

Animal, eyes at the outer base of the tentacles; foot with wing-like lobes.

Distr., 6 sp. W. Indies, Nicobar, Vanikoro, Pacific.

Fossil, 4 sp. Gault— (D'Orb.) Brit., France.

VELUTINA, Fleming.

Etym., *velutinus*, velvety (from *vellus*, a fleece).

Type, V. lævigata. Pl. VIII., fig. 7.

Shell thin; with a velvety epidermis; spire small; suture deep; aperture very large, rounded; peristome continuous, thin. No operc.

Animal with a large oblong foot; margin of the mantle developed all round, and more or less reflected over the shell; gills 2; head broad; tentacles subulate, blunt, far apart; eyes on prominences at their outer bases. Carnivorous. Lingual dentition like trivia (fig. 15, B.).

Distr., 4 sp. Britain, Norway, N. America, Icy sea to Kamtschatka. Living on stones near low water, and ranging to 30 fms.

Fossil, 3 sp. Miocene—. Brit.

Sub-genus. Otina (Gray). V. otis. *Shell* minute, ear shaped. Animal like velutina, but with a simple mantle, and very short tentacles. W. and S. W. Brit. coast; inhabiting chinks of rocks, between tide-marks (Forbes).

FAMILY II. Pyramidellidæ.

Shell spiral, turreted; nucleus minute, sinistral; aperture small; columella sometimes with one or more prominent plaits. *Operculum* horny, imbricated, nuclus internal.

Animal with broad ear-shaped tentacles, often connate; eyes behind the tentacles, at their bases; proboscis retractile; foot truncated in front; tongue unarmed. Species all marine.

Several genera of fossil shells are provisionally placed in this order, from their resemblance to *eulima* and *chemnitzia*.* Tornatella, usually placed in or near this family, is *opistho-branchiate*.

Pyramidélla, Lam.

Etym., diminutive of *pyramis*, a pyramid.

Syn., obeliscus, Humph. (P. dolabrata. Pl. VIII., fig. 11.)

Type, P. auris-cati. Pl. VIII., fig. 10.

Shell slender, pointed, with numerous plaited or level whirls; apex sinistral; columella with several plaits; lip sometimes furrowed internally. Operc. indented on the inner side to adapt it to the columellar plaits. The shell of the typical pyramidellæ bears some resemblance to *cancellaria*.

Distr., 11 sp. W. Indies, Mauritius, Australia.

Fossil, 12 sp. Chalk ?—. France, Brit.

Odostomia, Fleming, 1824.

Etym., *odous*, a tooth, and *stoma*, mouth.

Type, O. plicata, Pl. VIII., fig. 12.

Shell subulate or ovate, smooth; apex sinistral; aperture ovate; peristome not continuous; columella with a single tooth-like fold; lip thin; operculum horny, indented on the inner side.

Distr., sp. Brit., Medit., Red Sea, Australia.

Fossil, 15 sp.? Eocene—. Brit., France.

Very minute and smooth shells, having the habit of *rissoæ*, and like them sometimes found in brackish water. They range from low water to 40 fms. The animal is undistinguishable from chemnitzia.

* "The *Pyramidellidæ* present subjects of much interest to the student of extinct mollusca; numerous forms, bearing all the aspect of being members of this family, occur among the fossils of even the oldest stratified rocks. Many of them are gigantic compared with existing species, and the group, as a whole, may be regarded, rather as appertaining to past ages than the present epoch." (Forbes.)

Chemnitzia, D'Orbigny.

Etym., named in honour of Chemnitz, a distinguished conchologist of Nuremburg, who published seven volumes in continuation of Martini's "*Conchylien-Cabinet*," 1780-95.

Syn., turbonilla, Risso. Parthenia, Lowe. Pyramis and Jaminea, Br. Monoptigma, Gray. Amoura, Moller.

Type, C. elegantissima. Pl. VIII., fig. 13.

Shell slender, elongated, many-whirled; whirls plaited; apex sinistral; aperture simple; ovate; peristome incomplete; operculum horny, sub-spiral.

Animal, head very short, furnished with a long, retractile proboscis; tentacles triangular; eyes immersed at the inner angles of the tentacles; foot truncated in front, with a distinct *mentum*.

Distr., Brit. (4 sp.), Norway, Medit. Probably world-wide. Range from low water to 90 fms.

Fossil, 180 sp. Permian—. Brit., France, &c.

The "melaniæ" of the secondary rocks are provisionally referred to this genus. Those of the palæozoic strata to *loxonema*.

Sub-genus. *Eulimella*, Forbes. E. scillæ, Scacchi. 4 Brit. sp. Shell smooth and polished; columella simple; apex sinistral.

Eulima, Risso, 1826.

Etym., *eulimia*, ravenous hunger. *Syn.*, pasithea, Lea.

Type, E. polita. Pl. VIII., fig. 14.

Shell small, white, and polished; slender, elongated, with numerous level whirls; obscurely marked on one side by a series of periodic mouths, which form prominent ribs internally; apex acute; aperture oval, pointed above; outer lip thickened internally; inner lip reflected over the pillar. Operculum horny, sub-spiral.

Animal, tentacles subulate, close, with the eyes immersed at their posterior bases; proboscis long, retractile; foot truncated in front, mentum bilobed; operc. lobe winged on each side; branchial plume single; mantle with a rudimentary siphonal fold.

The eulimæ creep with the foot much in advance of the head, which is usually concealed within the aperture, the tentacles only protruding. (Forbes.)

Distr., 15 sp. Brit., Medit., India, Australia, Pacific. In 5—90 fms. water.

Fossil, 40 sp. Carb.?—. Brit., France, &c.

Sub-genus. *Niso*, Risso (=Bonellia, Desh.). N. terebellatus, Lam. sp. Axis perforated.

Fossil, 3 sp. Eocene—. Paris. *Distr.*, 5 sp. China, W. America (Cuming).

Stylina, Fleming.

Ex., S. astericola. Pl. VIII., fig. 15. (Syn. stylifer, Brod.)

Shell, hyaline, globular or subulate, apex tapering, styliform, nucleus sinistral.

Animal with slender, cylindrical tentacles, and small sessile eyes at their outer bases; mantle thick, reflected over the last whirls of the shell; foot large, with a frontal lobe. Branchial plume single. Attached to the spines of sea-urchins, or immersed in living star fishes and corals.

Distr., 6 sp. W. Indies, Brit., Philippines, Gallapagos.

LOXONEMA, Phillips.

Etym., loxos, oblique, and *nema,* thread; in allusion to the striated surface of many species.

Shell elongated, many-whirled; aperture simple, attenuated above, effused below, with a sigmoidal edge to the outer lip.

Fossil, 75 sp. L. silurian—Trias. N. America, Europe.

MACROCHEILUS, Phillips.

Etym., macros, long, and *cheilos,* lip.

Shell, thick, ventricose, buccinoid; aperture simple, effuse below; outer lip thin, inner lip wanting, columella callous, slightly tortuous.

Type, M. arculatus, Schlotheim sp. Devonian. Eifel.

Fossil, 12 sp. Devonian—Carboniferous. Brit., Belgium.

FAMILY III. CERITHIADÆ. Cerites.

Shell spiral, elongated, many-whirled, frequently varicose; aperture channelled in front, with a less distinct posterior canal; lip generally expanded in the adult; operculum horny and spiral.

Animal with a short muzzle, not retractile; tentacles distant, slender; eyes on short pedicels, connate with the tentacles; mantle-margin with a rudimentary siphonal fold; tongue armed with a single series of median teeth, and three laterals or uncini; marine, estuary, or fresh-water.

CERITHIUM (Adans.). Bruguiere.

Etym., ceration, a small horn.

Type., C. nodulosum. Pl. VIII., fig. 16.

Shell turreted, many-whirled, with indistinct varices; aperture small, with a tortuous canal in front; outer lip expanded; inner lip thickened. Operculum horny, paucispiral. Pl. VIII., fig. 16*.

Distr., above 100 sp. World-wide, the typical species tropical. Norway, Brit., Medit., W. Indies, India, Australia, China, Pacific, Gallapagos.

Fossil. 460 sp. Trias—. Brit., France, U. States, &c.

Sub-genera. Rhinoclavis, Sw. C. vertagus. Canal long, bent abruptly; operc., sub-spiral.

Bittium, Leach. C. reticulatum, Pl. VIII., fig. 17. Small northern species, ranging from low-water to 80 fathoms.

Triphoris, Deshayes. C. perversum, Pl. VIII., fig. 18. 30 sp. Norway —Australia. *Fossil.* Eocene—. Brit., France. Shell sinistral; anterior and posterior canals tubular. The third canal is only accidentally present, forming part of a varix.

Cerithiopsis, Forbes. C. tuberculare, Brit. Shell like *bittium;* proboscis retractile; operculum pointed, nucleus apical. Range 4—40 fms.

POTAMIDES, Brongniart. Fresh-water Cerites.

Etym., *potamos*, a river, and *eidos*, species.

Type., P. Lamarckii, Brong. (= Cerit. tuberculatum, Brard.)

Ex., P. mixtus. Pl. VIII., fig. 19.

Syn., tympanotomus, Klein, C. fuscatum, Africa. Pirenella, Risso, C. mammillatum, Pl. VIII., fig. 22.

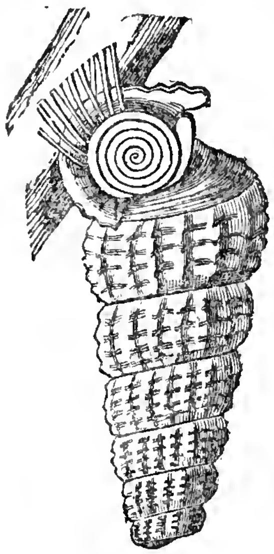


Fig. 78. *Cerithidea.**

Shell like cerithium, but without *varices*, in the very numerous typical fossil species; epidermis thick, olive-brown; operculum orbicular, many-whirled.

Distr., old world only? Africa, India. In the mud of the Indus they are mixed with sp. of ampullaria, venus, purpura, vulsella, &c. (Major W. E. Baker.)

Fossil (sp. included with cerithium) Eocene—. Europe.

Sub-genera. *Cerithidea.* Sw., C. decollata, Pl. VIII., fig. 24. Aperture rounded: lip expanded, flattened. Inhabit salt-marshes, mangrove swamps, and the mouths of rivers; they are so commonly out of the water as to have been taken for land-shells. Mr. Adams noticed them in the fresh-waters of the interior of Borneo, creeping on pontederia and sedges; they often suspend themselves by glutinous threads, fig. 78.

Distr. India, Ceylon, Singapore, Borneo, Philippines, Port Essington.

Terebralia, Sw. Cerith, Telescopium, Pl. VIII., fig. 21.

Shell pyramidal; columella with a prominent fold, more or less continuous towards the apex; and a second, less distinct, on the basal front of the whirls (as in *nerinæa*, fig. 79). India, N. Australia.

T. telescopium is so abundant near Calcutta, as to be used for burning into lime; great heaps of it are first exposed to the sun, to kill the animals. They have been brought alive to England (Benson).

Pyrazus, Montf. Cerit, palustre, Pl. VIII., fig. 20.

Shell with numerous indistinct varices; canal straight, often tubular; outer lip expanded. India, N. Australia.

Cerith radulum and granulatum of the W. African rivers approach very nearly the fossil *potamides*, but they have numerous varices.

* C. obtusa, Lam. sp. copied from Adams.

Lampania, Gray (batillaria, Cantor). Cerith, zonale. Pl. VIII., fig. 23.

Shell without varices, canal straight. Chusan.

The fossil potamides decussatus, Brug., of the Paris basin, resembles this section, and retains its spiral red bands.

NERINÆA, Defrance.

Etym., *nereis*, a sea-nymph.

Ex., N. trachea. Fig. 79.

Shell elongated, many-whirled, nearly cylindrical; aperture channelled in front; interior with continuous ridges on the columella and whirls.

Fossil, 150 sp. Inf. oolite—U. chalk. Brit., France, Germany, Spain, and Portugal. They are most abundant, and attain the largest size to the south; and usually occur in calcarious strata, associated with shallow-water shells. (Sharpe.)

Sub-genera. 1. *Nerinæa.* Folds simple: 2—3 on the columella; 1—2 on the outer wall; columella solid, or perforated. Above 50 sp.

2. *Nerinella* (Sharpe), columella solid; folds simple; columellar, 0—1; outer wall 1.

3. *Trochalia* (Sharpe), columella perforated, with one fold; outer wall simple, or thickened, or with one fold; folds simple.

4. *Ptygmatis* (Sharpe), columella solid or perforated, usually with 3 folds; outer wall with 1—3 folds, some of them complicated in form.

Fig. 79.*

? FASTIGIELLA, Reeve.

Type., F. carinata, Reeve.

Shell like turritella; aperture with a short canal in front (Mus., Cuming, and Brit. M.).

APORRHAIS, Aldrovandus.

Etym., aporrhais (Aristotle) "spout-shell" from aporrheo, to flow away.

Syn., chenopus Philippi.

Type, A. pes-pelecani. Pl. IV., fig. 7, and fig. 80.

Shell with an elongated spire; whirls numerous, tuberculated; aperture narrow, with a short canal in front; outer lip of the adult expanded and lobed or digitated; operc. pointed, lamellar.

Animal with a short broad muzzle; tentacles cylindrical, bearing the eyes on prominences near their bases, outside; foot short, angular in front;

* Fig. 79. Nerinæa trachea, Desl., partly ground down to shew the form of the interior. Bath oolite, Ranville. Communicated by John Morris, Esq.

branchial plume single, long; lingual ribbon linear; teeth single, hooked, denticulated; uncini 3, the first transverse, 2 and 3 claw-shaped.

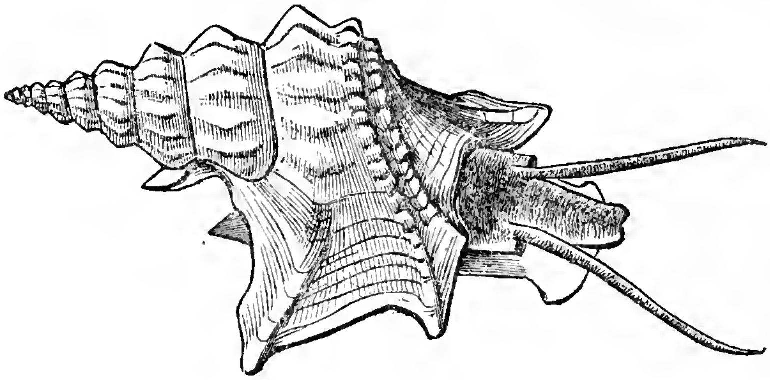


Fig. 80.*

Distr., 3 sp. Labrador, Norway, Brit., Medit. W. Africa. Range,—100 fms.

Fossil; see Pteroceras and Rostellaria; above 200 species, ranging from the lias to the chalk, probably belong to this genus, or to genera not yet constituted.

STRUTHIOLARIA, Lam.

Etym., *struthio*, an ostrich (-foot), from the form of its aperture.

Type, S. straminea, Pl. IV., fig. 6.

Shell turreted; whirls angular; aperture truncated in front; columella very oblique; outer lip prominent in the middle, reflected and thickened in the adult; inner lip callous, expanded; operculum claw-shaped, curved inwards, with a projection from the outer, concave edge.

Animal with an elongated muzzle? tentacles cylindrical; eye-pedicels short, adnate with the tentacles, externally; foot broad and short. (Kiener.)

Distr., 5 sp. Australia and New Zealand; where alone it occurs sub-fossil.

FAMILY IV. MELANIADÆ.

Shell spiral, turreted; with a thick, dark epidermis; aperture often channelled, or notched in front; outer lip acute; operculum horny, spiral. The spire is often extensively eroded by the acidity of the water in which the animals live.

Animal with a broad non-retractile muzzle; tentacles distant, subulate; eyes on short stalks, united to the outer sides of the tentacles; foot broad and short, angulated in front; mantle-margin fringed; tongue long and linear, with a median and 3 lateral series of hooked multi-cuspid teeth. Often viviparous. Inhabiting fresh-water lakes and rivers throughout the warmer parts of the world. Only fossil in Britain.

* Fig. 80. Aporrhais pes-pelecani, L., from a drawing by Joshua Alder, Esq., in the "British Mollusca."

Melania, Lam.

Etym., *Melania*, blackness (from *melas*).

Type, M. amarula. Pl. VIII., fig. 25.

Syn. Thiara, Megerle. Pyrgula, Crist.

Shell turreted, apex acute (unless eroded); whirls ornamented with striæ or spines; aperture oval, pointed above: outer lip sharp, sinuous; operculum subspiral. Pl. VIII., fig. 25*.

Distr., 160 sp. S. Europe, India, Philippines, Pacific Islands. Distinct groups in the southern states of N. America.

Fossil, 25 sp. Eocene—. Europe (v. *chemnitzia*).

Sub-genera. Melanàtria, Bowdich. M. fluminea* Pl. VIII., fig. 26. Aperture somewhat produced in front; operculum with rather numerous whirls. This section includes some of the largest sp. of the genus, and is well typified by the fossil, M. Sowerbii (cerit. melanoides, Sby.) of the Woolwich sands. Old World, India, Philippines.

Vibex, Oken, V. fuscatus, Pl. VIII., fig. 29. V. auritus. W. Africa. Whirls spirally ridged, or muricated; aperture broadly channelled in front.

Ceriphasia, Sw., C. sulcata. N. America. Aperture like vibex; slightly notched near the suture.

Hemisinus, Sw., H. lineolatus. W. Indies. Aperture channelled in front.

Melafùsus, Sw. (Io, Lea. Glottella, Gray.) M. fluviatilis. Pl. VIII., fig. 27. U. States. Aperture produced into a spout in front.

Melàtoma, Anthony (not Sw.) M. altilis. Shell like anculotus; with a deep slit at the suture. U. States.

Anculotus, Say. A. præmorsus. Pl. VIII., fig. 28. Shell globular; spire very short; outer lip produced. U. States.

Amnicola, Anthony. A. isogona. Pl. IX., fig. 23. U. States.

? Pachystoma, Gray. M. marginata, Eocene. Paris. Peristome thickened externally, all round.

Paludomus, Swainson.

Etym., *palus*, a marsh, and *domus*, home.

Syn., tanalia, Gray. Hemimitra, Sw.

Type, P. aculeatus, Gm. sp. Pl. IX., fig. 34.

Shell, turbinated, smooth or muricated; with wavy stains beneath the olive epidermis; spire small, usually eroded; operc. horny, lamellar, nucleus external. Animal like melania; mantle-margin fringed (Eydoux).

Distr., 10 sp. Ceylon (Himalaya ?) in the mountain-streams, sometimes at an elevation of 6,000 feet. The Himalayan sp. (*melania conica*, Gray,

* This is a good section of *melania*, but Mr. Gray's type does not well represent it, being more like a pirena in the form of its aperture.

hemimitra retusa, Sw., and several others), referred to this genus, have a concentric operculum, like *paludina.*

MELANÓPSIS, Lam.

Types, M. buccinoides, M. costata. Pl. VIII., fig. 30.

Shell; body-whirl elongated; spire short and pointed; aperture distinctly notched in front; inner lip callous; operculum sub-spiral.

Distr., 20 sp. Spain, Asia Minor, New Zealand.

Fossil, 25 sp. Eocene—. Europe.

Sub-genus. Piréna, Lam. (faunus, Montf.) P. atra. Pl. VIII., fig. 31. Spire elongated, many whirled; outer lip of the adult produced.

Distr., 4 sp.? S. Africa, Madagascar, Ceylon, Philippines.

FAMILY V. TURRITELLIDÆ.

Shell tubular, or spiral; upper part partitioned off; aperture simple; operculum horny, many-whirled.

Animal with a short muzzle; eyes immersed, at the outer bases of the tentacles; mantle-margin fringed; foot very short; branchial plume single; tongue armed.

TURRITÉLLA, Lam.

Etym., diminutive of *turris,* a tower.

Syn., terebellum, torcula, zaria and eglisia, Gray.

Type, T. imbricata. Pl. IX., fig. 1.

Shell elongated, many-whirled, spirally striated; aperture rounded, margin thin; operculum horny, many-whirled; with a fimbriated margin.

Animal with long, subulate tentacles; eyes slightly prominent; foot truncated in front, rounded behind, grooved beneath; branchial plume very long; lingual ribbon minute; median teeth hooked, denticulated; uncini 3, serrulated. Carnivorous?

Distr., 50 sp. World-wide. Ranging from the Laminarian Zone to 100 fms. W. Indies, U. States, Brit. (1 sp.), Iceland, Medit., W. Africa, China, Australia, W. America.

Fossil, 170 sp., Neocomian—. Brit. &c., S. America, Australia.

Sub-genera. Proto, Defr., P. cathedralis, Pl. IX., fig. 3, aperture truncated below.

Mesalia, Gray, M. sulcata (var.) Pl. IX., fig. 2. Greenland—S. Africa.

Fossil, Eocene. Brit., France.

? ACLIS, Lovén.

Etym., A, without, *kleis,* a projection.

Syn., alvania, Leach (not Risso).

Type, A. perforatus, Mont. Pl. IX., fig. 4.

Shell minute, like turritella; spirally striated; aperture oval; outer lip prominent; axis slightly rimate; operculate.

Animal with a long retractile proboscis; tentacles close together, slender, inflated at the tips; eyes immersed at the bases of the tentacles; operc. lobe ample, unsymmetrical; foot truncated in front. Ranges to 80 fathoms water. 3 Brit. sp. Norway.

Fossil. ? sp., Miocene—. Brit. (Crag).

CÆCUM, Fleming.

Syn., corniculina, Münster. Brochus, Bronn. Odontidium, Phil.

Type, C. trachea, Pl. IX, fig. 5. Young sp., fig. 6.

Shell at first discoidal, becoming decollated when adult; tubular, cylindrical, arched; aperture round, entire; apex closed by a mammillated septum. Operc. horny, many-whirled. Lingual teeth, 0; uncini, 2, the inner broad and serrulated.

Distr., Brit., 2 sp., 10 fathoms. Medit.

Fossil, 4 sp. Eocene—. Brit., Castelarquato.

VERMETUS, Adanson. Worm-shell.

Syn., siphonium, Gray. Serpuloides, Sassi.

Types, V. lumbricalis, Pl. IX., fig. 7.

Shell tubular, attached; sometimes regularly spiral when young; always irregular in its adult growth; tube repeatedly partitioned off; aperture round; operc. circular, concave externally.

Distr., Portugal, Medit., Africa, India.

Fossil, 12 sp. Neocomian—. Brit., France, &c.

? Sub-genus. Spiroglyphus, Daud. S. spirorbis Dillw. sp., irregularly tubular; attached to other shells, and half buried in a furrow which it makes as it grows. Perhaps an annelide?

SILIQUARIA, Brug.

Etym., *siliqua*, a pod.

Type, S. anguina, Pl. IX., fig. 8.

Shell tubular; spiral at first, irregular afterwards; tube with a continuous longitudinal slit.

Distr., 7 sp. Medit., N. Australia. Found in sponges.

Fossil, 10 sp. Eocene—. France, &c.

SCALARIA, Lam. Wentle-trap.

Etym., *scalaris*, like a ladder. *Type*, S. pretiosa, Pl. IX., fig. 9 (= T. scalaris, L.)

Shell, mostly pure white and lustrous; turreted; many-whirled; whirls round, sometimes separate, ornamented with numerous transverse ribs; aperture round; peristome continuous. Operc. horny, few-whirled.

Animal with a retractile proboscis-like mouth; tentacles close together, long and pointed, with the eyes near their outer bases; mantle-margin simple, with a rudimentary siphonal fold; foot obtusely triangular, with a fold (*mentum*) in front. Lingual dentition nearly as in *bulla;* teeth 0; *uncini* numerous, simple; sexes distinct; predacious? Range from low water to 80 fathoms. The animal exudes a purple fluid when molested.

Distr., nearly 100 sp. Mostly tropical. Greenland, Norway, Brit., Medit., W. Indies, China, Australia, Pacific, W. America.

Fossil, nearly 100 sp. Coral-rag—. Brit., N. America, Chile, India.

FAMILY VI. Litorinidæ.

Shell spiral, turbinated or depressed, never pearly; aperture rounded; peristome entire; operculum horny, pauci-spiral.

Animal with a muzzle-shaped head, and eyes sessile at the outer bases of the tentacles; tongue long, armed with a median series of broad, hooked teeth, and 3 oblong, hooked uncini. Branchial plume single. Foot with a linear duplication in front, and a groove along the sole. Mantle with a rudimentary siphonal canal; operc. lobe appendaged.

The species inhabit the sea, or brackish water, and are mostly litoral, feeding on algæ.

Litorina, Férussac. Periwinkle.

Etym., *litus*, the sea-shore.

Type, L. litorea, Pl. IX., fig. 10.

Shell turbinated, thick, pointed, few-whirled; aperture rounded, outer lip acute, columella rather flattened, imperforate, operculum pauci-spiral, fig. 81. Lingual teeth hooked and trilobed; uncini hooked and dentated.

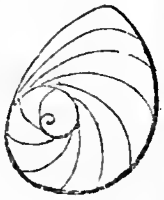


Fig. 81.

Distr., 40 sp. The periwinkles are found on the sea-shore, in all parts of the world. In the Baltic they live within the influence of fresh-water, and frequently become distorted; similar monstrosities are found in the Norwich crag.

The common sp. (*L. litorea*) is oviparous; it inhabits the lowest zones of sea-weed between tide-marks. An allied sp. (*L. rudis*) frequents a higher region, where it is scarcely reached by the tide; it is viviparous, and the young have a hard shell before their birth, in consequence of which the species is not eaten. The tongue of the periwinkle is two inches long; its foot is divided by a longitudinal line, and in walking the sides advance alternately. The periwinkle and trochus are the food of the thrush, in the Hebrides, during winter.

Fossil, 10 sp? Miocene—. Brit., &c. It is probable that a large proportion of the oolite and cretaceous shells referred to *turbo,* belong to this genus, and especially to the section *tectaria.*

Sub-genera. *Tectaria,* Cuvier, 1817 (= Pagodella, Sw.) L. pagodus, Pl. IX., fig. 11. Shell muricated or granulated; sometimes with an umbilical fissure. Operc. with a broad, membranous border. W. Indies, Zanzibar, Pacific.

Modulus, Gray (and nina, Gray) M. tectum, Pl. IX., fig. 13. Shell trochiform or naticoid; porcellanous; columella perforated; inner lip worn or toothed; operc. horny, many-whirled. *Distr.*, Philippines, W. America.

Fossarus (Adans.) Philippi. F. sulcatus, Pl. IX., fig. 12. *Syn.*, phasianema, Wood. Shell perforated; inner lip thin; operc. not spiral. *Distr.*, Medit. *Fossil,* 3 sp. Miocene—. Brit., Medit.

Risella, Gray. Lit., melanostoma, Pl. IX., fig. 14. Shell trochiform, with a flat or concave base; whirls keeled; aperture rhombic, dark or variegated, operc. pauci-spiral. Distr., N. Zealand.

SOLARIUM, Lam. Stair-case-shell.

Etym., solarium, a dial.

Syn., architectoma, Bolten. Philippia, Gray. Helicocryptus, D'Orb?

Type., S. perspectivum, Pl. IX., fig. 15.

Shell orbicular, depressed; umbilicus wide and deep; aperture rhombic; peristome thin; operculum horny, sub-spiral.

The spiral edges of the whirls, seen in the umbilicus, have been fancifully compared to a winding stair-case.

Distr., 25 sp. Tropical seas. Medit., E. Africa, India, China, Japan, Australia, Pacific, W. America.

Fossil, 56 sp. Eocene—. Brit., &c. 26 other sp. (oolites—chalk,) are provisionally referred to this genus; the cretaceous sp. are *nacreous* (v. trochus).

Sub-genera. Torinia, Gray. T. cylindracea, operc. conical, multi-spiral, with projecting edges, fig. 82. Living, New Ireland. *Fossil,* Eocene. Brit. Paris.

Omalaxis, Desh. (altered to *bifrontia*) S. bifrons, discoidal, the last whirl disengaged. 6 sp. Eocene, Paris, Brit.

? Orbis, Lea. Discoidal, whirls quadrate. *Fossil,* Eocene, America.

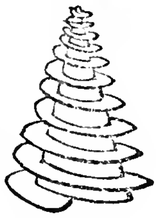


Fig. 82.*

? PHORUS, Montf. Carrier-shell.

Etym., phoreus, a carrier.

Syn., onustus, Humph., Xenophorus, Fischer.

Examples, P. conchyliophorus, Born. P. corrugatus, Pl. X., fig. 1.

Shell trochiform, concave beneath; whirls flat, with foliaceous or stellated margins, to which shells, stones, &c., are usually affixed; aperture very oblique, not pearly; outer lip thin, much produced above, receding far beneath. Operc. horny, imbricated, nucleus external (as in *purpura* and *paludomus,*) with the transverse scar seen through it, fig. 83. (Mus. Cuming.)

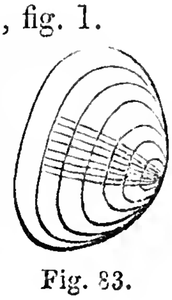


Fig. 83.

* Operculum of S. patulum, Lam. $\frac{3}{1}$, from Deshayes.

Animal with an elongated (non-retractile ?) proboscis; tentacles long and slender, with sessile eyes at their outer bases; sides plain; foot narrow, elongated behind. (Adams.) Related to *scalaria ?*

Most of the phori attach foreign substances to the margins of their shells, as they grow; particular species affecting stones, whilst others prefer shells or corals. They are called "mineralogists," and "conchologists," by collectors; P. solaris and P. indicus are nearly or quite free from these disguises. They are said to frequent rough bottoms, and to scramble over the ground, like the strombs, rather than glide evenly.

Distr., 9 sp. W. Indies, India, Malacca, Philippines, China, W. America.

Fossil, 15 sp. Chalk ?—Eocene—. Brit., France. Shells extremely like the recent *phorus*, are met with even in the carb. limestone.

Lacuna, Turton.

Etym., *lacuna*, a fissure.

Type, L. pallidula, Pl. IX., fig. 16. *Syn.*, medoria, Gray.

Shell, turbinated, thin; aperture semi-lunar; columella flattened, with an umbilical fissure. Operc. pauci-spiral.

Animal, operculigerous lobe furnished with lateral wings and tentacular filaments. Teeth, 5 cusped; uncini 1, 2 dentated, 3 simple. Spawn (*ootheca*) vermiform, thick, semicircular. Range, low-water—50 fathoms.

Distr., Northern shores, Norway, Brit., Spain. *Fossil*, 1 sp. Glacial beds, Scotland.

? Litiopa, Rang.

Etym., *litos*, simple, *ope*, aperture.

Type, L. bombix. Pl. IX., fig. 24.

Shell minute, pointed; aperture slightly notched in front; outer lip simple, thin; inner lip reflected. Operc. spiral.

Distr., Atlantic, Medit., on floating sea-weed, to which they adhere by threads. *Fossil*, 1 sp. Miocene (Crag.).

Rissoa, Frémenville.

Etym., named after Risso,* a French zoologist.

Type, R. labiosa, Pl. IX., fig. 17. *Syn.*, cingula, Flem.

Shell minute, white or horny; conical, pointed, many-whirled; smooth, ribbed, or cancellated; aperture rounded; peristome entire, continuous; outer lip slightly expanded and thickened. Operc. sub-spiral.

The animal has long, slender tentacles, with eyes on small prominences near their outer bases; the foot is pointed behind; the operculigerous lobe has a wing-like process and a filament (*cirrus*) on each side. Lingual teeth single, sub-quadrate, hooked, dentated; uncini 3; 1 dentated, 2, 3, claw-

* It is much to be regretted that some modern naturalists have tried to find out and bring into use the obscure genera of Risso, and the worthless fabrications of Montfort and Rafinesque, which had better have remained unknown.

shaped. They range from high-water to 100 fathoms, but abound most in shallow water, near shore, on beds of *fucus* and *zostera*.

Distr., about 70 sp. Universally distributed, but most abundant in the north temperate zone. N. America, W. Indies, Norway, Brit., Medit., Caspian, India, &c. *Rissoa parva* adheres to sea-weeds, by threads, like litiopa (Gray).

Fossil, 100 sp. Permian—. Brit., France, &c.

Sub-genera. Rissoina, D'Orb. Aperture channelled in front. Living and Fossil (10 sp. Bath oolite.— Brit.) =*Tuba*, Lea? America.

Hydrobia, Hartm. (=Paludinella, Lovén. Paludestrina, D'Orb.) *Shell* smooth; foot rounded behind; operc. lobe without filament. *Type*, litorina ulvæ, Pl. IX., fig. 18. *Fossil*, 10 sp. Wealden—. Brit., &c.

Syncera, Gray (Assiminea, Leach). S. hepatica. *Shell* like Hydrobia; tentacles connate with the eye pedicels, which equal them in length. Teeth 5—7 cusped; uncini 1, 2, dentated, 3 rounded. *Distr.*, brackish water. Brit., India.

Nematura, Benson. N. deltæ. Pl. IX., fig. 21. Aperture contracted; peristome entire. Operc. pauci-spiral. *Fossil*, eocene. Isle of Wight.

Jeffreysia, Alder (=Rissoëlla, Gray, MS.), J. diaphana. Shell minute, translucent. Operc. semilunar, imbricated, with a projection from the straight, inner side. (Pl. IX., fig. 19.) Head elongated, deeply cleft, and produced into two tentacular processes; mouth armed with denticulated jaws, and a spinous tongue; tentacles linear, eyes far behind, prominent, only visible through the shell; foot bi-lobed in front. 2 sp. Brit. On sea-weed, near low water (Alder).

Skenea, Fleming.

Etym., named after Dr. Skene of Aberdeen; a cotemporary of Linnæus.

Syn., delphinoïdea, Brown.

Type, S. planorbis, Pl. IX., fig. 20.

Shell minute orbicular, depressed, few-whirled; peristome continuous, entire, round. Operc. pauci-spiral. Animal like rissoa, foot rounded behind. Found under stones at low-water, and amongst the roots of *corallina officinalis*.

Distr., ? sp. Northern seas. Norway, Brit.

? Truncatella, Risso. Looping-snail.

Type, T. truncatula. Pl. IX., fig. 25. (Mus., Hanley.)

Shell minute, cylindrical, truncated; whirls striated transversely; aperture oval, entire; peristome continuous. Operculum sub-spiral!

Animal with short, diverging triangular tentacles; eyes centrally behind; head bi-lobed; foot short, rounded at each end (Forbes).

The truncatellæ are found on stones and sea-weeds between tide-marks, and survive many weeks out of the water (Lowe). They walk by contracting the space between their lips and foot, like the geometric caterpillars (Gray). They are found semi-fossil, along with the human skeletons in the modern limestone of Guadaloupe.

Distr., 15 sp. W. Indies, Brit., Medit., Rio, Cape, Mauritius, Philippines, Australia, Pacific (Cuming).

? LITHOGLYPHUS, Megerle.

Type, L. fuscus. Pl. IX., fig. 22.

Shell naticoid, often eroded; whirls few, smooth; aperture large, entire; peristome continuous, outer lip sharp, inner lip callous; umbilicus rimate; epidermis olivaceous; operculum pauci-spiral.

Distr., sp. Europe, Oregon.

FAMILY VII. PALUDINIDÆ.

Shell conical or globular, with a thick, olive-green epidermis; aperture rounded; peristome continuous, entire; operculum horny or shelly, normally concentric.

Animal with a broad muzzle; tentacles long and slender; eyes on short pedicels, outside the tentacles. Inhabiting fresh-waters in all parts of the world.

PALUDINA, Lam. River-snail.

Etym., *palus* (paludis) a marsh. *Syn.*, viviparus, Gray.

Type, P. Listeri. Pl. IX., fig. 26. (P. vivipara, fig. 61.)

Shell turbinated, with round whirls; aperture slightly angular behind; peristome continuous, entire; operc. horny, concentric. *Animal* with a long muzzle, and very short eye-pedicels; neck with a small lappet on the left side, and a larger on the right, folded to form a respiratory siphon; gill comb-like, single; tongue short; teeth single, oval, slightly hooked and denticulated; uncini 3, oblong, denticulated. The paludinæ are viviparous; the shells of the young are ornamented with spiral rows of epidermal cirri.

Distr., 60 sp. Rivers and lakes throughout the N. hemisphere; Black sea, Caspian.

Fossil, 50 sp. Weald—. Brit., &c.

Sub-genus. *Bithinia* (Prideaux), Gray. B. tentaculata, Pl. IX., fig. 27. Shell small; operc. shelly. Animal oviparous; with only one neck-lappet, on the right side. The bithiniæ oviposit on stones and aquatic plants; the female lays from 30 to 70 eggs in a band of three rows, cleaning the surface as she proceeds; the young are hatched in three or four weeks, and attain their full growth in the second year (Bouchard).

AMPULLARIA, Lam. Apple-snail, or idol-shell.

Etym., *ampulla*, a globular flask.

Ex., A. globosa, Pl. IX., fig. 30. *Syn.*, pachylabra, Sw.

Shell globular, with a small spire, and a large ventricose body-whirl; peristome thickened and slightly reflected. Operc. shelly.

Animal with a long incurrent siphon, formed by the left neck-lappet; left gill developed, but much smaller than the right*; muzzle produced into

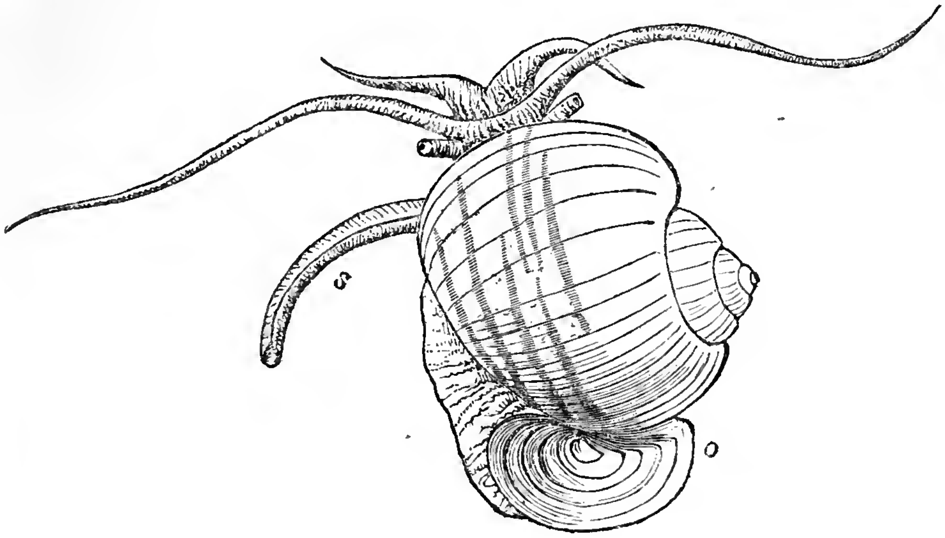


Fig. 84.†

two long tentacular processes; tentacles extremely elongated, slender. Inhabits lakes and rivers throughout the warmer parts of the world, retiring deep into the mud in the dry season, and capable of surviving a drought, or removal from the water for many years. In the lake Mareotis, and at the mouth of the Indus, ampullariæ are abundant, mixed with marine shells. Their eggs are large, inclosed in capsules, and aggregated in globular masses.

Distr., 50 sp. S. America, West Indies, Africa, India.

Sub-genera. *Pomus*, Humph. A. ampullacea. Operc. horny.

Marisa, Gray (ceratodes, Guilding). A. cornu-arietis. Pl. IX., fig. 31. Operc. horny. Shell discoidal.

Asolene, D'Orb. A. platæ. Animal without a respiratory siphon; operc. shelly. Distr., S. America.

Lanistes, Montf. A. bolteniana, L., Pl. IX., fig. 32. Shell reversed, umbilicated, peristome thin; operc. horny. Distr., W. Africa, Zanzibar, Nile.

Meladomus, Sw. Paludina olivacea, Sby. Shell reversed, imperforate; peristome thin; operc. horny.

? Amphibola, Schumacher.

Syn., ampullacera, Quoy. Thallicera, Sw.

* The ampullaria is said to have a pulmonic sac in addition to its gills (Gray, Owen), but we have not met with specimens sufficiently well preserved to exhibit it. It would be very desirable to examine the amp. cornu-arietis, in which, probably, the gills are symmetrical, as in the cephalopods.

† Fig. 84. Ampullaria canaliculata, Lam. (from D'Orb.) South America. The branchial siphon (*s*) is seen projecting from the left side; *o*, operculum

Type, A. australis, Pl. IX., fig. 33.

Shell globular, with an uneven, battered, surface; columella fissured; outer lip channelled near the suture; operc. horny, sub-spiral. *Animal* without tentacles; eyes placed on round lobes; air-breathing; respiratory cavity closed, except a small valvular opening on the right side; a large gland occupies the position of the gill of paludina; sexes united (Quoy). Mr. Gray places this genus amongst the true *pulmonifera*.

Distr., 3 sp. Shores of New Zealand and the Pacific Islands. The living shells sometimes have *serpulæ* attached to them (Cuming). They are eaten by the New Zealanders.

VALVATA, Müller. Valve-shell.

Types, V. piscinalis, Pl. IX., fig. 28. V. cristata, Pl. IX., fig. 29.

Shell turbinated, or discoidal, umbilicated; whirls round or keeled; aperture not modified by the last whirl; peristome entire; operc. horny, multispiral.

Animal with a produced muzzle; tentacles long and slender, eyes at their outer bases; foot bi-lobed in front; branchial plume long, pectinated, partially exserted on the right side, when the animal is walking. Lingual teeth broad; uncini 3, lanceolate; all hooked and denticulated.

Distr., 6 sp. Brit., N. America.

Fossil, 19 sp. Wealden—. Brit., Belgium, &c.

FAMILY VIII. NERITIDÆ.

Shell thick, semi-globose; spire very small; cavity simple, from the absorption of the internal portions of the whirls; aperture semi-lunate; columellar side expanded and flattened; outer lip acute. Operculum shelly, sub-spiral, articulated.

At each end of the columella there is an oblong muscular impression, connected on the outer side by a ridge, on which the operculum rests; within this ridge the inner layers of the shell are absorbed.

Animal with a broad, short muzzle, and long slender tentacles; eyes on prominent pedicels, at the outer bases of the tentacles; foot oblong, triangular. Lingual dentition similar to the *turbinidæ*. Teeth 7; uncini very numerous.

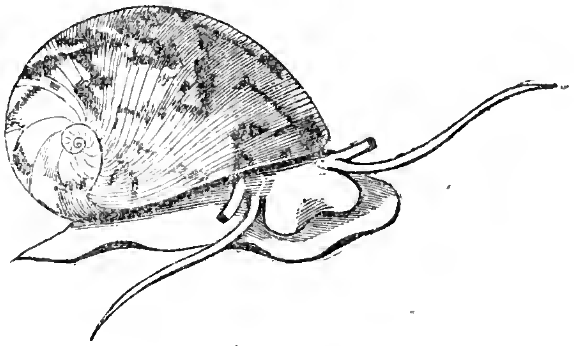


Fig. 85.*

* Fig. 85. Nerita polita, L. (from Quoy and Gaimard) New Ireland.

NERITA, L. Nerite.

Etym. *Nerites*, a sea-snail, from nereïs.

Type, N. ustulata, Pl. IX., fig. 35.

Shell thick, smooth or spirally grooved; epidermis horny; outer lip thickened and sometimes denticulated within; columella broad and flat, with its inner edge straight and toothed; operc. shelly, fig. 86.

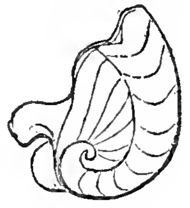


Fig. 86.*

Distr., 116 sp. Nearly all warm seas. W. Indies, Red Sea, Zanzibar, Philippines, Australia, Pacific, W. America, (Cuming).

Fossil, 60 sp. Lias—. Brit. &c. The palæozoic nerites are referred by D'Orbigny to *turbo, natica*, &c. N. haliotis is a *pileopsis*.

Sub-genera. Neritoma, Morris, 1849. N. sinuosa, Sby. Portland stone, Swindon. (Mus., Lowe). Shell ventricose, thick; apex eroded; aperture with a notch in the middle of the outer lip. Casts of this shell are common, and exhibit the condition of the interior characteristic of all the *nerites;* it was probably fresh-water.

Neritopsis, Grateloup. N. radula, Pl. VIII., fig. 9. Shell like *nerita;* inner lip with a single notch in the centre.

Distr., 1 sp. Pacific. *Fossil*, 20 sp. Trias ? Brit., France, &c.

Velates, Montf. N. perversa, Gm. Pl. IX., fig. 36. Inner lip very thick and callous; outer lip prolonged behind, and partially enveloping the spire.

PILEOLUS, (Cookson) J. Sowerby.

Etym., *pileolus*, a little cap.

Type, P. plicatus, Pl. IX., fig. 37, 38.

Shell limpet-like above, with a sub-central apex; concave beneath, with a small semi-lunar aperture, and a columellar disk, surrounded by a broad continuous peristome.

Distr., marine; only known as fossils of the Bath oolite, Ancliffe, and Minchinhampton, 3 sp. *P. neritoides* is a neritina.

NERITINA, Lam. Fresh-water nerite.

Examples, N. zebra, Pl. IX., fig. 39. N. crepidularia, Pl. IX., fig. 40.

Shell rather thick at the aperture, but extensively absorbed inside; outer lip acute; inner straight denticulated; operc. shelly, with a flexible border; slightly toothed on its straight edge.

Animal like *nerita;* lingual teeth;—median, minute; laterals 3, 1 large, sub-triangular, 2, 3, minute; uncini about 60, first very large, hooked, denticulated; the rest equal, narrow, hooked, denticulated.

The neritinæ are small globular shells, ornamented with a great variety of black or purple bands and spots, covered with a polished horny epidermis.

* Fig. 86. Operculum of N. peloronta. W. Indies.

They are mostly confined to the fresh waters of warm regions. One sp. (N. fluviatilis) is found in Brit. rivers, and in the brackish water of the Baltic. Another extends its range into the brackish waters of the N. American rivers. And the West Indian *N. viridis* and *meleagris*, are found in the sea.

N. crepidularia has a continuous peristome, and approaches *navicella* in form; it is found in the brackish waters of India. N. corona (Madagascar) is ornamented with a series of long tubular spines.

Distr., 76 sp. W. Indies, Norway, Brit., Black Sea, Caspian, India, Philippines, Pacific, W. America.

Fossil, 20 sp. Eocene—. Brit., France. &c.

NAVICELLA, Lam.

Etym., *navicella*, a small boat. *Type*, N. porcellana. Pl. IX., fig. 41.

Shell oblong, smooth, limpet-like; with a posterior, sub-marginal apex; aperture as large as the shell, with a small columellar shelf, and elongated lateral muscular scars; operculum very small, shelly.

Distr., 18 sp. India, Mauritius, Moluccas, Australia, Pacific.

FAMILY IX., TURBINIDÆ.

Shell spiral, turbinated or pyramidal, nacreous inside; operculum calcarious and pauci-spiral, or horny and multi-spiral.

Animal with a short muzzle; eyes pedunculated at the outer bases of the long and slender tentacles; head and sides ornamented with fringed lobes and tentacular filaments (*cirri*); branchial plume single; lingual ribbon long and linear, chiefly contained in the visceral cavity; median teeth broad; laterals 5, denticulated; uncini very numerous (sometimes nearly 100), slender, with hooked points (Fig. 15, A.).

Marine, feeding on sea-weeds (*algæ*).

The shells of nearly all the turbinidæ are brilliantly pearly, when the epidermis and outer layer of shell are removed; many of them are used in this state for ornamental purposes.

TURBO, L. Top-shell.

Etym., *turbo*, a whipping-top.

Syn., batillus, marmorostoma, callopoma, &c. (Gray).

Type, T. marmoratus. Pl. X., fig. 2.

Shell turbinated, solid; whirls convex, often grooved or tuberculated; aperture large, rounded, slightly produced in front; operculum shelly and solid, callous outside, and smooth, or variously grooved and mammillated, internally horny and pauci-spiral. In *T. sarmaticus* the exterior of the operculum is botryoidal, like some of the tufaceous deposits of petrifying wells.

Animal with pectinated head-lobes.

Distr., 60 sp. Tropical seas, W. Indies, Medit., Cape, India, China, Australia, New Zealand, Pacific, Peru.

Fossil, 360 sp. (including litorina) L. Silurian—. Universal.

PHASIANELLA, Lam. Pheasant-shell.

Syn., eutropia (Humphr.) Gray. Tricolea, Risso.

Type, P. australis. Pl. X., fig. 3.

Shell elongated, polished, richly coloured; whirls, convex; aperture oval, not pearly; inner lip callous, outer thin; operc. shelly, callous outside, sub-spiral inside.

Animal with long ciliated tentacles; head-lobes pectinated, wanting in the minute sp.; neck-lobes fringed; sides ornamented with 3 cirri; branchial plume long, partly free; foot rounded in front, pointed behind; its sides moved alternately in walking; lingual teeth even-edged; laterals 5, hooked, denticulated; uncini about 70, gradually diminishing outwards, hooked and denticulated.

Distr., 25 sp. Australia, large sp. India, Philippines; small sp. Medit., Brit., W. Indies, very small sp.

Fossil, 70 sp. Devonian ?—. Europe.

The similarity of the existing Australian fauna, to that of the European oolites, strengthens the probability that some, at least, of these fossil shells are rightly referred to Phasianella.

IMPERATOR, Montf.

Type, I, imperialis, Pl. 10, fig. 4. *Syn.*, calcar.

Shell trochiform, thick, with a flat or concave base; whirls keeled or stellated; aperture angulated outside, brilliantly pearly; operc. shelly.

Distr., 20 sp. ? S. Africa, India, Australia, New Zealand.

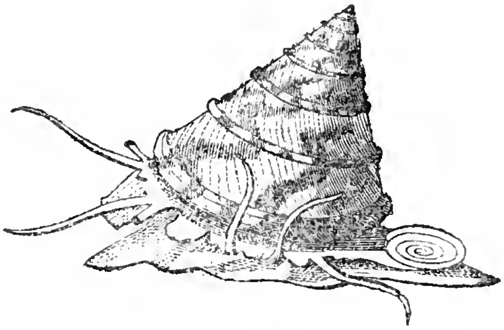


Fig. 87.*

TROCHUS, L.

Etym., *trochus*, a hoop.

Syn., cardinalia, tegula, and livona, Gray. Infundibulum, Montf. Chlorostoma, Sw. Trochiscus, Sby. Monilea, Sw.

Types, T. niloticus. Pl. X., fig. 5. T. zizyphinus. Fig. 87.

* Fig. 87. *Trochus zizyphinus*, L., Pegwell Bay, Kent.

Shell pyramidal, with nearly a flat base; whirls numerous, flat, variously striated; aperture oblique, rhombic, pearly inside; columella twisted, slightly truncated; outer lip thin; operculum horny, multi-spiral. Fig. 88 (T. pica).

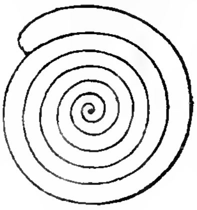


Fig. 88.

Animal with 2 small or obsolete head-lobes between the tentacles; neck lappets large: sides ornamented with lobes, and 3—5 cirri; gill very long, linear; lingual teeth 11, denticulated; uncini—90, diminishing outwards.

Distr., 150 sp. World-wide. Low-water to 15 fathoms; the smaller species range nearly to 100 fathoms.

Fossil, 360 sp. Devonian—. Europe, N. America, Chile.

Sub-genera. *Pyramis*, Chemn., Tr. obeliscus, Pl. X., fig. 6, columella contorted, forming a slight canal.

Gibbula, Leach. Tr. magus, Brit. Shell depressed, widely umbilicated; whirls tumid. Head-lobes largely developed; lateral cirri 3.

Margarita, Leach. Tr. helicinus. Pl. X., fig. 7. Shell thin; cirri 5 on each side. Distr., 17 sp. Greenland, Brit., Falkland Islands. Near low-water, under stones and sea-weed.

Elenchus, Humph. (= Canthiridus, Montf.) E. iris. Pl. X., fig. 8. Smooth, thin, imperforate, with a prominent base. Australia, N. Zealand. *F. iris* scarcely differs in form from Tr. zizyphinus; *E. badius* is like a pearly phasianella; and *E. varians* (bankivia, Menke) would be called a *chemnitzia*, if fossilized. Pl. X., fig. 9.

Rotella, Lamarck.

Etym., diminutive of *rota*, a wheel. (Syn., Helicina, Gray!)

Type, R. vestiaria. Pl. X., fig. 10.

Shell, lenticular, polished; spire depressed; base callous; lingual teeth 13; uncini numerous, sub-equal.

Distr., 10 sp. India, Philippines, China, New Zealand.

Monodonta, Lam.

Etym., *monos*, one, and *odous*, (odontos) a tooth.

Syn., labio, Oken. Clanculus, Montf. Otavia, Risso.

Types, M. labeo. Pl. X., fig. 11. M. pharaonis. Pl. X., fig. 12.

Shell, turbinated, few-whirled; whirls spirally grooved and granulated; lip thickened internally, and grooved; columella toothed, more or less prominently and irregularly; operc. horny, many-whirled.

Distr., 10 sp? W. Africa, Red Sea, India, Australia.

Fossil, (included with trochus) Devonian—. Eifel.

Delphinula (Roissy), Lam.

Etym., diminutive of *delphinus*, a dolphin. (= Cyclostoma, Gray!)

Type, D. laciniata. Pl. X., fig. 13. (= T. delphinus, L.)

Shell orbicular, depressed; whirls few, angulated, rugose, or spiny; aperture round, pearly; peristome continuous; umbilicus open; operculum horny, many-whirled. On reefs, at low-water.

Animal without head-lobes; sides lobed and cirrated.

Distr., 20 sp. Red Sea, India, Philippines, China, Australia.

Fossil, 30 sp.? Trias ?—Miocene—. Europe.

Sub-genera. Liotia, Gray. L. gervillii. Pl. X., fig. 14. Aperture pearly, with a regular, expanded border. Operc. multi-spiral, calcarious. *Distr.*, 6 sp. Cape, India, Philippines, Australia. *Fossil*, Eocene—. Brit., France.

Collonia, Gray, 1850. C. marginata. Pl. X., fig. 16. Peristome simple. Operc. calcarious, with a spiral rib on the outer side. *Distr.*, Africa. *Fossil*, Eocene—. Paris.

Cyclostrema, Marryat. C. cancellata, Pl. X., fig. 15. Shell nearly discoidal, cancellated, not pearly; aperture round, simple; umbilicus wide. Operc. spiral, calcarious. *Distr.*, 12 sp. Cape, India, Philippines, Australia, Peru. In 5—17 fathoms. *Serpularia*, Rœmer, has the whirls smooth and dis-united. Eocene, Paris.

Adeorbis, Searles Wood.

Type, A. sub-carinatus. Pl. X., fig. 17.

Shell minute, not nacreous, depressed, few-whirled, deeply umbilicated; peristome entire, nearly continuous, sinuated in its inner side, and slightly so externally. Operc. shelly, multi-spiral.

Distr., W. Indies—China. Low-water to 60 fathoms.

Fossil, 5 sp. Miocene—. Brit.

Euomphalus, Sowerby.

Etym., *eu*, wide, and *omphalos*, umbilicus.

Syn., schizostoma, Bronn. Maclurea, Leseuer. Ophileta, Vanuxem. Platyschisma, McCoy.

Type, E. pentagonalis. Pl. X., fig. 18.

Shell depressed or discoidal; whirls angular or coronated; aperture polygonal; umbilicus very large. Operc. shelly, round, multi-spiral (Salter).

Fossil, 80 sp., L. sil.—Trias. N. America, Europe, Australia.

Sub-genus. Phanerotinus, J. Sby. 1840, E. cristatus, Phil. Carb. limestone. Brit. Shell discoidal; whirls separate; outer margin sometimes foliaceous.

Stomatella, Lam.

Etym., diminutive of *stoma*, the aperture.

Type, S. imbricata. Pl. X., fig. 19.

Shell ear-shaped, regular; spire small; aperture oblong, very large and oblique, nacreous; lip thin, even-edged; operc. circular, horny, multi-spiral. On reefs and under stones at low-water.

Distr., 20 sp. Cape, India, N. Australia, China, Japan, Philippines.

Sub-genus ? Gena, Gray. Spire minute, marginal; no operculum. 16 sp. Red Sea, India, Scychelles, Swan River, Philippines (Adams).

Broderipia, Gray.

Etym., named in honour of W. J. Broderip, Esq., the distinguished conchologist.

Type, B. rosea. Pl. X., fig. 20.

Shell minute, limpet-shaped, with a posterior sub-marginal apex; aperture oval, as large as the shell, brilliantly nacreous.

Distr., 3 sp. Philippines; Grimwood's Island, S. Seas (Cuming).

FAMILY X. Haliotidæ.

Shell spiral, ear-shaped or trochiform; aperture large, nacreous; outer lip notched or perforated. No operculum.

Animal with a short muzzle and subulate tentacles; eyes on pedicels at the outer bases of the tentacles; branchial plumes 2; mantle-margin with a posterior (anal) fold or siphon, occupying the slit or perforation in the shell; operc. lobe rudimentary; lingual dentition similar to trochus.

In addition to the true haliotids, we have retained in this group such of the trochi-form shells as have a notched or perforated aperture.

Haliotis, L. Ear-shell.

Etym., *halios*, marine, and *ous* (otos) an ear.

Type, H. tuberculata, Pl. X., fig. 21.

Shell ear-shaped, with a small flat spire; aperture very wide, iridescent; exterior striated, dull; outer angle perforated by a series of holes, those of the spire progressively closed. Muscular impresssion horse-shoe shaped, the left branch greatly dilated in front. In *H. tricostalis* (padollus, Montf.) the shell is furrowed parallel with the line of perforations.

Animal with fimbriated head-lobes; side-lobes fimbriated and cirrated; foot very large, rounded. Lingual teeth;—median small; laterals single, beam-like; uncini about 70, with denticulated hooks, the first 4 very large.

The haliotis abounds on the shores of the Channel Islands, where it is called the ormer, and is cooked after being well beaten to make it tender. (Hanley); it is also eaten in Japan. It is said to adhere very firmly to the rocks, with its large foot, like the limpet. The shell is much used for inlaying, and other ornamental purposes.

Distr., 75 sp. Brit., Canaries, Cape, India, China, Australia, New Zealand, Pacific, California.

Fossil, 4 sp. Miocene—. Malta, &c.

Sub-genus ? Deridobranchus, Ehrenberg, D. argus, Red Sea. Shell large and thick, like haliotis, but entirely covered by the thick, hard, plaited mantle of the animal.

Stomatia (Helblin), Lamarck.

Etym., *stoma*, the aperture.

Type, S. phymotis, Pl. X., fig. 22.

Shell like haliotis, but without perforations, their place being occupied by a simple furrow; surface rugose, spirally ridged; spire small, prominent aperture large, oblong, outer margin irregular.

Distr., 12 sp. Java, Philippines, Torres Straits, Pacific. Under stones at low water (Cuming).

Fossil. M. D'Orbigny refers to this genus 18 sp., ranging from the L. Silurian to the chalk, N. America, Europe.

Scissurella, D'Orb.

Etym., diminutive of *scissus*, slit.

Type, S. crispata, Pl. X., fig. 23. *Syn.*, anatomus, Montf.

Shell minute, thin, not pearly; body-whirl large; spire small; surface striated; aperture rounded, with a slit in the margin of the outer lip. Operculate.

Distr., 5 sp. Norway, Brit., Medit. In 7 fathoms water off the Orkneys, and in deep water cast of the Zetland Isles.

Fossil, 4 sp. Miocene—. Brit., Sicily.

Pleurotomaria, Defrance.

Etym., *pleura*, side, and *tome*, notch.

Type, P. anglica, Pl. X., fig. 24.

Shell, trochiform, solid, few-whirled, with the surface variously ornamented; aperture sub-quadrate, with a deep slit in its outer margin. The part of the slit which has been progressively filled up, forms a band round the whirls.

Fossil, 400 sp. Lower silurian—chalk. N. America, Europe, Australia. Specimens from clay strata retain their nacreous inner layers, those from the chalk and limestones have lost them, or they are replaced by crystalline spar. Pleurotomariæ with wavy bands of colour have been obtained in the carb. limestone of Lancashire. In this extensive group there are some species which rival the living turbines in magnitude and solidity, whilst others are as frail as ianthina.

Sub-genus. *Scalites*, Conrad (= raphistoma, Hall.) *E.g.*, S. angulatus and stamineus. L. silurian, New York. Shell thin; whirls angular, flat above (tabulated), 8 sp. L. silurian—carb. *Poly-tremaria*, D'Orb., is founded on P. catenata, Koninck, in which the margins of the slit are wavy, converting it into a series of perforations.

Murchisonia, D'Archiac.

Etym., named in honour of Sir Roderick I. Murchison.

Type, M. bilineata. Pl. X., fig. 25.

Shell elongated, many-whirled; whirls variously sculptured, and zoned like pleurotomaria; aperture slightly channelled in front; outer lip deeply notched.

The murchisoniæ are characteristic fossils of the palæozoic rocks; they have been compared to elongated pleurotomariæ, or to cerithia with notched apertures; the first suggestion is most probably correct.

Fossil, 50 sp. L. silurian—Permian. N. America, Europe.

TROCHOTOMA, Lycett.

Etym., *trochus,* and *tome,* a notch.

Syn., ditremaria, D'Orb.

Type, T. conuloides. Pl. X., fig. 26.

Shell trochiform, slightly concave beneath; whirls flat, spirally striated, rounded at the outer angles; lip with a single perforation near the margin.

Fossil, 10 sp. Lias—Coral Rag. Brit., France, &c.

? CIRRUS, Sowerby.

Etym., *cirrus,* a curl.

Type, C. nodosus, Sby. Min. Con. t. 141 and 219.

Shell sinistral, trochiform, base level; last whirl enlarging rather more rapidly, somewhat irregular.

Fossil, 2 sp. Inf. oolite, Bath oolite. Brit., France.

This genus was founded on a pleurotomaria, a euomphalus, and C. nodosus. (v. Min. Con.) It is still doubtful what species may be referred to it.

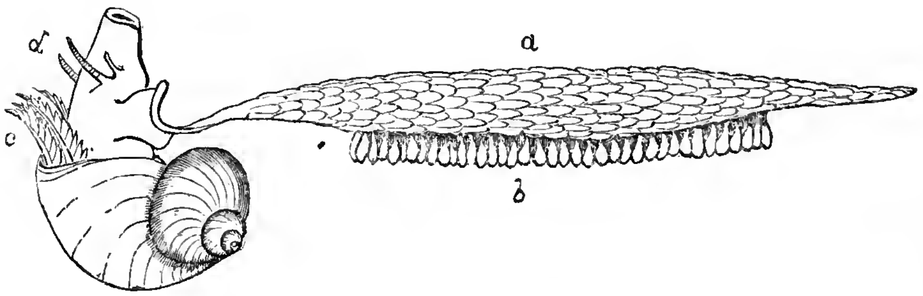


Fig. 89.*

IANTHINA, Lam. Violet-snail.

Etym., *ianthina,* violet-coloured.

Type, helix ianthina L. (I. fragilis, Lam.) Pl. X., fig. 27.

Shell thin, translucent, trochiform; nucleus minute, styliform, sinistral; whirls few, rather ventricose; aperture four-sided; columella tortuous; lip thin, notched at the outer angle. Base of the shell deep violet, spire nearly white.

Animal:—head large, muzzle-shaped, with a tentacle and eye-pedicel on

* Fig. 89. Ianthina fragilis, Lam. (from Quoy and Gaimard). Atlantic. *a* raft, *b* egg capsules, *c* gills, *d* tentacles and eye-stalks.

each side, but no eyes; foot small, secreting a float composed of numerous cartilaginous air-vesicles, to the under surface of which the ovarian capsules are attached. Lingual ribbon, rachis unarmed; uncini numerous, simple (like *scalaria*). Branchial plumes 2. Sexes separate.

Distr., 6 sp. Atlantic, Coral sea.

The ianthinæ, or oceanic-snails, are gregarious in the open sea, where they are found in myriads, and are said to feed on the small blue acalephæ (*velella*). They are frequently drifted to the southern and western British shores, especially when the wind continues long from the S.W.; in Swansea bay the animals have been found quite fresh. When handled they exude a violet fluid from beneath the margin of the mantle. In rough weather they are driven about and their floats broken, or detached, in which state they are often met with. The capsules beneath the further end of the raft have been observed to be empty, at a time when those in the middle contained young with fully formed shells, and those near the animal were filled with eggs. They have no power of sinking and rising in the water. The raft, which is much too large to be withdrawn into the shell, is an extreme modification of the operculum.

FAMILY XI. Fissurellidæ.

Shell conical, limpet-shaped; apex recurved; nucleus spiral, often disappearing in the course of growth; anterior margin notched, or apex perforated; muscular impression horse-shoe shaped, open in front.

Animal with a well-developed head, a short muzzle, subulate tentacles, and eyes on rudimentary pedicels at their outer bases; sides ornamented with short cirri; branchial plumes 2, symmetrical; anal siphon occupying the anterior notch or perforated summit of the shell. Lingual dentition similar to trochus.*

Fissurella, Lam. Key-hole limpet.

Etym., diminutive of *fissura*, a slit.

Type, F. Listeri. Pl. XI., fig. 1.

Shell oval, conical, depressed with the apex in front of the centre and perforated; surface radiated or cancellated; muscular impression with the points incurved.

In very young shells the apex is entire and sub-spiral; but as the perforation increases in size it encroaches on the summit and gradually removes it. The key-hole limpets are locomotive; they chiefly inhabit the laminarian zone, but range downwards to 50 fms.

Distr., 120 sp. America, Brit., S. Africa, India, China, Australia. U. California—Cape Horn.

* Fissurella is the best gasteropod for comparison with the bivalves; its large gills, placed one on each side, and its symmetrical shell, pierced with a median orifice for the escape of the out-going branchial current, are unmistakeable indications of homologies with the lamelli-branchiata. See p. 48.

Fossil, 25 sp. Carb. ? oolites—. Brit., France.

Sub-genera. Pupillia, Gray. F. apertura, Born. (= hiantula, Lam.) Shell smooth, surrounded by a sharp white edge; perforation very large. *Distr.,* S. Africa.

Fissurellidæa, D'Orb. F. hiatula, Lam. (=megatrema, D'Orb.) Shell cancellated; covered by the mantle of the animal. 3 sp. Cape, Tasmania.

(*Macroschisma,* Sw.) F. macroschisma. Pl. XI., fig. 2. Anal aperture close to the *posterior* margin of the shell. The animal is so much larger than its shell, as to be compared to the *testacelle* by Mr. Cuming. Distr., Philippines, Swan river.

Lucapina, Gray. F. elegans, Gray (=aperta, Sby.). Shell white, cancellated, margin crenulated; covered by the reflected mantle. 3 sp. California.

PUNCTURELLA, Lowe.

Syn., cemoria, Leach. Diadora, Gray.

Type, P. noachina. Pl. XI., fig. 3.

Shell conical, elevated, with the apex recurved; perforation in front of the apex, with a raised border internally; surface caucellated.

Distr., 2 sp. Greenland, Boreal America, Norway, N. Brit., Tierra-del-fuego. In 20—100 fathoms water.

Fossil, in the glacial formations of N. Brit.

RIMULA, Defrance.

Etym., diminutive of *rima,* a fissure. (Syn., Rimularia.)

Recent type, R. Blainvillii. Pl. XI., fig. 4.

Shell thin and cancellated, with a perforation near the anterior margin.

Distr., several sp. found on sandy mud at low-water, or dredged in from 10—25 fms. Philippiues (Cuming).

Fossil, 3 sp. Bath oolite—coral-rag. Brit., France.

EMARGINULA, Lam.

Etym., dimunitive of *emarginata,* notched.

Type, E. reticulata. Pl. XI., figs. 5, 6.

Shell oval, conical, elevated, with the apex recurved; surface cancellated; anterior margin notched, Muscular impressiou with recurved points. The *nucleus* (or shell of the fry) is spiral, and resembles *scissurella.* The anterior slit is very variable in extent. The animal of Emarginula (and also of puncturella) has an isolated cirrus on the back of the foot, perhaps representing the operculigerous lobe (Forbes). Lingual dentition; median teeth subquadrate; laterals 4, oblong, imbricated; uncini about 60, the first large and thick, with a lobed hook, the rest linear, with serrulated hooks (Lovén).

Distr., 26 sp. W. Iudies, Brit., Norway, Philippines, Australia. Range from low-water to 90 fathoms.

Fossil, 40 sp. Trias—. Brit., France.

Sub-genus. Hemitoma, Sw. *Type,* E. octoradiata. (E. rugosa. Pl. XI., figs. 7, 8.) Shell depressed; anterior margin slightly channelled.

PARMÓPHORUS, Blainville. Duck's-bill limpet.

Etym., parme, a shield, and *phoreus,* a bearer.

Type, P. australis. Pl. XI., fig. 9. *Syn.,* Scutus, Montf.

Shell lengthened-oblong, depressed; apex posterior; front margin arched. Muscular impression horse-shoe shaped, elongated. The shell is smooth and white, and permanently covered by the reflected borders of the mantle. The animal is black, and very large compared with the shell; its sides are fringed with short cirri, and its eyes sessile on the outer bases of thick tentacles; it is found in shallow-water, and walks freely (Cuming).

Distr., 10 sp. New Zealand, Australia, Philippines, Singapore, Red Sea, Cape.

Fossil, 3 sp. Eocene?—. Paris basin.

FAMILY XII. CALYPTRÆIDÆ. Bonnet-limpets.

Shell limpet-like, with the apex more or less spiral; interior simple, or divided by a shelly-process, variously shaped, to which the adductor muscles are attached.

Animal with a distinct head; muzzle lengthened; eyes on the external bases of the tentacles; branchial plume single. Lingual teeth single, uncini 3.

The bonnet-limpets are found adhering to stones and shells; most of them appear never to quit the spot on which they first settle, as the margins of their shells become adapted to the surface beneath, whilst some wear away the space beneath their foot, and others secrete a shelly base. Both their form and colour depend on the situation in which they grow; those found in the cavities of dead shells are nearly flat, or even concave above, and colourless. They are presumed to feed on the sea-weed growing round them, or on animacules; a *calyptræa,* which Professor Forbes kept in a glass, ate a small sea slug (*goniodoris*) which was confined with it. Both *calyptræa* and *pileopsis* sometimes cover and hatch their spawn in front of their foot (Alder and Clarke).

Mr. Gray arranges the bonnet-limpets next after the vermetidæ; their lingual dentition is like *velutina.*

CALYPTRÆA, Lam. Cup-and-saucer limpet.

Etym., calyptra, a (lady's) cap.

Syn., lithedaphus, Owen.

Types, C. equestris. Pl. XI., fig. 10. C. Dillwynnii, fig. 11.

Shell conical; limpet-shaped; apex posterior, with a minute, spiral nucleus; margin irregular; interior with a half-cup shaped process on the posterior side, attached to the apex, and open in front. Surface rugose or cancellated.

Animal with a broad muzzle; tentacles rather short; lanceolate; eyes on bulgings at the outer bases of the tentacles; mantle-margin simple, sides plain. Found under stones, between tide-marks, and in shallow water (Cuming).

Distr., 50 sp. W. Indies, Honduras, Brit., Medit., Africa, India, Philippines, China, Japan, New Zealand, Gallapagos, Chili.

Fossil, 30 sp. Carb? chalk—. Brit., France, &c.

Sub-genera. *Crucibulum*, Schum. (Dispotæa, Say., Calypeopsis, Less.) Ex. C. rudis, Pl. XI., fig. 12. Shell spinulose; internal cup entire; attached by one of its sides. Distr., W. America, Japan, W. Indies. Found on shells, with its base worn, or smoothed by a shelly deposit (Gray). Between this section and the next there are several intermediate forms.

Trochita, Schum. (Infundibulum, J. Sby., Galerus, Humph. Trochatella and Siphopatella, Lesson.) T. radians, Pl. XI., figs. 13, 14. (=Patella trochoides, Dillw.) T. sinensis, Pl. XI., fig. 15. Shell circular, more or less distinctly spiral; apex central; interior with a more or less complete sub-spiral partition. Distr., chiefly tropical, but ranges from Britain to New Zealand. *T. prisca* (McCoy) is found in the carb. limestone in Ireland; and several large species occur in the London clay and Paris basin. The recent C. sinensis — the "China-man's hat" of collectors—is found on the southern shores of England, and in the Mediterranean, in 5—10 fms. water (Forbes). Its lingual dentition is given by Lovén;— median teeth broad, hooked, denticulated; uncini 3, the first hooked and serrated, 2, 3 claw-shaped, simple.

Crepidula, Lam.

Etym., *crepidula*, a small sandal.

Type, C. fornicata, Pl. XI., fig. 16. *Syn.*, crypta, Humph.

Shell oval, limpet-like; with a posterior, oblique marginal apex; interior polished, with a shelly partition covering its posterior half.

The crepidulæ resemble the fresh-water navicellæ in form; but the internal ledge which mimics the columella of the nerite, is here the basis of the adductor muscles.

They are sedentary on stones and shells, in shallow water, and are sometimes found adhering to one another in groups of many successive generations. The specimens or species which live inside empty spiral shells are very thin, nearly flat, and colourless.

Distr., 40 sp. W. Indies, Honduras, Medit., W. Africa, Cape, India, Australia, W. America.

Fossil, 14 sp. Eocene—. France, N. America, Patagonia.

Pileopsis, Lam. Bonnet-limpet.

Etym., *pileos*, a cap, and *opsis*, like.

Syn., capulus, Montf. Brocchia, Bronn.

Type, P. hungaricus, Pl. XI., fig. 17. P. militaris, Pl. XI., fig. 18.

Shell conical; apex posterior, spirally recurved; aperture rounded; muscular impression horse-shoe shaped.

Animal with a fringed mantle-margin; lingual teeth like *calyptræa.*

P. hungaricus (the Hungarian-bonnet) is found on oysters, in 5 to 15 fms. water; more rarely as deep as 80 fms., and then very small. P. militaris is extremely like a *velutina.*

Distr., 7 sp. W. Indies, Norway, Brit., Medit., India, Australia, California.

Fossil, 20 sp. Lias—. Europe.

Sub-genus. Amathina, Gray. A. tricarinata, Pl. XI., fig. 19. Shell depressed, oblong; apex posterior, not spiral, with three strong ribs diverging from it to the anterior margin.

Platyceras, Conrad (acroculia, Phil.). P. vetustus. Carb., limestone. Brit.

Fossil, 20 sp. Devonian—Trias. America, Europe.

HIPPONYX, Defrance.

Etym., hippos, a horse, and *onyx,* a hoof.

Type, H. cornucopia, Pl. XI., figs. 20, 21.

Shell thick, obliquely conical, apex posterior; base shelly, with a horse-shoe-shaped impression, corresponding to that of the adductor muscle.

Distr., 10 sp. W. Indies. Persian Gulf, Philippines, Australia, Pacific, W. America.

Fossil, 10 sp. U. chalk—. Brit., France, N. America.

Sub-genus. Amalthea, Schum. A. conica. Like hipponyx, but forming no shelly base; surface of attachment worn and marked with a crescent-shaped impression. Often occurs on living shells, such as the large turbines, and turbinellæ of the Eastern seas.

FAMILY XIII. PATELLIDÆ. Limpets.

Shell conical, with the apex turned forwards; muscular impression horse-shoe-shaped, open in front.

Animal with a distinct head, furnished with tentacles, bearing eyes at their outer bases; foot as large as the margin of the shell; mantle plain or fringed. Respiratory organ in the form of one or two branchial plumes, lodged in a cervical cavity; or of a series of lamellæ surrounding the animal, between its foot and mantle. Mouth armed with horny jaws, and a long ribbon-like tongue, furnished with numerous teeth, each consisting of a pellucid base and an opaque hooked apex.

The order *cyclo-branchiata* of Cuvier included the chitons and the limpets, and was characterised by the circular arrangement of the branchiæ. At a comparatively recent period it was ascertained that some of the patellæ (*acmæa*) had a free, cervical gill; whilst the chitons exhibited too many peculiarities to admit of being associated so closely with them. Professor

Forbes has very happily suggested that the cyclo-branchiate gill of patella is, in reality, a single, long branchial plume, originating on the left side of the neck, coiled backwards round the foot, and attached throughout its length. This view is confirmed by the circumstance that the gill of the sea-weed limpets (*nacellæ*) does not form a complete circle, but ends without passing in front of the animal's head.

PATELLA, L. Rock limpet.

Etym., *patella*, a dish. *Syn.*, helcion, Montf.

Ex., P. longicostata, Pl. XI., fig. 22.

Shell oval, with a sub-central apex; surface smooth, or ornamented with radiating striæ or ribs; margin even or spiny; interior smooth.

Animal with a continuous series of branchial lamellæ; mantle-margin fringed; eyes sessile, externally, on the swollen bases of the tentacles; mouth notched below. Lingual teeth 6, of which 4 are central, and 2 lateral; uncini 3.

The tongue of the common British limpet (P. vulgata) is rather longer than its shell; it has 160 rows of teeth, with 12 teeth in each row, or 1,920 in all (Forbes.) The limpets live on rocky coasts, between tide-marks, and are consequently left dry twice every day; they adhere very firmly, by atmospheric pressure (15lbs per square inch), and the difficulty of detaching them is increased by the form of the shell. On soft calcarious rocks, like the chalk of the coast of Thanet, they live in pits half an inch deep, probably formed by the carbonic acid disengaged in respiration; on hard limestones only the aged specimens are found to have worn the rock beneath, and the margin of their shell is often accommodated to the inequalities of the surrounding surface. These circumstances would seem to imply that the limpets are sedentary, and live on the sea-weed within reach of their tongues, or else that they return to the same spot to roost. On the coast of Northumberland we have seen them sheltering themselves in the crevices of rocks, whose broad surfaces, overgrown with nullipores, were covered with irregular tracks, apparently rasped by the limpets in their nocturnal excursions.*

The limpet is much used by fishermen for bait; on the coast of Berwickshire nearly 12,000,000 have been collected yearly, until their numbers are so decreased that collecting them has become tedious (Dr. Johnston). In the north of Ireland they are used for human food, especially in seasons of scarcity; many tons weight are collected annually near the town of Larne alone (Pattison).

On the western coast of S. America there is a limpet which attains the diameter of a foot, and is used by the natives as a basin (Cuming).

* If limpets are placed in stale water, or little pools exposed to the hot sun, they creep out more quickly than one would expect; the tracks they leave are very peculiar, and not likely to be mistaken when once seen.

Distr., 100 sp. Brit., Norway, &c. World-wide.

Fossil, above 100 sp. of patellidæ, including *acmæa,* L. silurian—. N. America, Europe.

Sub-genera. Nacella, Schum. (=patina, Leach.) Example, P. pellucida. Pl. XI., fig. 23. Shell thin; apex nearly marginal. Animal with the mouth entire below. Branchiæ not continued in front of the head. Found on the fronds and stalks of sea-weeds. Brit., Cape, Cape Horn.

Scutellina, Gray. S. crenulata. Shell with a broad margin, internally. 7 sp. Red Sea—Philippines—Pacific—Panama (Cuming).

Metoptoma, Phillips. M. pileus Ph. Shell limpet-like, side beneath the apex truncated. Resembling the posterior valve of a chiton. 7 sp. Carb. limestone. Brit.

Acmæa, Eschscholtz.

Etym., *acme,* a point.

Syn., tectura, M. Edw. Lottia and scurria, Gray. Patelloida, Quoy.

Type, A. testudinalis. Pl. XI., fig. 24.

Shell like patella. *Animal* with a single pectinated gill; lodged in a cervical cavity, and exserted from the right side of the neck when the creature walks. Lingual teeth 3 on each side of the median line. Low-water to 30 fms. (Forbes.)

Distr., 20 sp. Norway, Brit., Australia, Pacific, W. America.

Sub-genera. Lepeta, Gray (= pro-pilidium, Forbes). Patella cæca, Müll. Shell minute, apex *posterior.* Animal blind. Brit. 30—90 fms.

Pilidium, Forbes. P. fulva, Müll. Brit. 20—80 fathoms water. Shell small, apex anterior. Animal blind; gills 2, not projecting; mantle even-edged. Both lepeta and pilidium have large single median teeth, with trilobed hooks; and 2 hooked uncini on each side.

Gadinia (Adanson), Gray.

Type, G. peruviana. Plate XI., fig. 26. *Syn.*, mouretia, Sby.

Shell conical; muscular impression horse-shoe shaped, the right side shortest, terminating at the siphonal groove.

Animal with a single cervical gill; tentacles expanded, funnel-shaped.

Distr., 8 sp. Medit., Red Sea, Africa, Peru.

Fossil, 1 sp. Sicily.

? Siphonaria, Blainville.

Type, S. sipho. Pl. XI., fig. 25.

Shell like patella; apex sub-central, posterior; muscular impression horse-shoe shaped, divided on the right side by a deep siphonal groove, which produces a slight projection on the margin.

Animal with a broad head, destitute of tentacles; eyes sessile on prominent rounded lobes; gill? single. The siphonariæ are found between tide-marks, like limpets; Mr. Gray places them with the pulmonifera, between auriculidæ and cyclostomidæ.

Distr., 30 sp. Cape, India, Philippines, Australia, New Zealand, Pacific, Gallapagos, Peru, Cape Horn (Cuming).

Fossil, 3 sp. Miocene —.

FAMILY XIV., Dentaliadæ. Tooth-shells.

Dentalium, L.

Type, D. elephantinum. Pl. XI., fig. 27.

Shell tubular, symmetrical, curved, open at each end, attenuated posteriorly; surface smooth or longitudinally striated; apertnre circular, not constricted.*

Animal attached to its shell near the posterior, anal orifice; head rudimentary, eyes 0, tentacles 0; oral orifice fringed; foot pointed, conical, with symmetrical side-lobes, and an attenuated base, in which is a hollow communicating with the stomach. Branchiæ 2, symmetrical, posterior to the heart; blòod red (Clarke); sexes united? Lingual ribbon wide, ovate; rachis 1-toothed; uncini single, flanked by single unarmed plates.

The tooth-shells are animal-feeders, devouring foraminifera and minute bivalves; they are found on sand, or mud, in which they often bury themselves. The British sp. range from 10—100 fms. (Forbes.)

Distr., 30 sp. W. Indies, Norway, Brit., Medit., India.

Fossil, 70 sp. Devonian—. Europe, Chile.

FAMILY XV., Chitonidæ.

Chiton, L.

Etym., *chiton*, a coat of mail.

Ex., C. squamosus, spinosus, fascicularis, fasciatus. Pl. XI., figs. 28—31.

Shell composed of 8 transverse imbricating plates, lodged in a coriaceous mantle, which forms an expanded margin round the body. The first seven plates have posterior apices; the eighth has its apex nearly in front. The six middle plates are each divided by lines of sculpturing into a dorsal and two lateral areas. All are inserted into the mantle of the animal by processes (apophyses) from their front margins. The posterior plate is considered homologous with the limpet-shell, by Mr. Gray; the other plates appear like portions of its anterior slope, successively detached. The border of the mantle is either bare, or covered with minute plates, hairs, or spines.

* D. gadus of Montagu is an annelide, belonging to the genus *ditrupa*.

Animal with a broad creeping disk like the limpet; proboscis armed with cartilaginous jaws, and a long linear tongue; lingual teeth 3; median small, laterals large, with dentated hooks; uncini 5, trapezoidal, one of them erect and hooked. No eyes, or tentacles. Branchiæ forming a series of lamellæ between the foot and the mantle, round the posterior part of the body. The heart is central, and elongated like the dorsal vessel of the annelides; the sexes are united; the re-productive organs are symmetrically repeated on each side, and have two orifices; the intestine is straight, and the anal orifice posterior and median.

Distr. More than 200 species are known; they occur in all climates throughout the world; most abundant on rocks at low-water, but frequently obtained by dredging in 10—25 fathoms water. Some of the small British species range as deep as 100 fms. (Forbes.) W. Indies, Europe, S. Africa, Australia, and New Zealand, California to Chiloë.

Fossil, 24 sp. Silurian—. Brit., Belgium, &c.

*Sub-genera.** *Chiton*, (Syn., lophurus, Poli. Radsia, callo-chiton, ischno-chiton, and lepto-chiton, Gray).

Ex., C. squamosus. Pl. XI., fig. 28. Border tessellated.

Distr. Brazil, W. Indies, Newfoundland, Greenland, Brit., Medit., Cape, Philippines, Australia, New Zealand, W. America.

Tonicia, Gray. C. elegans. Margin bare. *Distr.* Greenland, C. Horn, New Zealand, Valparaiso.

Acanthopleura, Guilding. C. spinosus. Pl. XI., fig. 29. Margin covered with spines, or elongated scales. *Syn.* Schizo-chiton, corephium, plaxiphora, onycho-chiton, enoplo-chiton, Gray. *Distr.* W. Indies, C. Horn, Falklands, Africa, Philippines, Australia, New Zealand, Valparaiso.

Mopalia, Gray. C. Hindsii. Border hairy. *Distr.*, W. America, Falkland Islands.

Katharina, Gray, C. tunicatus. Mantle covering all but the centre of the plates. *Distr.* New Zealand, W. America.

Cryptochiton, Gray, "Saw-dust chiton." C. amiculatus. Valves covered with scaly epidermis. *Syn.*, cryptoconchus, Sw. Amicula, Gray. *Distr.*, California, New Zealand.

Acanthochites, Leach. C. fascicularis. Pl. XI., fig. 30. Border ornamented with tufts of slender spines, opposite the plates. *Distr.*, Brit., Medit. New Zealand.

Chitonellus, Lam. C. fasciatus, Quoy. Pl. XI., fig. 31. Border velvety; exposed portion of the plates small, distant; apophyses close to-

* The sub-genera of Mr. Gray are founded on the form of the *plates of insertion*; they are described in detail in the proceedings of the Zoological Society. Dr. Middendorf employs the number of the *branchial laminæ* for distinguishing the sections.

gether. *Distr.*, 10 sp. W. Indies, W. Africa, Philippines, Australia, Pacific, Panama. The chitonellæ are found in fissures of coral rock (Cuming).

Grypho-chiton, Gray. C. nervicanus.

Helminthochiton, Salter, 1847. H. Griffithii, Salter Geol. Journ. Plates sub-quadrate, not covered by the mantle; apophyses widely separated. *Fossil.* Silurian. Ireland.

W. OSTELL, PRINTER, HART STREET, BLOOMSBURY.

A

MANUAL OF THE MOLLUSCA.

A MANUAL OF THE MOLLUSCA;

OR,

RUDIMENTARY TREATISE

OF

RECENT AND FOSSIL SHELLS.

BY

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ILLUSTRATED BY

A. N. WATERHOUSE AND JOSEPH WILSON LOWRY.

PART II.

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MDCCCLIV.

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ERRATA AND ADDENDA.

Page 7 line 5 *for* "pterpoda" *read* "pteropoda."
— " 13 *for* "brachiapoda" *read* "brachiopoda."
11 " 16 *for* "pector" *read* "pecten."
15 " 30 *for* "Mr. Robert" *read* "Mr. George Roberts;" the statement is undoubtedly correct.
22 " 16 *for* "slerotic" *read* "sclerotic."
25 Note. Striped muscular fibre has been observed in *Salpa.* (Huxley.)
28 line 8 erase the words "when withdrawn."
28 Fig. 16 *a,* anterior; *p,* posterior; *l,* lateral; *r,* rachidian.
30 line 27 erase "and by four in the brachiopoda."
39 " 22 the "tubular structure" of *pinna* is probably occasioned by the growth of a confervoid sponge between the laminæ. (Quekett.)
46 " 13 erase the word "cylindrella."
50 " 7 *for* "brachiopoda" *read* "opistho-branches."
52 erase lines 20—23, and see p. 245.
54 line 12 *see* Supplement.
65 M. Verany and H. Müller have shown that the *Hectocotyle* is developed in place of the right arm of the third pair of the male cephalopod, and *spontaneously* detached. See SUPPLEMENT.
67 line 8 from bottom, *for* "dorsal" *read* "ventral."
68 *Tremoctopus* is a sub-genus of *Octopus,* not of *Philonexis.*
70 line 16 add "*Type,* Loligo Aalensis, Schubler."
71 " 14 *for* "Fidenas ? Gray" *read* "R. palpebrosa."
79 Note. *for* "the apocryphal genus *spongarium* was founded on" *read* "*most* of the so-called *spongaria* are."
89 Sub-genus 6, Diploceras (Salter). The shell is supposed to have resembled *Gonioceras,* and the external tube to be a simple cavity formed by the approximation of the lateral angles.
94 line 15 (and Pl. III. fig. 4) *for* "Rhothomagensis" *read* "Rothomagensis, from *Rothomagum,* Rouen."
100 " 6 *for* "riam" *read* "rima."
105 " 8 *for* "Strombidia, Sw." *read* "Rimella, Ag."
106 erase line 3.
108 *Admete* (viridula) is a boreal form of Cancellaria, without plaits.

Page 108 Cuma (angulifera) and Rapana (p. 109) are Purpuræ.

115 Cithara, Schum. belongs to *Fam. Conidæ*.

127 line 15 *add Syn.* Polyphemopsis, Portlock.

128 " 2 *for* "Triphoris," *read* "Triforis."

— " 9 *for* "eidos, facies" *read* "ides, patronymic termination."

129 *Fastigiella; Fossil*, Eocene. Paris (*Cerithium rugosum*, Lam.)

131 *for* "Pachystoma, Gray" *read* "Chilostoma, Desh."

132 Remove *Aclis* to the Pyramidellidæ.

— line 3 from bottom, (and Pl. IX. fig. 4) *for* "A. perforata, Mont. MS." *read* "A. supranitida, Wood."

135 line 4 erase "Nina, Gray."

— " 6 *for* "many-whirled" *read* "few-whirled."

136 (and Pl. IX. fig. 24) *for* "Litiopa *bombix*" *read* "L. bombyx."

142 *Navicella* inhabits freshwaters, adhering to stones and plants.

145 line 30 *for* "Maclurea, Les." *read* "Straparollus, D'Orb."

154 line 6 from bottom, *for* "Pattison" *read* "R. Patterson."

155 *Metoptoma* is a sub-genus of *Pileopsis*, not Patella.

Exp. Plates. Pl. V. fig. 5, *for* "California" *read* "W. Indies."

" — fig. 7, *for* "China" *read* "W. Indies."

" VII. fig. 15, *for* "Philippines" *read* "Tahiti."

" XII. fig. 13, *for* "Australian Ids." *read* "Tahiti."

" — fig. 43, *for* "*Sby*. Philippines" *read* "Gray, ½ Jamaica.

Page 165 *Glandina;* the Lusitanian Bulimus Algirus belongs to this genus.

168 line 15 *insert* "devour" *before* "animal substances."

177 " 16 *for* "Megaloma" *read* "Lomastoma."

253 " 3 from bottom, erase "Ætheria has a large foot."

261 " 25 erase "*Aucella*, Keyserling;" it is a pearly shell, distinct from *Monotis* of Münster.

NOTICE.

In the long interval since the publication of the first part of this Manual, materials have so accumulated on the writer's hands, that it has been found impracticable to condense them within the space at first contemplated. The illustrations also have been more numerous than was originally expected, and occupy considerably more room. But although a SUPPLEMENT has become inevitable, the publisher has allowed an extra number of pages, in order to render the present part complete in itself. The writer hopes to make the Appendix more valuable by figures and descriptions of the animals of many hitherto undescribed Bivalve genera, the materials for which have already been placed at his disposal by Dr. J. E. Gray. The present part owes much to the assistance of Mr. Albany Hancock, of Newcastle; Mr. Thos. Davidson, F.G.S., and Mr. T. H. Huxley, F.R.S.

A

MANUAL OF THE MOLLUSCA.

PART II.

CLASS II. GASTEROPODA.—ORDER II. Pulmonifera.

This order embraces all the land-snails and other *mollusca* which breathe air. They are normal gasteropods, having a broad foot, and usually a large spiral shell; their breathing-organ is the simplest form of lung, and is like the branchial chamber of the sea-snails, but lined with a network of respiratory vessels. One large division of the land-snails is furnished with an operculated shell; the rest are in-operculate, and sometimes shell-less.

The *pulmonifera* are closely related to the plant-eating sea-snails (*holostomata*), through *Cyclostoma*, and to the *nudibranches* by *Oncidium*. As a group, they are generally inferior to the sea-snails, on account of the comparative imperfection of their senses, and the union of the functions of both sexes in each individual.

SECTION A. In-operculata.

The typical pulmonifera vary much in appearance and habits, but agree essentially in structure. Most of them have sufficiently large shells; in the slugs, however, the shell is small and concealed, or rarely quite wanting. Snail-shells contain a larger proportion of animal matter than sea-shells, and their structure is less distinctly stratified (p. 40). In form, these shells represent many marine genera. The greater part are terrestrial, only some of the smaller families inhabit fresh-waters, or damp places near the sea. The respiratory orifice is small and valve-like,* to prevent too rapid desiccation in the land-snails, and to guard against the entry of water in the aquatic tribes. Land-snails are universally distributed; but the necessity for moist air, and the vegetable nature of their food, favour their multiplication in warm and humid regions; they are especially abundant in islands, whilst in hot and desert countries they appear only in the season of rain or dews. Their geological history is less complete than that of the purely marine orders; but

* Hence they are called *Adelo-pneumona* (concealed-lunged) by Gray.

their antiquity might be inferred from the distribution of peculiar genera in remote islands, associated with the living representatives of the ancient fauna of Europe. Fresh-water snails (*Limnæidæ*) occur in the English Weald, but fossil land-snails have not been found in strata older than the Tertiary in Europe, and then under forms generically, and even in one instance specifically, identical with living types of the new world (*Megaspira, Proserpina, Glandina,* and *Helix labyrinthica*). In the coal-strata of Nova Scotia, Sir Chas. Lyell has discovered a single specimen of a reversed and striated shell, apparently a *Clausilia*.

The *lingual dentition* of the pulmonifera confirms, in a remarkable manner, those views, respecting the affinities of the order, and its zoological value, which have been deduced from the more obvious characters afforded by the animal and shell. The operculated land-snails have seven-ranked teeth, like *Paludina* and *Litorina*. The in-operculated air-breathers have, without known exception, rows of very numerous, similar teeth, with broad bases, resembling tessellated pavement. Their crowns are recurved, and either aculeate or dentated. The lingual ribbon is very broad, often nearly as wide as it is long; and the number of teeth in a row (though usually a third less) is sometimes as great, or even greater, than the number of rows. The rows of teeth are straight or curved or angulated; when the rows are straight the teeth are similar in shape; curves indicate gradual changes, and angles accompany sudden alterations of form.

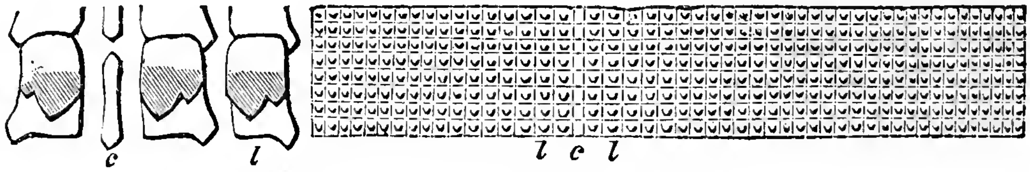
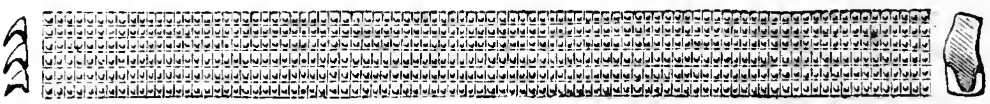


Fig. 90. *Lingual teeth of Achatina.**

The absolute number of teeth is only a specific character, and is usually greatest in the larger species; but the *Helicellæ* have fewer teeth in proportion than the *Helices*, and Velletia has fewer than *Ancylus*. The anomalous genus *Amphibola* (p. 139) has an unusually broad tongue, armed with teeth similar to those of the snail.



Fig, 91. *Lingual teeth of Amphibola.*†

About one-third the lingual membrane is spread over the tongue; the rest has its margins rolled together, and is lodged in a sac or dental canal, which

* Fragment of the lingual membrane of *Achatina fulica*, with central and lateral teeth more enlarged, from a specimen communicated by J. W. Laidlay, Esq.

† Part of the tongue of *Amphibola avellana*, from a preparation by J. W. Wilton, Esq., of Gloucester.

diverges downwards from the posterior part of the mouth, and terminates outside the buccal mass of muscles.*

The mode in which the tongue is used, may be seen by placing a *Limnæa* or *Planorbis* in a glass of water, inside which the green *conferva* has begun to grow; they will be observed incessantly cleaning off this film. The upper lip with its mandible is raised, the lower lip—which is horse-shoe shaped—expands, the tongue is protruded and applied to the surface for an instant, and then withdrawn; its teeth glitter like glass-paper, and in *Limnæa* it is so flexible, that frequently it will catch against projecting points, and be drawn out of shape slightly as it vibrates over the surface.

"The development of the (in-operculate) Pulmonifera has been worked out by Van Beneden and Windischmann,† by Oscar Schmidt,‡ and by Gegenbaur;§ the memoir, by the last named author, contains full information respecting *Limax* and *Clausilia*, and some important notices with regard to *Helix*.

"The yelk undergoes complete division. The first stage of development consists in the separation of the embryo into mantle and foot. The anterior part of the body, in front of the mantle, dilates and forms a contractile sac—the homologue of the *velum* of marine gasteropods—which in *Doris, Polycera*, and *Æolis*, has been seen to exhibit similar contractions. (*Gegenbaur.*) To this contractile vesicle the name of *Yelk-sac* was given by Van Beneden and Windischmann, but it is a very different organ from the true Yelk-sac, which exists in the Cephalopoda alone among molluscs.

"A similar contractile dilatation exists at the end of the foot—and the contractions of this 'caudal' vesicle and of the 'vitellary' vesicle alternate, so as to produce a kind of circulation before the development of the heart.

"The oral tentacles and parts about the mouth are the last to be completed.

"A peculiar gland exists during the embryonic period, attached to the parietes of the 'vitellary' vesicle, which Gegenbaur and Schmidt compare to a Wolffian body.

"Gegenbaur draws attention to the fact, that the first rudiment of the shell in *Limax*, *Clausilia* and probably *Helix*, is not secreted on the exterior of the mantle, as in other *gasteropoda;* but is deposited, in the form o calcarious granules, within its substance.

"Besides, therefore, the possession of Wolffian bodies, and of especial contractile organs, which subserve respiration and circulation during embryonic life—the terrestrial *gasteropoda* are further distinguished by the

* Thomson, An. Nat. Hist. Feb. 1851.

† Recherches sur l'embryogenie des Limaces. Müller's Archiv. 1841.

‡ Ueber die Entwickelung von *Limax agrestis* Müller's Archiv, 1851.

§ Beiträge zur Entwickelungs geschichte der Land-gasteropoden. Siebold and Kölliker's Zeitschrift, 1852.

peculiar mode of development of their shells—if the observations upon *Clausilia* and *Helix* may be extended to the rest. The first development of the shell within the substance of the mantle (a relation found hitherto only in the *Cephalopoda*) is up to the present time a solitary fact, without parallel among the other gasteropodous families." (*Huxley*.)

FAMILY I. HELICIDÆ.* Land-snails.

Shell external, usually well developed, and capable of containing the entire animal; aperture closed by an *epiphragm* during hybernation.†

Animal, with a short retractile head, with four cylindrical, retractile tentacles, the upper pair longest and bearing eye-specks at their summits. Body spiral, distinct from the foot; respiratory orifice on the right side, beneath the margin of the shell; reproductive orifice near the base of the right ocular tentacle; mouth armed with a horny, dentated, crescent-shaped upper mandible; lingual membrane oblong, central teeth in-conspicuous, laterals numerous, similar. (See Intr. p. 17.)

HELIX, L.‡

Type, H. pomatia, L. Roman snail. *Etym. Helix*, a coil.

Shell umbilicated, perforated or imperforate; discoidal, globosely-depressed or conoidal; aperture transverse, oblique, lunar or roundish; margins distinct, remote or united by callus.

Animal with a long foot, pointed behind; lingual teeth usually in straight rows, edge-teeth dentated.

Distr. including the sub-genera, above 1,200 sp. (several hundred sp. are undescribed). World-wide; ranging northward as far as the limit of trees, and southward to Tierra-del-fuego, but most abundant by far in warm and humid climates. M. D'Orbigny observed 6 sp. at elevations exceeding 11,000 feet, in S. America, and Layard found *H. gardeneri* at the height of 8,000 feet in Ceylon. The species of tropical and southern islands are mostly peculiar. Several of the smaller British species, and even the large garden-snail (*H. aspersa*), have been naturalised in the most remote colonies. The Neapolitans and Brazilians eat snails.

Fossil (extinct) sp. about 50. Eocene —. Europe.

Sections; Acavus, Montf. Shell imperforate. H. hæmastoma, Pl. XII. fig. 1.

Geotrochus (lonchostoma) Hasselt, Trochiform, flat beneath.

Polygyra, Say. Depressed, many-whirled. H. polygyrata, Pl. XII. fig. 2.

* The account of this family is chiefly taken from Dr. L. Pfeiffer's *Monographia Heliceorum*.

† The *epiphragm* is a layer of hardened mucus, sometimes strengthened with carbonate of lime; it is always minutely perforated opposite the respiratory orifice.

‡ The synonomy of the genus would fill several pages. See Intr. 1, p. 59.

Tridopsis, Raf. Aperture contracted by tooth-like projections. H. hirsuta, Pl. XII. fig. 5.

Carocolla, Lam. Peristome continuous. H. lapicida, Pl. XII. fig. 3.

Sub-genera. *Anastoma*, Fischer. (Tomigerus, Spix.) H. globulosa Pl. XII. fig. 4. Aperture of adult turned upwards, ringent; 4 sp. Brazil. *Hypostoma* (Boysii) Albers, is a minute Indian snail, in which the aperture is similarly distorted. *Lychnus* (Matheroni, Req.) has a similar shell, but no apertural teeth; 3 sp. occur in the Eocene Tertiary of the S. France.

Streptaxis, Gray. H. contusa, Pl. XII. fig. 6. Sub-globose, lower whirls receding from the axis of the upper; 24 sp. Brazil, W. Africa, Mascarene Ids. S. Asia.

Sagda, Beck. H. epistylium, Pl. XII. fig. 7. Imperforate, globosely conoid, close-whirled, aperture lamellate within, lip sharp; 3 sp. Jamaica.

Prosérpina (nitida) Guilding. Shell depressed, shining, callous beneath; aperture toothed inside; peristome sharp. *Distr.* 6 sp. Jamaica, Cuba, Mexico. *Fossil*, Eocene—. I. Wight (*F. Edwards*).

Helicella, Lam.* *Type*, H. cellaria, Pl. XII. fig. 8. Shell thin, depressed; peristome sharp, not reflected. Lingual edge-teeth aculeate. 90 sp.

Stenopus (cruentatus) Guild. *Syn.* Nanina (citrina) Gray; Ariophanta (lævipes, Pl. XII. fig. 9) Desm. Shell thin, polished; peristome thin, not reflected. Animal with the tail truncated and glandular, like *Arion*; mantle-margin produced, partly covering the shell. *Distr.* 70 sp. S. Asia and Ids. N. Zealand, Pacific Ids. W. Indies.

Vitrina, Draparnaud, Glass-snail.

Type, V. Draparnaldi, Pl. XII. fig. 28. *Syn.* Helicolimax, Fer.

Shell imperforate, very thin, depressed; spire short, last whirl large; aperture large, lunate or rounded, columellar margin slightly inflected, peristome often membranous.

Animal elongated, too large for complete retraction into the shell; tail very short; mantle reflected over the shell-margin, and furnished with a posterior lobe on the right side. Lingual teeth (of type) 100 rows of 75 each; marginal teeth with a single, long, recurved apex (*Thomson*). Occasionally animal-feeders, like the slugs.

V. Cuvieri and *Freycineti* (Helicarion Fer.) tail longer, more abruptly truncated, with a caudal gland like *arion*, mantle more developed.

Distr. 64 sp. Old World, 58; Greenland, 1; Brazil, 5.

Sub-genera. *Daudebardia*, Hartm. (Helicophanta, Fér.) V. brevipes, Pl. XII. fig. 29. Shell perforated, horizontally involute; aperture oblique, ample; 3 sp. Central Europe.

Simpulopsis (sulculosa) Beck; shell succinea-shaped. 5 sp. Brazil.

* For this group Mr. Gray formerly employed the name *Zonites*, given originally by Montfort to Helix Algira; in his later works he adopts *Helicella*.

SUCCINEA, Draparnaud. Amber-snail.

Type, S. putris, Pl. XII. fig. 23.

Syn. Cochlohydra, Fér. Helisiga (S. Helenæ) Less. Amphibulima (patula) Beck; Pelta (Cumingii) Beck.

Shell imperforate, thin, ovate or oblong; spire small; aperture large, obliquely oval; columella and peristome simple, acute.

Animal large, tentacles short and thick, foot broad; lingual teeth like *helix;* S. putris has 50 rows, of 65 teeth each (*Thomson*). Inhabits damp places, but rarely enters the water.

Distr. 68 sp. Europe 5, Africa 3, India 1, Australia 1; Pacific Ids. 17, N. America 14, S. America 11, W. Indies 11. *Fossil.* Eocene, Brit.

Sub-genus. Omalonyx, D'Orb. O. unguis. Pl. XII. fig. 24. Shell oval, convex, translucent, spire nearly obsolete, margins sharp. Animal large, slug-like; shell placed on the middle of the back, with the mantle slightly reflected upon it all round. *Dist.* 2 sp. Bolivia; Juan Fernandez.

BULIMUS, Scopoli.

Etym. ? *Boulimos,* extreme hunger (in allusion to its voracity!)

Syn. Bulinus, Brod. (not Adans). *Type.* B. oblongus. Pl. XII. fig. 10.

Shell oblong or turreted; aperture with the longitudinal margins unequal, toothless or dentate; columella entire, revolute externally or nearly simple; peristome simple or expanded.

Animal like Helix. *B. ovatus* attains a length of 6 inches, and is sold in the market of Rio; it oviposits amongst dead leaves, the eggs have a brittle shell, and the young when hatched are an inch long. (See p. 54, fig. 31.)

Sections. Odontostomus (gargantuus) Beck, aperture toothed, 13 sp. Brazil.

Pachyotis, Beck (Caprella, Guild.) fig. 91.*

Partula, Fér. P. faba. Pl. XII. fig. 13, *Tahiti.* 26 sp. Asiatic, Australian and Pacific Ids. 24; S. America 2. The animal is ovo-viviparous.

Gibbus (*Lyonnetianus*) Montf. Shell hump-backed; Mauritius, 2 sp.

Bulimulus, Leach. B. decollatus. Pl. XII. figs. 11, 12. Shell small, lip acute. Above 300 sp. England 3 sp.

Zua, Leach. Z. lubrica. Pl. XII. fig. 14. Shell polished, columella slightly truncated.

Azeca, Leach. A. tridens. Pl. XII. fig. 15. Shell polished, peristome thickened and toothed.

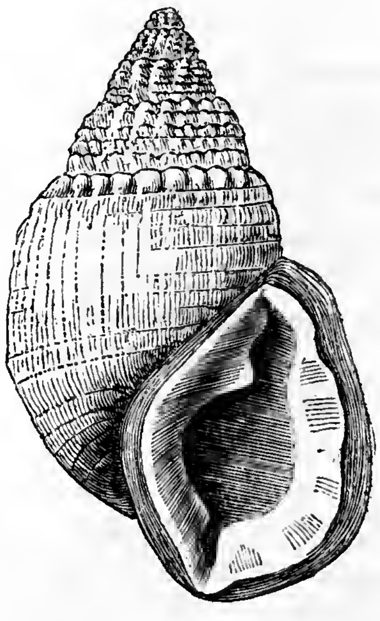


Fig. 91* *B. auris-vulpina.*

* Fig. 91. *Bulimus auris-vulpina,* Chemn. The great extinct land-snail of St.

Distr. 650 sp. Europe 30, Asia 130, Australia and Pacific Ids. 46, Africa 50, S. States 3, Tropical and S. American 330.

Fossil. 30 sp. Eocene —. Europe, S. Helena, Australia, W. Indies. B. Guadalupensis occurs in modern limestone, with human remains.

ACHATINA, Lamarck. Agate-shell.

Type, A. variegata, Pl. XII. fig. 22.

Syn. Cochlitoma, Fér. Columna, Perry. Subulina (octona) Beck. Liguus (virgineus) Montf. Cionella (acicula) Jeffr.

Shell imperforate, bulimiform; columella twisted, and truncated in front; aperture oval, angular above; peristome simple, acute.

Animal snail-like. The great African Achatinæ are the largest of all land-snails, attaining a length of 8 inches; their eggs exceed an inch in length, and have a calcarious shell.

Distr. 120 sp. Europe 9, Africa 38, Asia 8, tropical America 29.

Fossil. 14 sp. Eocene —. Europe; St. Helena.

Sub-genera. Glandina (voluta) Schum. (Oleacina, Bolten; Polyphemus, Montf.) *Shell* oblong, fusiform; aperture narrow, elliptical. *Animal* twice as long as the shell; eye tentacles deflected at the tips, beyond the eyes; vibraeula much shorter, also deflected; lips elongated, tentacular. Frequents low and moist situations; in confinement one refused vegetable food, but at another snail. (*Say.*) 40 sp. W. Indies, Central America, Mexico, Florida. *Fossil.* Eocene —. *Glandina costellata.* I. Wight. (*F. Edwards.*)

Achatinella (vulpina) Sw. (Helicteres, Fér.) Columella twisted into a strong, tooth-like fold. Sandwich Ids. 25, Mariannes 2, Ceylon 1.

PUPA, Lamarck. Chrysalis-shell.

Type, P. uva. Pl. XII. fig. 16. *Syn.* Torquilla (juniperi) Studer.

Shell rimate or perforate, cylindrical or oblong; aperture rounded, often toothed;* margins distant, mostly united by a callous lamina.

Animal with a short foot, pointed behind; lower tentacles short.

Distr. 160 sp. Greenland 1, Europe 76, Africa 23, India 12, Pacific Ids. 2, N. America 30, S. America 5. *Fossil.* 40 sp. Eocene —. Europe.

Sub-genus. Vertigo, Müll. V. Venetzii. Pl. XII. fig. 17. Shell minute, sometimes sinistral. Animal with the oral tentacles rudimentary or obsolete. 12 sp. Old World.

CYLINDRÉLLA, L. Pfeiffer. Cylinder-snail.

Type, C. cylindrus. Pl. XII. fig. 20.†

Helena; from a specimen presented by Chas. Darwin, Esq. See "Journal of a Voyage round the World."

* Dr. Pfeiffer terms those teeth *parietal* which are situated on the body-whirl those on the outer lip *palatal*, and on the inner lip *columellar*.

† The figure is taken from a sp. in Mr. Cuming's cabinet, in which the empty apex, usually decollated, remains attached to the adult shell.

Syn. Brachypus, Guild. Siphonostoma, Sw.

Shell cylindrical or pupiform, sometimes sinistral, many-whirled, apex of the adult truncated, aperture round, peristome continuous, expanded.

Animal similar to *clausilia;* foot short, oral tentacles minute.

Distr. 50 sp. W. Indies 35, Mexico 5, Texas 2, S. America 1.

Balèa, Prideaux.

Type, B. perversa. Pl. XII. fig. 21. *Syn.* Fusulus, Fitz.

Shell slender, usually sinistral, fusiform, multispiral, aperture ovate; peristome acute, margins unequal, wall of the aperture with one slight plait; columella simple.

Animal snail-like; teeth 20.20; rows 130 (*Thomson*).

Distr. 8 sp. Norway, Hungary, New Granada, Tristan d'Acunha. The British sp. is found, very rarely, in Porto Santo, only on the highest peak, at an elevation of 1,665 feet. (*Wollaston.*)

Sub-genus. Megaspira (elatior) Lea. Pl. XII. fig. 18. Shell dextral, with the columella transversely plaited. *Distr.* 1 sp. Brazil. *Fossil,* 1 sp. Eocene —. Rheims.

Tornatellina, Beck.

Etym. Diminutive (or patronymic termination) of *tornatella.*

Type, T. bilamellata, Ant. *Syn.* Strobilus, Anton. Elasmatina, Petit.

Shell imperforate, ovate or elongated; aperture semi-lunar, margins unequal, disunited; columella twisted, truncated; inner lip 1-plaited.

Distr. 11 sp. Cuba 1, S. America 2, Juan Fernandez 2, Pacific Ids. 5, N. Zealand 1.

Paxillus, A. Adams.

Type, P. adversus, Ad. Borneo.

Shell small, pupiform, sinistral, rimate; spire pointed; aperture semi-ovate, ascending on the body-whirl; inner lip spreading, 1-plaited, outer lip expanded, notched in front.

Clausilia, Draparnaud.

Etym. Dimin. of *clausum* a closed place. *Syn.* Cochlodina, Fér.

Ex. C. plicatula, Drap. (=C. Rolphii, Leach). Pl. XII. fig. 19.

Shell fusiform, sinistral; aperture elliptical or pyriform, contracted by lamellæ, and closed when adult by a moveable shelly plate (*clausium*) in the neck.

Animal with a short, obtuse foot; upper tentacles short, lower very small. *C. bidens* has 120 rows of 50 teeth; C. nigricans 90 rows of 40 teeth each.

Distr. Above 200 sp. Europe 146, Asia 48, Africa 4, S. America 3.

Fossil, 20 sp. Eocene —. Brit. France. Coal-strata, N. Scotia. (*Lyell.*) *C. maxima,* Grat. Miocene, Dax is two inches in length.

FAMILY II. LIMACIDÆ. Slugs.

Shell small or rudimentary, usually internal, or partly concealed by the mantle, and placed over the respiratory cavity.

Animal elongated; body not distinct from the foot; head and tentacles retractile; tentacles 4, cylindrical, the upper pair supporting eyes; mantle small, shieldshaped; respiratory and excretory orifices on the right side.

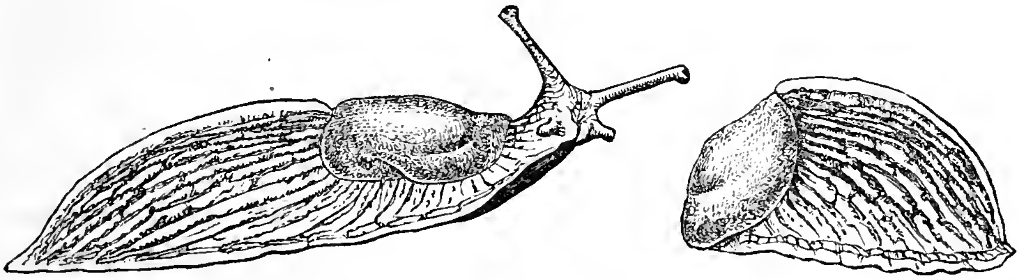


Fig. 92. *Limax Sowerbii Fér. Brit.*

LIMAX, L. Slug.

Type, L. maximus. Pl. XII. fig. 25. (L. cinereus, Müll.)

Shell internal, oblong, flat, or slightly concave beneath, nucleus posterior; margin membranous; epidermis distinct.

Animal, foot pointed and keeled behind; mantle shieldshaped, on the front of the back, granulated or marked with concentric striæ; respiratory orifice on the right side, near the posterior margin of the mantle; reproductive orifice near the base of the right ocular tentacle; lingual teeth tricuspid, those near the margin simple, aculeate.

The slugs are connected with the snails by *Vitrina;* their teeth are similar, but have more elongated cusps. The creeping-disk, or *sole* of the foot, extends the whole length of the animal; but they frequently lift up their heads, like the snails, and move their tentacles in search of objects above them. They often climb trees, and some can lower themselves to the ground by a mucous thread. When alarmed they withdraw their heads beneath the mantle, as in fig. 92. Slugs feed chiefly on decaying vegetable and animal substances; they oviposit at any time of the spring and summer when the weather is moist, and bury themselves in drought and frost. *Limax noctilucus,* Fér. (Phosphorax, Webb.) found in Teneriffe, has a luminous pore in the posterior border of the mantle.

Distr. 22 sp. Europe, Canaries, Sandwich Ids.

Fossil. Eocene —. Brit. The Ancylus ? latus, Edw. of the I. Wight appears to be a Limax.

Sub-genus. Geomalacus (*maculosus*) Allman. Ireland. *Shell* unguiform. *Animal* with a mucus gland at the extremity of the tail; respiratory orifice near the right anterior border of the mantle.

INCILARIA, Benson.

Type, I. bilineata, Cantor, Chusan. *Syn.* ? Meghimatium, Hasselt.

Animal elongated, tapering behind, entirely covered by a mantle; tentacles 4, the upper bearing eyes, the lower entire; respiratory orifice on the right side, near the front of the mantle. Lon. 1½ inches.

Philomycus (Raf.) Fér. = Tebennophorus, Binney, 1842, Bost. Soc. Journ. (Helix Carolinensis, Bosc) is also a slug with a long mantle.

ARION, Férussac. Land-sole.

Type, A. empiricorum, Fér. *Syn.* Limacella, Brard.

Shell oval, concave; or represented by numerous irregular calcarious granules.

Animal, slug-like; respiratory orifice on the right side, towards the front of the mantle; reproductive orifice immediately below it; tail rounded, slightly truncated, terminated by a mucus-gland. Lingual teeth, as in *limax;* A. empiricorum has 160 rows of 101 teeth each. The land-soles occasionally animal substances, such as dead worms, or injured individuals of their own species. They lay 70-100 eggs, between May and September, are 26-40 days hatching, and attain their full growth in a year; they begin to oviposit a month or two before that period. The eggs of *A. hortensis* are very phosphorescent for the first 15 days. (*Bouchard.*)

Distr. 6 sp. Europe. Norway, Brit. Spain, S. Africa.

Fossil. Newer Pliocene, Maidstone. (*Morris.*)

Plectrophorus (*corninus*, Bosc) Fér. 3 sp. Teneriffe; represented as having a small conical shell on the tail; probably an erroneous observation.

PARMACELLA, Cuvier.

Type, P. Olivieri, Cuv. *Etym. parma,* a small shield.

Syn. ? Peltella (Americana), Van Beneden.

Shell concealed, oblong, nearly flat, apex sub-spiral.

Animal vitrina-like, with an ample foot, pointed behind, and furnished with a mucus-pore; mantle small, shield-like, in the middle of the back, partly or entirely concealing the shell.

P. calyculata, Sby. (Cryptella, Webb,) Pl. 12, fig. 27, is patelliform, with an exposed papillary spire. *Distr.* 7 sp. S. Europe; Canary Ids. N. India.

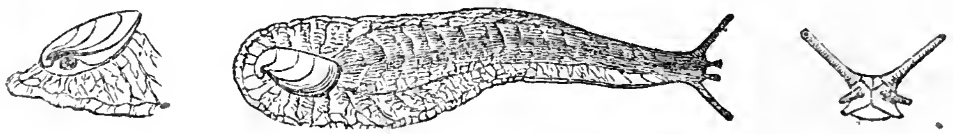


Fig. 93. *Testacella haliotoides, Fer.* *

TESTACELLA, Cuvier.

Shell small, ear-shaped, situated on the posterior extremity of the body.

Animal, slug-like, elongated and tapering towards the head; back with

* Back view of a half-grown individual; side-view of shell on the tail, and front view of the head. From specimens communicated by Arthur Mackie, Esq., of Norwich.

2 principal lateral furrows, from which numerous vein-like grooves ramify; mantle not larger than the shell; respiratory orifice on the right side, beneath sub-spiral apex of the shell; reproductive orifice behind the right tentacle. The Testacella is subterranean in its habits, feeding on earth-worms, and visiting the surface only at night. Its lingual membrane is very large and wide, with about 50 rows of 20.20 teeth, which diminish rapidly in size towards the centre; each tooth is slender, barbed at the point, and slightly thickened at the base, and furnished with a projection on the middle of the posterior side.

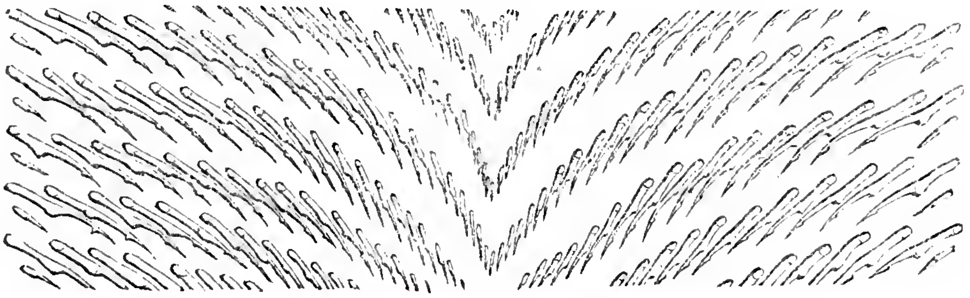


Fig. 94.*

Distr. 3 sp. S. Europe; Canary Ids. Brit. (introduced.)

FAMILY III. ONCIDIADÆ.

Animal, slug-like, destitute of any shell, completely covered by a coriaceous mantle; tentacles cylindrical, retractile, with eyes at their extremities; foot much narrower than the mantle.

ONCIDIUM, Buchanan.

Type, O. Typhæ, Buch. *Etym.* Diminutive of *Onkos*, a tubercle.

Animal oblong, convex, usually tuberculated; head with 2 retractile tentacles, bearing the eyes; mouth covered by a notched veil; no horny jaws; tongue broad, with above 70 rows of lingual teeth (in *O. celticum*), teeth 54.1.54;† the central teeth minute, triangular, with a single obtuse spine; laterals, slightly curved; heart opistho-branchiate; respiratory orifice posterior, distinct from the vent; sexes combined, ♂ organ under the right tentacle, ♀ at the posterior extremity of the body.

Distr. 16 sp. Brit. Medit. Red Sea, Mauritius, Australia, Pacific. The typical *Oncidia* live on aquatic plants, in the marshes of the warmer parts of the old world. Those which frequent sea-shores have been separated under the name *Peronia*, Bl. (Onchis, Fér). One species (*O. celticum*) is found

* Part of the lingual membrane of *T. haliotides*, from a preparation by Fisher Cocken, Esq., of Botesdale. The dentition resembles that of *Ianthina*.

† This is a convenient mode of stating the number of lingual teeth in each row; it means that there is a single (symmetrical) tooth in the centre, and 54 lateral (unsymmetrical) teeth on each side. If the number of rows of teeth on the dental membrane is known, it may be added below, thus—*Peronia Mauritiana*, $\frac{80.1.80}{68.}$

on the coast of Cornwall, congregated in little groups, about a foot or two from the surface of the sea, where the waves break over them. They ascend and descend, so as to maintain their distance as the tides rise and fall; but will not bear long immersion in sea-water. (Couch.)

? *Buchanania* (*oncidioides*) Lesson. Named after Dr. F. Hamilton (Buchanan), the Zoologist of India. *Animal* oval, entirely covered by a simple mantle; respiratory orifice in the centre of the back; head with 4 tentacles, retractile beneath the mantle; foot oval, much smaller than the mantle; length 3½ inches. Coast of Chile. (Requires confirmation.)

VAGINULUS, Férussac.

Type, V. Taunaisii, Fér. *Syn.* Veronicella, Bl.

Animal elongated, slug-like, entirely covered by thick coriaceous mantle, smooth or granulated; head retractile under mantle; tentacles 4, upper pair slender, cylindrical, inflated at the tips and bearing eyes, lower pair short, bifid; foot linear, pointed behind; sexes united; ♂ orifice behind the right tentacle, ♀ midway on the right side, beneath the mantle; respiratory and excretory orifices at posterior extremity, between mantle and foot. Inhabits forests, in decayed wood and under leaves.

Distr. 6 sp. W. Indies, S. America, India, Philippines.

FAMILY IV. LIMNÆIDÆ.

Shell thin, horn-coloured; capable of containing the whole animal when retracted; aperture simple, lip sharp; apex sometimes eroded.

Animal with a short dilated muzzle; tentacles 2, eyes sessile at their inner bases; mouth armed with an upper mandible, tongue with teeth similar to *Helix*. The Limnæids inhabit fresh-waters, in all parts of the world; they feed chiefly on decaying leaves, and deposit their spawn in the form of oblong transparent masses, on aquatic plants and stones. They frequently glide beneath the surface of the water, shell downwards, and hybernate or restivate in the mud.

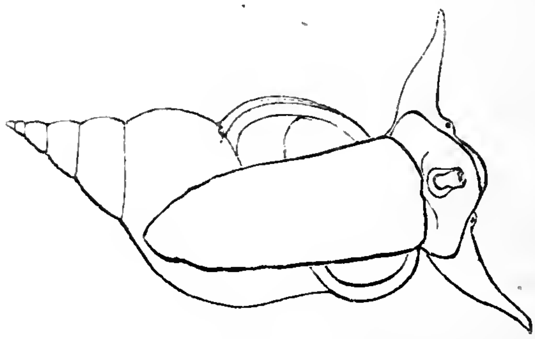


Fig. 95.

LIMNÆA,* Lamarck. Pond-snail.

Etym. *Limnaios*, marshy. *Type*, L. stagnalis, fig. 95. Pl. XII. fig. 30.

* Adjectives employed as names for shells should have the feminine termination.

Shell spiral, more or less elongated, thin, translucent; body-whirl large, aperture rounded in front; columella obliquely twisted.

Animal with a short, broad head; tentacles triangular, compressed; lingual teeth (*L. stagnalis*) 55.1.55, about 110 rows, central teeth minute, laterals bicuspid, the inner cusp largest. *L. peregra* feeds on the green fresh-water algae; *L. stagnalis* prefers animal substances.

Distr. 50 sp. Europe, Madeira, India, China, N. America.

Fossil, 70 sp. Wealden —. Brit. France.

Sub-genus, Amphipeplea, Nilsson. A. glutinosa, Pl XII. fig. 31. *Shell* globular, hyaline. *Animal* with a lobed mantle, capable of expansion over the shell. Europe; Philippines.

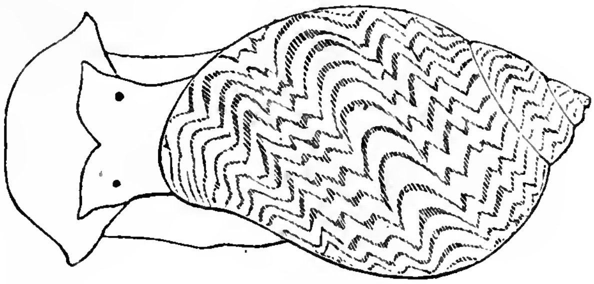


Fig. 96.

CHILINIA, Gray. Chilian-snail.

Ex. C. pulchra, D'Orb. fig. 96. *Syn.* Dombeya, D'Orb.

Shell oval, thin, ornamented with dark spots or wavy bands; columella thickened, with 1 or 2 strong prominent folds.

Distr. 14 sp. S. America; in clear running streams.

Fossil, 1 sp. Miocene, Rio Negro, Patagonia (D'Orb.)

PHYSA, Draparnaud.

Type, P. fontinalis, Pl. XII. fig. 32. *Etym. Physa,* a pouch.

Syn. Bulin, Adans. Rivicola, Fitz. Isidora, Ehr.

Shell ovate, sinistrally spiral, thin, polished; aperture rounded in front.

Animal with long slender tentacles; the eyes at their bases; mantle margin expanded and fringed with long filaments.

P. hypnorum (Aplexa, Fleming) has an elongated spire, and the mantle margin is plain. *Physopsis,* Krauss, S. Africa, has the base of the columella truncated. *Camptoceras* (terebra), Benson, India, has the whirls disunited, and the peristome continuous.

Distr. 20 sp. N. America, Europe, S. Africa, India, Philippines.

Fossil, 14 sp. Wealden —. Brit. France. The largest living sp. (P. Maugeræ, California) is 15 lines in length. A fossil sp. found at Grignon measures 26 lines, and another equally large occurs in India.

ANCYLUS, Geoffroy. River-limpet.

Etym. Ancylus (agkulos) a small round shield.

Type, A. fluviatilis, Müll. Pl. XII. fig. 33 (Patella lacustris, L.)

Shell conical, limpet-shaped, thin; apex posterior, sinistral; interior with a sub-spiral muscular scar.

Animal like Limnæa; tentacles triangular, with eyes at their bases; lingual teeth 37.1.37, in 120 rows, centrals small, laterals with long recurved hooks.

Distr. 14 sp. N. and S. America, Europe, Madeira. On stones and aquatic plants in running streams. *Fossil*, 8 sp. Eocene, Belgium.

Sub-genera, Velletia (oblonga, Lightf.) Gray. (Aeroloxus, Beck) Shell and animal dextral; lingual teeth 40, in 75 rows. 3 sp. West Indies, Europe. *Fossil*, 2 sp. Eocene. Brit. France.

Latia (neritoides) Gray; shell limpet-like, interior with a transverse plate, turned up and notched on one side. N. Zealand.

PLANORBIS, Müller.

Syn. "Coret," Adans. *Type*, P. corneus, Pl. XII. fig. 34.

Shell discoidal, dextral, many-whirled; aperture crescentic, peristome thin, incomplete, upper margin projecting.

Animal with a short, round foot; head short, tentacles slender, the eyes at their inner bases; lingual teeth sub-quadrate, central and marginal bicuspid, laterals tricuspid; excretory orifices on left side of the neck.

Some species of *Planorbis* have the sutures and spire deeply sunk, and the umbilicus flattened; specimens occur with the spire elevated (fig. 97*). *P. contortus*, a minute species, has above 6,000 teeth, (*Cocken*). P. corneus secretes a purple fluid (Lister). *P. lacustris* (Segmentina, Fleming) has the whirls contracted, internally, by periodic septa, 3 in a whirl, with triradiate openings.

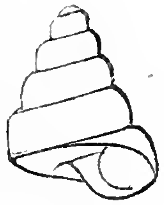


Fig. 97.

Distr. 60 sp. N. America, Europe, India, China.

Fossil, 60 sp. Wealder —. Brit. France.

FAMILY V. AURICULIDÆ.

Shell spiral, covered with horny epidermis, spire short, body-whirl large; aperture elongated, denticulated; internal septum progressively absorbed.

Animal with a broad and short muzzle, tentacles 2, cylindrical, the eyes sessile behind them; mantle-margin thickened; orifices as in the snails; foot oblong; sexes united; mouth with a horny upper jaw; lingual teeth numerous, central series distinct, hooked, tricuspid. *A. livida* has about 31 laterals (Loven); another species examined by Mr. Wilton has 11 large laterals and about 100 smaller (*uncini*) on each side, gradually diminishing towards the edge, fig. 98, *c.* central teeth, *l.* laterals.

* *P. marginatus*, var. Rochdale, communicated by J. S. Gaskoin, Esq.

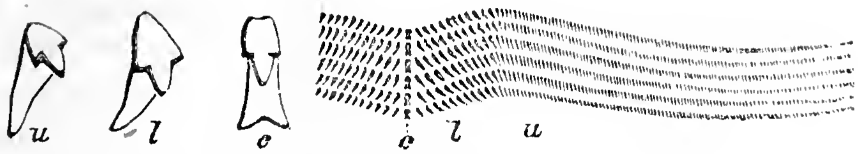


Fig. 98

The *Auriculæ* frequent salt-marshes, damp hollows, and places overflowed by the sea; they were long regarded as marine animals, and their shells confused with those of *Tornatella* and *Ringicula*.

AURICULA, Lamarck.

Type. A. Judæ. Pl. XII. fig. 35. *Etym*. *Auricula*, a little ear.

Syn. Cassidula, Fér (not Lam.) Marinula (pepita) King. Geovula, Sw.

Shell oblong, with thick, dark epidermis; spire obtuse; aperture long, narrow, rounded in front, with 2 or 3 strong folds on the inner lip; outer lip expanded and thickened.

Distr. 50 sp. Philippines, Celebes, Feejees, Australia, Peru.

Fossil, 20 sp. ? Neocomian —. France.

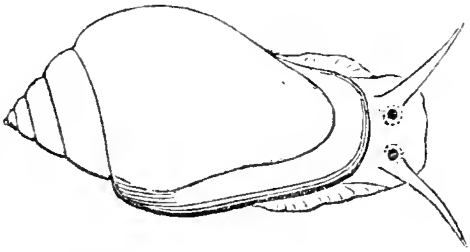


Fig. 99. *A. auris-felis*. (From Eyd. and Soul).

A. Judæ has truncated tentacles; the typical species are met with in the brackish-water swamps of tropical islands, on the roots of mangroves, and by small streams within the influence of the tide. One species has been observed by Mr. Adams in nearly 2 fathoms water.

Sub-genera, *Polydonta*, Fischer, *P. scarabæus*, Pl. XII. fig. 36. (Scarabus imbrium, Montf.) Shell oval, compressed; spire pointed many-whirled, with lateral varices; aperture toothed on both sides. *Distr*. 20 sp. India, Borneo, Celebes, Pacific Ids. Inhabits moist spots in woods near the sea, and is wholly terrestrial, feeding on decayed vegetables. (*Adams*.)

Pedipes (afra) Adans. *Shell* ovate, spirally striated, aperture denticulated on both sides; the animal loops in walking, like *truncatella*. *Distr*. W. Indies, Africa, Philippines, Pacific Ids. Under stones on the sea-shore.

Fossil, 5 sp. Eocene —. Brit. France.

CONOVULUS, Lamarck.

Type, C. coniformis, Brug. Pl. XII. fig. 37. (= Voluta coffea, L.?)

Syn. Melampus, Montf. Rhodostoma, Sw.

Shell obtusely cone-shaped, smooth; spire short, flat-whirled; aperture long, narrow; lip sharp, denticulated within; columella twisted in front; wall of the aperture with 1 or 2 spiral plaits.

Animal with short, tapering and rather compressed tentacles; foot divided transversely into two portions, advanced successively in walking.

Distr. W. Indies, Europe. In salt-marshes and on the sea-shore. The British species have thin ovate shells, with the spire moderately produced, and the aperture oval. They form the sub-genus *Alexia.* (denticulata) Leach. *Fossil.* Eocene. Brit. France.

CARYCHIUM, Müller.

Type, C. minimum, Pl. XII. fig. 39.

Syn. Auricella, Hartm.

Shell minute, oblong, finely striated transversely; aperture oval, toothed, margins thickened, united by callus.

Animal with 2 blunt, cylindrical tentacles; eyes black, sessile, near together, behind the tentacles.

Distr. 3 sp. Europe; N. America. At the roots of grass in damp places, especially near the sea.

Fossil. Miocene —. Europe.

The genus *Siphonaria*, described at p. 155, is supposed to be pulmoniferous, and to bear somewhat the same relation to *Auricula* that Ancylus does to *Limnaea.* The lingual dentition is similar to Auricula; the centre teeth are distinct, the laterals numerous and hooked.

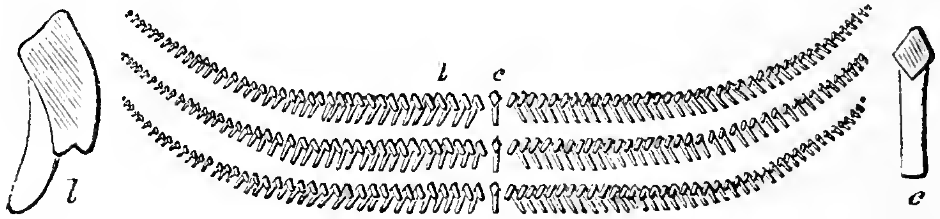


Fig. 100.*

SECTION B. OPERCULATA.*

The Operculated land-snails are exceedingly like periwinkles (*litorinæ*), and chiefly differ from them in the situations they inhabit, and the medium respired. They have a long truncated muzzle, 2 slender contractile tentacles, and the eyes are sessile on the sides of the head.‡ The mantle-margin is simple, and the pulmonary cavity is situated on the back of the neck, and quite open in front. Lingual ribbon narrow; teeth 7-ranked.

* *Siphonaria* sp. from the Cape; three rows of teeth, *c* central, *l* laterals, from a preparation by J. W. Wilton, Esq., of Gloucester.

† *Phanero-pneumona* (open-lunged), Gray. The account of this group is chiefly taken from the Catalogue prepared by my friend Dr. Baird.

‡ The tentacles of the *helicidæ* are retractile, by inversion (p. 25) those of the *cyclostomidæ* are contractile only.

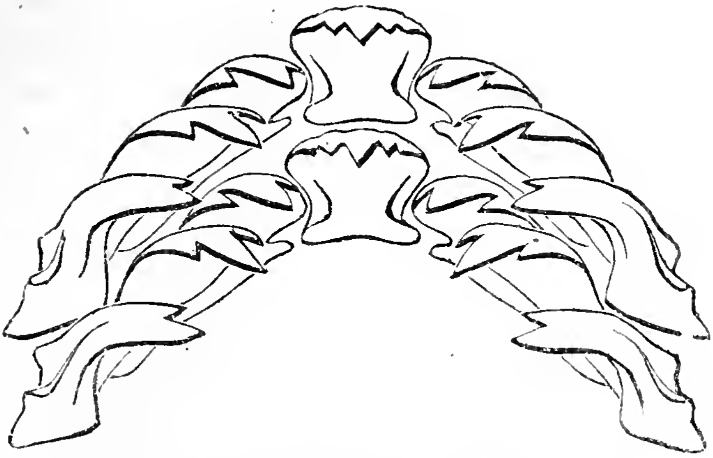


Fig. 101. *Lingual teeth of Cyclophorus.**

The sexes are distinct; the shell is spiral, and closed by an operculum, presenting many beautiful modifications of structure, characteristic of the smaller groups, which are often peculiar to limited regions, as in the *Helicidæ*. The oldest fossil species are found in the Eocene Tertiary.

FAMILY VI. CYCLOSTOMIDÆ.

Shell spiral, rarely much elongated, often depressed, spirally striated; aperture nearly circular; peristome simple. *Operculum* distinctly spiral.

Animal with the eyes on slight prominences at the outer bases of the tentacles; tentacles contractile only; foot rather elongated.

CYCLOSTOMA, Lamarck.

Etym. *Cyclos* circle, *stoma* mouth. *Type*, C. elegans, Pl. XII. fig. 40.

Syn. Leonia (mammillaris) and Lithidion, Gray.

Shell turbinated, thin, axis perforated; aperture oval; peristome continuous, simple, straight or expanded; epidermis very thin. Operculum shelly, pauci-spiral.

Animal with clavate tentacles; sole of the foot divided by a longitudinal groove, the sides moved alternately in walking; the end of the long muzzle is also frequently applied, as by the looping-snails (Truncatellæ), and used to assist in climbing.

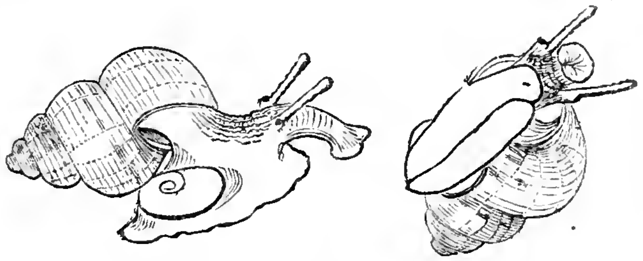


Fig. 102. *Cyclostoma elegans, from Charlton, Kent.*

Distr. Above 80 sp. S. Europe; Africa, Madagascar. The only British

* *C. aquilum, Sby.* (original). From a specimen gathered by J. W. Laidlay, Esq. on the steps of the great idol-temple of Maulmein, Birmah.

sp. *C. elegans*, is found on calcarious soils; it ranges to the Canaries and Algeria, and occurs fossil in the newer Tertiaries. Nearly half the species have the whirls spirally keeled, and have been distinguished under the name *Tropidophora*, by Troschel. They are found in Madagascar and the adjacent islands and coast of Africa. *Fossil*, 20 sp. Eocene, Europe.

Sub-genera. Otopoma (foliaceum), Gray. *Shell* sub-globose, umbilicated; peristome with an ear-like process covering part of the perforation. *Distr.* 15 sp. Arabia, Madagascar, China, New Ireland.

Choanopoma (lincina) Pfr. *Shell* often a little decollated; peristome usually double, the outer edge angularly expanded. *Lincina* (labeo) Br. has the last whirl produced. *Jamaicia* (anomala) C. B. Adams, has the operculum convex. *Distr.* 70 sp. W. Indies, and a few in Tropical America.

Cistula (fascia), Gray. = *Tudora* (megacheila), Gray. *Shell* ovate or elongated, apex usually decollated, peristome free; operculum with a thin shelly outer coat. *Chondropoma* (semilabre) Pfr. differs in the operculum being "sub-cartilaginous." *Distr.* About 70 sp. W. Indies; Tropical America, 8 sp.

Realia (hieroglyphica), Gray. = Hydrocæna (part) Parreyss, Omphalotropis, Pfr. Liarea (Egea), Gray. Bourciera (helicinæformis) Pfr. *Shell* turrited or turbinate, perforated; peristome simple, straight or expanded; operculum pauci-spiral, horny. *Distr.* 17 sp. Canaries, ? Mauritius, Pacific Ids. (Ecuador, *Bourciera.*)

Pomatias (maculatum), Studer. *Shell* slender, transversely striated; peristome reflected; operculum cartilaginous, concamerated within. *Distr.* 10 sp. S. Europe; Corfu.

? Ferussina, Grateloup.

Etym. named in honour of Baron Ferussac.

Type, F. anastomæformis, Gr. *Syn.* Strophostoma, Desh.

Shell rounded, depressed, umbilicated; whirls transversely striated above, spirally keeled below; aperture turned obliquely upwards, peristome simple, Operculum. ?

Fossil, 1 sp. Miocene —. Dax; Turin.

Cyclophorus, Montfort.

Etym. Cyclos, circle, *phoreus*, bearer.

Type, C. involutus, Pl. XII. fig. 41.

Shell depressed, openly umbilicated; aperture circular; peristome continuous, straight or expanded; epidermis thick; operculum horny, many-whirled.

Animal with long, slender pointed tentacles; foot broadly expanded, not grooved.

Distr. About 90 sp. India, Philippines, New Zealand, Pacific Ids. Tropical America. *C. gibbus*, Fér. (Alycaeus, Gray) has the last whirl distorted.

C. cornu-venatorium, Sby. (Aulopoma, Troschel) Ceylon, has the peristome free when adult; the operculum is larger than the aperture, and reflected over it.

Sub-genera. Pterocyclos (rupestris), Benson. Myxostoma and Steganostoma, Troschel. *Shell* depressed, nearly discoidal, widely umbilicated; peristome expanded, produced into a little wing at the suture; operc. sub-cartilaginous, spirally lamellated. *Distr.* 16 sp. India, Ceylon, Birmah, Borneo?

Cyclotus (fuscescens) Guilding (Aperostoma, Troschel). *Shell* depressed, widely umbilicated; operculum shelly, whirls numerous, with raised margins. *Distr.* 44 sp. W. Indies, Tropical America, India, Asiatic Ids. *Fossil.* Eocene, I. Wight (F. Edwards).

Leptopoma (perlucidum) Pfr. *Shell* turbinated, peristome simple, reflected; operc. membranous. *Distr.* 29 sp. Philippines, India, New Guinea, N. Zealand, Pacific Ids.

*Megaloma** (cylindraceum) Guild. (Farcimen, Troschel.) *Shell* oblong or pupa-shaped, scarcely perforated, aperture circular; operc. thin, horny, many-whirled, flat. *Distr.* 19 sp. West Indies, Tropical America, Canaries, India, Mauritius. *Fossil.* Eocene —. Paris and I. of Wight (*E. Forbes.*)

Craspedopoma (lucidum) Pfr. *Shell* turbinate, rimate, a little contracted near the aperture; operc. round, horny, many-whirled. *Distr.* 3 sp. Madeira, Palma. *Fossil.* Eocene —. I. Wight, Madeira.

Cataulus (tortuosus) Pfr. *Shell* pupa-shaped, with the base keeled, producing a channel in the front of the aperture; operc. circular, horny, the whirls easily separable. *Distr.* 6 sp. Ceylon.

Diplommatina (folliculus) Benson. *Shell* minute, (1 sp. sinistral) conical, with costulated whirls; peristome double; operc. horny, multispiral. *Distr.* 3 sp. India.

Pupina, Vignard.

Type, P. bicanaliculata, Sby. Pl. XII. fig. 42. Australian Ids.

Shell sub-cylindrical, usually polished; aperture circular, peristome thickened, notched in front and at the suture; operc. membranous, narrow-whirled. P. *grandis*, Forbes, has a dull epidermis.

Distr. 8 sp. Philippines, New Guinea, New Ireland, Louisiades.

Sub-genus, Rhegostoma (nunezii) Hasselt. Aperture with a narrow channel in the middle of the columellar side. 6 sp. Philippines. Nicobar. In *R. lubricum* (Callia, Gray) the sinus is obsolete. *R. pupiniforme* (Pupinella, Gray) is perforated, and has a dull epidermis.

Helicina, Lamarck.

Type, H. Neritella, Lam.

Syn. Oligyra, Say. Pachytoma, Sw. Ampullina, Bl. Pitonillus, Montf.

* Abridged from *Megaloma-stoma;* Swainson, who judiciously curtailed several preposterously long names, allowed this to remain.

Shell globose, depressed or keeled, callous beneath; aperture squarish or semi-lunar; columella flattened; peristome simple, expanded; operc. shelly or membraneous, squarish or semi-ovate, lamellar.

Animal like *Cyclophorus;* lingual teeth 3.1.3. (Gray.)

Distr. 150 sp. W. Indies, 50; Tropical America, 44; Pacific Ids., 26; Australian Ids. 3; Philippines, 7.

Sub-genera. Lucidella, (aureola) Gray. Peristome more or less toothed internally; 8 sp. W. Indies, Tropical America.

Trochatella (pulchella), Sw. *Shell* not callous beneath; peristome simple, expanded. W. Indies 16 sp. Venezuela 1.

Alcadia, Gray. A. Brownei, Pl. XII. fig. 43. *Jamaica. Shell* helix-shaped, often velvety, callous beneath; columella flattened, straight; peristome slit in front; operc. shelly, semi-ovate, with a tooth-like process adapted to the slit in the peristome. *Distr.* 17 sp. Cuba, Jamaica and Haiti.

Stoastoma, C. B. Adams.

Etym. Stoa pillared, *stoma,* mouth. *Type,* S. pisum, Ad.

Shell minute, globose-conic or depressed, spirally striated; aperture semi-oval; peristome continuous; inner margin straight, forming a small spiral keel round the umbilicus; operc. shelly, lamellar.

Distr. 19 sp. Jamaica. *S. succineum* (Electrina, Gray) has smooth whirls. I. Opara, Polynesia.

FAMILY VII. Aciculidæ.

Shell elongated, cylindrical; operculum thin, sub-spiral.

Animal with the muzzle rather produced, slender and truncated; eyes sessile on the upper part of the head, behind the base of the slender tentacles; foot oblong, short, pointed behind.

Acicula, Hartmann.

Type, A. fusca, Pl. XII. fig. 44. *Syn.* Acme and Acmaea, Hartm.*

Shell minute, slender, nearly imperforate; peristome slightly thickened, margins sub-parallel, joined by a thin callus; operc. hyaline.

Distr. 5 sp. Brit. Germany, France; Vanicoro (on leaves). *A. fusca* is found in low, marshy situations, at the roots of grass; it occurs fossil in the Newer Pleiocene of Essex (J. Brown).

Geomelania, Pfeiffer.

Type. G. Jamaicensis. Pfr. *Etym. Ge,* the ground (i.e. terrestrial).

Shell imperforate, turreted; aperture entire, effused; peristome simple, expanded; margins joined, basal produced into a tongue-shaped process; operc. oval, pellucid, whirls few, rapidly enlarging.

Distr. 21 sp. Jamaica.

* All given in the same year, 1821; the name *Acmaea* having been employed by Eschscholtz for a genus of limpets, *Acicula* has been retained by Pfeiffer and Gray for this land-shell.

ORDER III. Opistho-branchiata.

Shell rudimentary or wanting. *Branchiæ* arborescent or fasciculated, not contained in a special cavity, but more or less completely exposed on the back and sides, towards the rear (*opisthen*) of the body. Sexes united. (*M. Edwards*).

The molluscs of this order may be termed sea-slugs, since the shell, when it exists, is usually small and thin, and wholly or partially concealed by the animal. When alarmed or removed from their native element, they retract their gills and tentacles, and present such a questionable shape that the inexperienced naturalist will be likely enough to return them, with the refuse of the dredge, into the sea. Their internal structure presents many points of interest; in some the gizzard is armed with horny spines, or large shelly plates; in others the stomach is extremely complicated, its ramifications and those of the liver being prolonged into the branches of the respiratory organ. The tongue is always armed, but the number and arrangement of the lingual teeth is exceedingly variable, even in the same family; usually the dental membrane is broad and short, with many similar teeth in each row. The alimentary canal terminates more in the rear of the body than in the other univalve shell-fish.* The gills are behind the heart, and the auricle behind the ventricle; conditions which characterize the embryonic state of the mollusca generally.

Comparatively little is known of the geographical distribution of these animals; they have been found wherever the requisite search has been made, and are probably much more numerous than at present estimated. The shell-bearing genera flourished in the period when the secondary strata were deposited. The living species are chiefly animal-feeders, preying on other shell-fish and on zoophytes.

SECTION A. Tecti-branchiata.†

Animal usually provided with a shell, both in the larval and adult state; branchiæ covered by the shell or mantle; sexes united.

FAMILY I. Tornatellidæ.

Shell external, solid, spiral or convoluted, sub-cylindrical; aperture long and narrow; columella plaited; sometimes operculated.

Animal with a flattened, disk-like head, and broad obtuse tentacles; foot ample, furnished with lateral and operculigerous lobes.

* In the cuttle-fishes and pteropods it is bent upon itself *ventrally*, in the sea-snails *dorsally*, terminating in front, near its origin; the vascular system partakes of this flexure, and the gills are in advance of the heart. (*Huxley.*)

† *Mono-pleuro-branchiata. Bl.* *Pomato-branchia*, (from *poma*, a lid). Wiegm. The order *Tecti-branchiata* of Cuvier included only the family *Bullidæ;* it is here made to comprise the *Infero-branches* also; no object being gained by the multiplication of descriptive epithets.

The shells of this family are chiefly extinct, ranging from the period of the coal strata, and attaining their greatest development in the cretaceous age. *Tornatella* is essentially related to *Bulla*, but presents some resemblance to the *Pyramidellidæ* in its plaited and operculated aperture; in *Tornatina* the nucleus, or apex, is sinistral. The spiral striae which ornament many of the species, are punctate, as in the Bullidæ; and the outer lip often remarkably thickened, as in Auricula.

TORNATELLA, Lamarck.

Type. T. tornatilis, Pl. XIV. fig. 1. *Syn*. Actæon, Montf. (not Oken), Dactylus (solidulus) Schum. ? Monoptygma (elegans) Lea.

Shell solid, ovate, with a conical, many-whirled spire; spirally grooved or punctate-striate; aperture long, narrow, rounded in front; outer lip sharp; columella with a strong, tortuous fold; operculum horny, elliptical, lamellar.

Animal white; head truncated and slightly notched in front, furnished posteriorly with recumbent tentacular lobes, and small eyes behind them, near their inner bases; foot oblong, lateral lobes slightly reflected on the shell. Lingual teeth 12.12, similar, with long simple hooks.

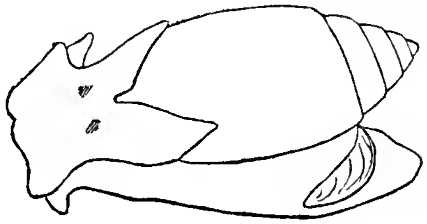


Fig. 103.

Distr. 16 sp. U. States, Brit. Senegal, Red Sea, Philippines, Japan, Peru. T. tornatilis inhabits deep water, (—60 fms. *Forbes*).

Fossil, 70 sp. Trias — Lias —. N. America, Europe, S. India.

Sub-genera, *Cylindrites* (Llhwyd) Lycett. C. acutus, Sby. Pl. XIV. fig. 2. (A.) Shell smooth, slender, sub-cylindrical, spire small, aperture long and narrow, columella rounded, twisted, and directed slightly outwards. (B.) Shell oval, spire sunk, whirls with acute margins. Bath Oolite, Brit.

Acteonina, D'Orb. Tornatellæ "without columella plaits," 30 sp. Carb.—Portlandian, (including *Cylindrites*).

Acteonella, D'Orb. A. Renauxiana, Pl. XIV. fig. 3. Shell thick, cone-like or convoluted, spire short or concealed, aperture long and narrow, columella with 3 strong and regular spiral plaits in front. *Distr*. 11 sp. Chalk; Brit. France.

Acteon Cabanetiana, D'Orb. (*Itieria*, Matheron, 1842) Coral-rag, France, belongs to the genus *Nerinea* (D'Orb.) p. 129.

CINULIA. Gray.

Type, C. avellana, Pl. XIV. fig. 4. *Syn*. Avellana and Ringinella, D'Orb.

Shell globular, thick, spirally groved and punctate, spire small; aperture narrow, rounded and sinuated in front; outer lip thickened and reflected; crenulated inside, columella with several tooth-like folds.

Fossil, 20 sp. Neocomian —Chalk. Brit. France.

RINGICULA, v. p. 112, Pl. V. fig. 21.

GLOBICONCHA, D'Orbigny.

Type, G. rotundata, D'Orb. *Fossil*, 6 sp. Chalk. France.

Shell ventricose, smooth, aperture crescent-shaped, simple, not toothed or thickened on the columellar side.

VARIGERA, D'Orbigny. 1850.*

Type, V. Guerangeri, D'Orb. *Fossil*, 8 sp. Neoc:—. Chalk. France.

Shell like *Globiconcha*, but with lateral varices.

TYLOSTOMA, Sharp. 1849.

Type, T. Torrubiæ, Sh. *Etym.* *Tulos*, a callosity, *stoma*, mouth.

Shell ventricose, smooth or punctate-striate, spire moderate, aperture ovate-lunate, pointed above, rounded in front; outer lip periodically (once or twice in a whirl) thickened inside and expanded, rising slightly; inner lip callous, spread over body-whirl.

Distr. 4 sp. L. Cretaceous rocks, Portugal.

? PTERODONTA, D'Orbigny.

Type, P. inflata, D'Orb. *Fossil*, 8 sp. Chalk. France.

Shell oblong, ventricose, spire elongated; aperture oval, lip slightly expanded, notched in front, and with a tooth-like ridge internally, remote from the margin.

? TORNATINA, A. Adams.

Type, T. voluta. Pl. XIV. fig. 5.

Shell cylindrical or fusiform, spire conspicuous, apex sinistral, suture channelled, columella callous, 1-plaited.

Animal with a broad, trigonal head, rounded in front; tentacular lobes triangular, with eyes at their outer bases; foot short, truncated in front.

Distr. 15 sp. W. Indies, U. States, Medit. Philippines, China, Australia. On sandy bottoms, ranging to 35 fms. (*Adams*).

Volvula, Adams (Bulla acuminata, Brug.) is a small convoluted shell, with the spire concealed, and the columella obsoletely folded; it is referred to *Cylichna* by Lovén, to *Ovulum* by Forbes. *Distr.* Brit. Medit. *Fossil.* Miocene —. Suffolk.

FAMILY II. BULLIDÆ.

Shell globular or cylindrical, convoluted, thin, often punctate-striated;

* The dates of M. D'Orbigny's genera, given in the *Prodrome de Paleontologie*, are dates of *invention;* the names were not published, in many instances, until years afterwards.

spire small or concealed; aperture long, rounded and sinuated in front; lip sharp. No operculum.

Animal more or less investing the shell; head a flattened disk,* with tentacular lobes, often united; eyes immersed in the centre of the disk, or wanting; foot oblong, furnished with a posterior lobe (*meta-podium*), and side-lobes (*epipodia*); gill single on the right side of the back, covered by the shell; mantle-margin simple or expanded, and enveloping the shell. Lingual dentition very various; central teeth often wanting, laterals single or numerous. Gizzard armed with calcarious plates. Sexes united.

The *Bullidæ* are animal-feeders; they are said to use their lateral lobes for swimming. About 150 recent species have been described by Mr. A. Adams in Sowerby's *Thesaurus Conchyliorum*. *Fossil* species date from the lower Oolites; one is found in the Aralo-Caspian formation.

BULLA, Lamarck. Bubble-shell.

Type, B. ampulla, Pl. XIV. fig. 6. *Syn.* Haminea (hydatis) Leach.

Shell oval, ventricose, convoluted, external or only partially invested by the animal; apex perforated; aperture longer than the shell, rounded at each end; lip sharp.

Animal with a large cephalic disk, truncated in front, bilobed behind, the lobes laminated beneath; eyes sub-central, immersed or wanting; lateral lobes very large, reflected on the sides of the shell, posterior lobe covering the spire; foot quadrate; gizzard furnished with 3 chiton-like plates; teeth.?

Bulla naucum (*Atys*, Montf. *Alicula*, Ehr. *Roxania*, Leach). Pl. XIV. fig. 7; has the columella twisted, and the spire entirely concealed.

Distr. 50 sp. In all temperate and tropical seas, especially on sandy bottoms, ranging from low water to 25 or 30 fms.

Fossil, 70 sp. Ool. —. S. America, U.S. Europe.

Sub-genera ? *Crypt-opthalmus* (smaragdinus) Ehr. Red sea. *Shell* scarcely convolute, fragile, oval, convex, without spire or columella. *Animal* semi-cylindrical, head with short tentacular lobes, eyes small, concealed under the lateral margins of the head, mantle and lateral lobes enveloping the shell.

Phaneropthalmus, A. Adams. (Xanthonella, Gray) B. lutea, Quoy, New Guinea. *Shell* oval, convex, pointed behind, columella margin with a curved process. *Animal* long, cylindrical, head with short tentacular lobes, eyes in middle of disk, lateral lobes enveloping.

Linteria, A. Adams (Glaucouella, Gray), Bulla viridis, Rang. Pl. XIV. fig. 7. *Shell* oval, widely open, showing the rudimentary internal spire.

* The cephalic expansion of the Bullidæ is formed by the fusion of the dorsal and oral tentacles. (*Cuvier.*) The tentacular lobes, or posterior part of the disk is supplied with nerves from the olfactory ganglia; the anterior portion of the disk receives branches from the labial nerve, which comes from the front margin of the cerebroid. (*Hancock.*)

Animal with a squarish, disk-like head, eyes sessile in the centre; mantle not investing; a posterior lobe; lateral lobes enveloping. (Pl.XIV. fig. 8, not 7).

ACERA, Müller.

Type, A. bullata, Pl. XIV. fig. 9. *Etym. Akeros*, hornless.

Shell thin, flexible, globosely-cylindrical, spire truncated, whirls channelled; aperture long, expanded and deeply sinuated in front, outer margin disunited at the suture; columella open, exposing the whirls.

Animal with a short and simple head-lobe, truncated in front and eyeless; lateral lobes nearly concealing the shell; lingual teeth hooked and serrulate, laterals about 40, narrow, claw-shaped; gizzard armed with horny teeth.

Distr. 7 sp. Greenland, Brit. Medit. Zanzibar, India, New Zealand.

A. bullata is found amongst weed, in 1—15 fms. water (*Forbes*).

CYLICHNA, Lovén.

Type, C. cylindracea, Pl. XIV. fig. 10. *Syn.* Bullina, Risso.

Shell strong, cylindrical, smooth or punctate-striate; spire minute or truncated; aperture narrow, rounded in front; columella callous, with one plait.

Animal short and broad, not investing the shell; head flattened, truncated in front, with sub-centrally immersed eyes, tentacular lobes more or less united; foot oblong, posterior and lateral lobes not much developed; gizzard armed; lingual teeth squarish, recurved and serrated, with 1 large and 5 or 6 small hooked laterals.

Distr. 20 sp. U. States, Greenland, Brit. Red Sea, Australia.

Fossil. Miocene —. Brit.

AMPHISPHYRA, Lovén.

Type. A. pellucida, Johnst. (*Amphi-sphyra*, double hammer.)

Syn. Utriculus (part) Brown. Rhizorus, Montf. Diaphana, Brown.

Shell small, thin, ovate, truncated, spire minute papillary, aperture long.

Animal entirely retractile into its shell; head wide, short, with lateral triangular tentacles; the eyes behind them minute, immersed; muzzle bi-lobed in front; foot oblong, truncated in front, notched behind; teeth 1.1.1, central quadrate, serrulate; laterals broad, hooked.

Distr. 5 sp. U. States, Norway, Brit. Borneo, Mexico.

APLUSTRUM, Schumacher.

Type, Bulla aplustre, Pl. XIV. fig. 11. *Etym. Aplustre*, a ship's flag.

Syn. Bullina, Fér. Hydatina (physis) Schum. Bullinula (scabra) Beck.

Shell oval, ventricose, highly coloured; spire wide, depressed; aperture truncated in front; outer lip sharp.

Animal, with a very large foot, extending beyond the shell all round, and capable of enveloping it; a posterior lobe reflected on the spire; mantle not investing; tentacular lobes large, oval, ear-shaped; labial tentacles four; eyes small, black, sessile at the inner bases of the tentacles; lingual teeth (*B. physis*) 13.0.13, serrated.

Distr. 10 sp. U. States, W. Indies, Mauritius, Ceylon, China, Australia.

SCAPHANDER, Montfort.

Type, S. lignarius, Pl. XIV. fig. 12. *Etym.* *Scaphe* boat, *aner*, man.

Shell oblong, convolute; spirally striated; aperture much expanded in front; spire concealed; epidermis thick; lingual teeth 1.0.1. crested.

Animal with a large oblong head, destitute of eyes; foot short and broad; lateral lobes reflected, but not enveloping the shell; gizzard of two large trigonal plates and a small narrow transverse plate (fig. 17).

Distr. 5 sp. U. States, Norway, Brit. Medit. on sandy ground; 50 fms.

Fossil, 8 sp. Eocene —. Brit. France.

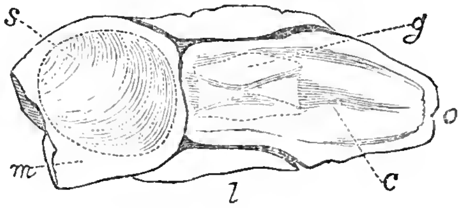


Fig. 104. *Bullæa aperta.**

BULLÆA, Lamarck.†

Type, B. aperta, Pl. XIV. fig. 13.

Shell internal, white, translucent, oval, slightly convoluted, spire rudimentary.

Animal pale, slug-like; mantle investing the shell; head oblong; eyeless; foot broad; lateral lobes large, but not enveloping; tongue with 2 or 4 series of sickle-shaped *uncini*; gizzard with 3 longitudinal shelly plates. Egg capsules ovate, in single series on a long spiral thread; fry with a ciliated head-veil and an operculated, spiral shell, (*Lovén*).

Distr. 10 sp. W. Indies, Greenland, Norway, Britain, Medit. Corea, Borneo. *Fossil*, Eocene —. France.

Sub-genus, *Chelidonura*, A. Adams, (Hirundella, Gray) B. hirundinaria, Quoy, Mauritius. *Shell* concealed; outer lip produced posteriorly into a spur; columellar border inflected. *Animal* with enveloping side lobes; mantle with two appendages behind, like the lateral processes of *Hyalaea.*

DORIDIUM, Meckel.

Etym. diminutive of *Doris.* *Syn.* Acera, Cuv. Eidothea, Risso.

* From a specimen dredged at Folkstone; *o*, mouth, *c*, head, or cephalic disk, *l*, side-lobes of the foot, *m*, mantle, The shell *s*, and gizzard *g*, are indistinctly seen through the translucent integuments.

† Gray adopts the pre-Linnean name *Philine* (Ascanius, 1762), and D'Orbigny the still older *Lobaria*, (Müller, 1741), names given to particular *species*, and not to *genera* as now understood.

Type, D. membranaceum, Meck. Medit.

Animal oblong, truncated behind, the angles produced and dilated or filiform; head ovate-oblong, retuse in front; side-lobes expanded, wing-like; mantle investing a rudimentary, membranous shell.

GASTROPTERON, Meckel.

Type, G. Meckelii, Bl. (Clio amate, Chiaje) Medit.

Animal shell-less, oval, with side-lobes developed into wing-like expansions meeting and uniting behind; cephalic disk triangular, obtuse in front, pointed behind, eyes centrally immersed; lingual teeth 5.1.5.; mantle? branchial plume exposed on the right side; reproductive orifice in front of the gill, excretory opening behind it. Lon. 1, lat. 2 inches.

Sormetus Adansonii, Bl. is described as semi-cylindrical, with sides grooved, head indistinct; shell unguiform, thin, and transparent.

Atlas (*Peronii,* Bl.) Lesueur. Head with 2 small tentacular lobes; body contracted in the middle; foot dilated circularly, and fringed at the margin.

FAMILY III. APLYSIADÆ.

Shell wanting, or rudimentary and covered by the mantle, oblong, trigonal, or slightly convoluted.

Animal slug-like, with distinct head, tentacles and eyes; foot long, drawn out into a tail behind; sides with extensive lobes, reflected over the back and shell; branchial plume concealed. Sexes united.

APLYSIA, Gmelin. Sea Hare.

Type. A. depilans, Pl. XIV. fig. 14. *Syn.* Siphonotus (geographicus) Ad.

Shell oblong, convex, flexible and translucent, with a posterior slightly incurved apex.

Animal oval, with a long neck and prominent back; head with 4 tentacles, dorsal pair ear-like with eyes at anterior lateral bases; mouth probosidiform, with horny jaws, lingual teeth 13.1.13, hooked and serrated, about 30 rows; gizzard armed with horny spines; sides with ample lobes folding over the back, and capable of being used for swimming; gill in the middle of the back, covered by the shell, and by a lobe of the mantle which is folded posteriorly to form an excretory siphon.

Distr. 40 sp. W. Indies, Norway, Brit. Medit. Mauritius, China.

The Sea-hares are mixed feeders, living chiefly on sea-weed, but also devouring animal substances; they inhabit the laminarian zone, and oviposit amongst the weed in spring, at which time they are frequently gregarious (*Forbes*). They are perfectly harmless animals and may be handled with impunity. When molested they discharge a violet fluid from the edge of the internal surface of the mantle, which does not injure the skin, has but a faint smell, and changes to wine-red (*Goodsir*). In old times they were objects of superstitious dread, on account of their grotesque forms, and the imaginary properties of their fluid, which was held to be poisonous and to produce indelible stains.*

Fossil: one or two shells of the newest tertiary in Sicily have been doubtfully referred to this genus.

Sub-genus, Aclesia (dolabrifera) Rang. *Shell* trapeziform. Side-lobes closely enveloping the body, leaving only a small dorsal respiratory opening, surface ornamented with filaments. W. Indies.

Dolabella, Lamarck.

Type. D. Rumphii, Pl. XIV. fig. 15. *Etym. Dolabella,* a small hatchet.

Shell hard, calcarious, trigonal, with a curved and callous apex.

Animal like Aplysia, with gill near posterior extremity of the body and lateral crests closely appressed, leaving only a narrow opening; ornamented with branching filaments.

Distr. 12 sp. Medit. Mauritius, Ceylon, Society Ids. Sandwich Ids.

Notarchus, Cuvier.

Type. N. Cuvieri, Bl. *Etym. Notos,* the back, *archos* vent.

Syn. Busiris (griseus) Risso, ? Bursatella (Leachii) Bl.

Animal shell-less, ornamented with filaments, sometimes dendritic, foot narrow, linear, lateral crests united, leaving only a narrow branchial slit; gills not covered by an opercular mantle lobe.

Distr. 4 sp. Medit. Red Sea.

Icarus, Forbes, 1843.

Type. I. Gravesii, F. *Syn. Lophocercus* (Sieboldtii) Krohn, 1847.

Shell like Bullæa; convoluted, thin, ovate, covered with epidermis, outer lip separated at the suture, posterior angle inflected and rounded.

Animal slender, papillose; tentacles 2, ear-shaped; eyes sessile on sides of head; side-lobes reflected and partly covering the shell, united behind; tail long and pointed.

Lobiger, Krohn.

Type, L. Philippii, Pl. XIV. fig. 16. Sicily.

Shell oval, transparent, flexible, slightly convoluted; covered with epidermis.

Animal slender, papillose, with 2 flattened, oval tentacles, and minute sessile eyes on the sides of the head; shell exposed on the middle of the back, covering the plume-like gill; sides with two pairs of rounded, dilated lobes, or natatory appendages, foot linear, tail long and slender.

* *Aplysia,* (from *a* and *pluo*) un-washable; the *Aplysia* of the Greek Fishermen were sponges unfit for washing!

FAMILY IV. PLEUROBRANCHIDÆ.

Shell limpet-like or concealed, rarely wanting; mantle or shell covering the back of the animal; gill lateral, between the mantle-margin and foot; food vegetable, stomach extremely complicated.

PLEUROBRANCHUS, Cuvier.

Ex. P. membranaceus, Pl. XIV. fig. 17. *Etym. Pleura* side, *branchia* gill.

Syn. Berthella (plumula) Bl. Oscanius (membr.) Gray.

Shell internal, large, oblong, flexible, slightly convex, lamellar, with a posterior, subspiral nucleus.

Animal oblong, convex; mantle covering the back and sides, papillated, containing spicula; foot large, separated from the mantle by a groove; gill single, free at the end, placed on the right side between the mantle and foot; orifices near the base of the gill; head with 2 grooved tentacles, eyes at their outer bases; mouth armed with horny jaws and covered by a broad veil with tentacular lobes.

Distr. 20 sp. S. America, Norway, Brit. Medit. Red Sea.

Sub-genus ? Pleurobranchæa Meckel; P. Meckelii, Leve, Medit. *Syn.* Pleurobranchidium (maculatum) Quoy, S. Australia. Mantle-margin very narrow, not concealing the gill; dorsal tentacles ear-like, oral veil tentaculiform.

POSTEROBRANCHÆA, D'Orbigny.

Type, P. maculata, D'Orb. Coast of Chile.

Animal shell-less; oval, depressed, covered by a mantle broader than the foot; foot oblong, bi-lobed behind; branchial plume on the left side, projecting posteriorly; reproductive orifice in front of gill, excretory behind; proboscis covered by a broad bi-lobed veil; no dorsal tentacles.

RUNCINA, (Forbes) Hancock.

Type, R. Hancocki, Forbes. *Syn.* ? Pelta, Quatr. (not Beck.)

Animal minute, slug-like, with a distinct mantle; eyes sessile on the front part of the mantle; no tentacles; gills 3, slightly plumose, placed with the vent on the right side, at the hinder part of the back, beneath the mantle; gizzard armed; reproductive organs on the right side.

Distr. on *Confervæ* near high-water mark, Torbay.

UMBRELLA, Chemnitz. Chinese-umbrella shell.

Type, U. umbellata, Pl. XIV. fig. 18. *Syn.* Acardo, Lam. Gastroplax, Bl.

Shell limpet-like, orbicular, depressed, marked by concentric lines of growth; apex sub-central, oblique, scarcely raised; margins acute; inner surface with a central coloured and striated disk, surrounded by a continuous irregular muscular impression.

Animal with a very large tuberculated foot, deeply notched in front; mouth small, proboscidiform, retractile into the pedal notch, covered by a small lobed veil; dorsal tentacles ear-shaped, with large plicated cavities at their bases; eyes small, sessile between the tentacles; mantle not extending beyond the shell; gill forming a series of plumes beneath the shell in front and on the right side; reproductive organ in front of the dorsal tentacles; excretory orifice posterior, tubular.

Distr. 3 sp. Canaries, Medit. India, China, Sandwich Ids.

Fossil 2 sp. Eocene —. U. States, Sicily.

TYLODINA, Rafinesque.

Type, T. punctulata, Raf. (= citrina, Joannis) 3 sp. Medit. Norway.

Shell limpet-like, depressed, apex sub-central, with a minute spiral nucleus.

Animal oblong, foot truncated in front, rather pointed behind; dorsal tentacles ear-like, with eyes sessile at their inner bases; oral tentacles broad; branchial plume projecting posteriorly on the right side.

FAMILY V. PHYLLIDIADÆ.

Animal shell-less, covered by a mantle, branchial laminæ arranged in series on both sides of the body, between the foot and mantle. Sexes united.

PHYLLIDIA, Cuvier.

Type, P. pustulosa, Cuv. *Etym.* Diminutive of *Phyllon*, a leaf.

Animal oblong, covered with a coriaceous tuberculated mantle; dorsal tentacles clavate, retractile into cavities near the front of the mantle; mouth with two tentacles; foot broadly oval; gills forming a series of laminæ extending the entire length of both sides; excretory orifice in the middle line, near the posterior end of the back, or between the mantle and foot; reproductive organs on the right side; stomach simple, membranous.

Distr. 4 sp. Medit. Red Sea, India.

DIPHYLLIDIA, Cuvier.

Type, D. Brugmansii, Cuv. *Syn.* Pleurophyllidia, Chiaje. Linguella, Bl.

Animal oblong, fleshy; mantle ample; gills limited to the hinder two-thirds of the body; head with minute tentacles and a lobe-like veil; vent at the right side, behind the reproductive orifices; lingual teeth 30.1.30.

Distr. 4 sp. Norway, Brit. (*D. lineata,* Otto) Medit.

SECTION B. NUDIBRANCHIATA.

Animal destitute of a shell except in the embryo state; branchiæ always external, on the back or sides of the body; sexes united.

The Nudibranchiate sea-slugs are found on all coasts where the bottom is firm or rocky, from between tide-marks to a depth of 50 fathoms; a few species are pelagic, crawling on the stems and fronds of floating sea-weed. They have been found by Middendorff, in the Icy Sea, at Sitka, and in the sea of Ochotsk; in the tropical and southern seas they are abundant. No satisfactory account, however, has been published of any except the European, and especially the British species, which form the subject of an admirable monograph by Messrs. Alder and Hancock, in the transactions of the Ray Society. They require to be watched and drawn whilst living and active, since after immersion in spirits they lose both their form and colour. In some the back is covered with a *cloak* or mantle (?) which contains calcarious spicula of various forms, sometimes so abundant as to form a hard shield-like crust.* The dorsal tentacles and gills pass through holes in the cloak somewhat like the "key-hole" in *Fissurella.* In others there is no trace of a mantle whatever. The eyes appear as minute black dots, immersed in the skin, behind the tentacles; they are well organized, and conspicuous in the young, but often invisible in the adult. The dorsal tentacles are laminated, like the antennæ of many insects (fig. 11, p. 23); they are never used as organs of touch, and are supplied with nerves from the olfactory ganglia. The nervous centres are often conspicuous by their bright orange colour; they are concentrated *above* the œsophagus; three pairs are larger than the rest, the *cerebroid* in front, the *branchial* behind, and the *pedal* ganglia at the sides. The cerebroid supplies nerves to the tentacles, mouth, and lips.

The *olfactory* ganglia are sessile on the front of the cerebroid (in *Doris*) or situated at the base of the tentacles (in *Æolis*). The *optic* ganglia are placed on the posterior border of the cerebroid; the auditory capsules are sessile on the cerebroid, immediately behind the eyes, they contain an agglomeration of minute *otolites* which are continually oscillating.† The *buccal* ganglia are below the œsophagus, united to the cerebroid by commissures, forming a ring; anterior to this a small ring is sometimes formed by the union of the 5th pair of nerves. The *pedal* ganglia (properly infra-œsophageal) are united laterally to the cerebroid and rarely meet below, but are united by commissures which form (together with those of the branchial centres) the 3rd ring, or *great nervous collar.* The *branchial* ganglia are united behind to the cerebroid, and sometimes blend with them; they supply the skin of the back, the rudimentary mantle, and the gills; beneath, and sessile on their front border is the single *visceral* ganglion. Besides this *excito-motory* system, (which includes the great centres, or brain, and the nerves of sensation and voluntary motion), the nudibranches possess a *sympathetic* system, consisting of innumerable minute ganglia, dotted over all the viscera, united by nerves forming plexuses, and connected in front with the buccal and branchial centres.‡

* According to Mr. Huxley, the "cloak" of the Dorids is not the equivalent of the *mantle*, but "has more relation to the *epipodium.*"

† The auditory capsules of other Mollusca (excepting the Nucleobranches) are attached to the posterior side of the pedal (sub-œsophageal) ganglia.

‡ The *sympathetic system* supplies nerves to the heart and other organs which are independent of the will, and not ordinarily susceptible of pain; they are called "organic" nerves, as all the *vegetative* functions depend on them. Its existence in the

The digestive organs of the Nudibranches present two remarkable modifications: in *Doris* and *Tritonia* the liver is compact and the stomach a simple membranous sac; whilst in *Æolis* the liver is disintegrated, and its canals so large that the process of digestion must be chiefly carried on in them, and they are regarded as cœcal prolongations of the stomach; the cœca extend into a series of gill-like processes, arranged upon the back of the animal, which also contain part or the whole of the true liver; the gastric ramifications vary exceedingly in amount of complexity.

The vascular system and circulation of the nudibranchiate molluscs is incomplete. In *Doris* veins can be traced only in the liver and skin; the greater part of the blood from the arteries escapes into the visceral sinus and into a net-work of sinuses in the skin, from which it returns to the auricle by two lateral veins, without having circulated through the gills. The heart is contained in a *pericardium* to which is attached a small ventricle, or *portal* heart, for impelling blood to the liver; the hepatic veins run side by side with the arteries and open into a circular vein, surrounding the vent, and supplying the gills. Only hepatic blood, therefore, circulates through the gills. In *Æolis* there are no special gills, but the gastro-hepatic papillæ are accompanied by veins which transmit blood to the auricle. The skin acts as an accessory breathing-organ; it performs the function entirely in the *Elysiadæ*, and in the other families when by accident the branchiæ are destroyed. The water on the gills is renewed by ciliary action. The fry is provided with a transparent, nautiloid shell, closed by an operculum, and swims with a lobed head-veil fringed with cilia, like the young of most other gasteropods.—*Hancock* and *Embleton*, Phil. Trans. 1852. An. Nat. Hist. 1843.

FAMILY VI. DORIDÆ.* Sea-lemons.

Animal oblong; gills plume-like, placed in a circle on the middle of the back; tentacles two; eye-specks immersed, behind the tentacles, not always visible in the adult; lingual membrane with usually numerous lateral teeth, rachis often edentulous; stomach simple; liver compact; skin strengthened with spicula, more or less definitely arranged.

DORIS, L.

Etym. *Doris*, a sea-nymph. *Ex.* D. Johnstoni, Pl. XIII. fig. 1.

Animal oval, depressed; mantle large, simple, covering the head and foot; dorsal tentacles 2, clavate or conical, lamellated, retractile within

Mollusca was first clearly demonstrated by M.M. Hancock and Embleton. The *excito-motory* system of the Mollusca corresponds with the *cerebro-spinal* system of the vertebrata.

* Contracted from *Dorididæ;* as the Greeks used Deucalides for *Deucaliontiades*. Ehrenberg divided the genus Doris into sections, by the number and form of the gills, characters of only specific importance.

cavities; gills surrounding the vent on the posterior part of the back, retractile into a cavity; head with an oral veil, sometimes produced into labial tentacles; mouth with a lower mandible, consisting of two horny plates, united near the front, and having 2 projecting points; lingual teeth numerous, central small, laterals similar, hooked and sometimes serrated (24-68 rows; 37-141 in a row; nidamental ribbon rather wide, forming a spiral coil of few volutions (p. 50, fig. 29.)

Sub-genus, Oncidoris (Bl. ?). D. bilamellata, Johnst. Back elevated, tuberculose; gills non-retractile; oral tentacles fused into a veil; buccal mass with a gizzard-like appendage; lingual teeth 2 in each row. (A. and H.)

D. scutigera (*Villiersia*) D'Orb. Rochelle; has the mantle more than usually strengthened with calcarious spicula.

The Dorids vary in length from 3 lines to more than 3 inches; they feed on zoophytes and sponges, and are most plentiful on rocky coasts, near low-water, but range as low as 25 fms. They occur in all seas, from Norway to the Pacific.

Goniodoris, Forbes.

Etym. Gonia, an angle. *Type,* G. nodosa, Pl. XIII. fig. 2.

Animal oblong; tentacles clavate, laminated, non-retractile; mantle small, simple, exposing the head and foot. Spawn coiled irregularly.

Distr. Norway, Brit. (2 sp.) Medit. China. Between tide-marks.

Triopa, Johnston.

Type, T. clavigera, Pl. XIII. fig, 3. *Syn.* Psiloceros, Menke.

Animal oblong; tentacles clavate, retractile within sheaths; mantle margined with filaments; gills few, pinnate, around or in front of the dorsal vent. (A. and H.) Lingual teeth 8.1.8, or 8.0.8.

Distr. Norway, Brit. Low-water — 20 fms.

Ægirus, Lovén.

Type, A. punctilucens, Pl. XIII. fig. 4. *Etym.* ? *Aix* (*aigos*) a goat.

Animal oblong or elongated, covered with very large tubercles; no distinct mantle; tentacles linear, retractile within prominent lobed sheaths; gills dendritic, placed around the dorsal vent. (A. and H.) Lingual teeth 17.0.17.

Distr. Norway, Brit. (2 sp.) France. Litoral zone.

Thecacera, Fleming.

Etym. Theke a sheath, *ceras* a horn. *Type,* T. pennigerum, Mont.

Animal oblong, smooth; tentacles clavate, laminated, retractile within sheaths; head with a simple frontal veil; gills pinnate, placed round the dorsal vent, and surrounded by a row of tubercles. (A. and H.)

Distr. Brit. 2 sp. Lon. $\frac{1}{4}$—$\frac{1}{2}$ inch. Found at low-water.

Polycera, Cuvier.

Etym. Polycera, many horns. *Type,* P. quadrilineata, Pl. XIII. fig. 5.

Animal oblong or elongated; tentacles laminated, non-retractile, sheathless; head-veil bordered with tubercles or tentacular processes; gills with 2 or more lateral appendages. (A. and H.)

Distr. Norway, 5 sp. Brit. Red Sea. Within tide-marks and in deep water on corallines. The spawn is strap-shaped, and coiled on stones, in July and August. P. ocellata (*Plocamophorus,* Rüppell) has the cephalic tentacles branched.

Idàlia, Leuckart.

Etym. Idalia, Venus, from Mt. Idalium in Cyprus.

Syn. Euplocamus, Phil. Peplidium (Maderæ) Lowe.

Ex. I. aspersa, Pl. XIII. fig. 6. Coralline zone.

Animal broadly oblong, nearly smooth, tentacles clavate or linear, with filaments at their base; head slightly lobed at the sides; mantle very small, margined with filaments; lingual teeth 2.0.2.

Distr. Norway, Brit. (4 sp.) Medit. Madeira.

Ancula, Lovén.

Syn. Miranda, A. and H. *Type,* A. cristata, Alder.

Animal slender, elongated; mantle entirely adnate, ornamented with simple filaments; tentacles clavate, laminated; with filiform appendages at their base; labial veil produced on each side.

Distr. Norway, Brit. Lon. ½ inch.

Ceratosoma (Gray), A. Adams.

Etym. Ceratois, horned, *soma,* body. *Type,* C. cornigerum, Ad.

Animal oblong, narrow, with two large and prominent horn-like processes on the posterior part of the back, behind the gills; gills 5, bipinnate; dorsal tentacles clavate, laminated, rising from rounded tubercles, non-retractile; head with short lateral processes: foot narrow.

Distr. Sooloo sea. (A. Adams.)

FAMILY VII. Tritoniadæ.

Animal with laminated, plumose, or papillose gills, arranged along the sides of the back; tentacles retractile into sheaths; lingual membrane with 1 central and numerous lateral teeth; orifices on the right side.

Tritonia, Cuvier.

Ex. T. plebeia, Pl. XIII. fig. 7.

Animal elongated; tentacles with branched filaments; veil tuberculated or digitated; gills in single series on a ridge down each side of the back; mouth armed with horny jaws; stomach simple; liver compact.

Distr. Norway, Brit. Under stones at low-water, — 25 fm. F. Hombergii, Cuv. found on the scallop-banks, attains a length exceeding 6 inches.

Scyllæa, L.

Type, S. pelagiea, Pl. XIII. fig. 8. *Etym. Scyllaea*, a sea-nymph.

Animal elongated, compressed; foot long, narrow and channelled, adapted for clasping sea-weed; back with 2 pairs of wing-like lateral lobes, bearing small tufted branchiæ on their inner surfaces; tentacles dorsal, slender, with lamellated tips, retractile into long sheaths; lingual teeth 24.1.24, denticulated; gizzard armed with horny, knife-like plates; orifices on the right side.

Distr. Atlantic, S. Brit. Medit. On floating sea-weed.

Nerea (punctata) Lesson, New Guinea; 10 lines long, with ear-shaped tentacles, and 3 pairs of dorsal lobes.

Tethys, L.

Etym. Tethys, the sea (personified.) *Syn.* Fimbria, Bohadsch.

Type, T. fimbriata, L. Pl. XIII. fig. 9.

Animal elliptical, depressed; head covered by a broadly expanded, fringed disk, with 2 conical tentacles, retractile into foliaceous sheaths; gills slightly branched, a single row down each side of the back; reproductive orifices behind first gills, vent on right side, behind second gill; stomach simple.

Distr. 1 sp. Medit. Attains a foot in length, and feeds on other molluscs and crustaceans. (*Cuvier.*)

? Bornella (Gray), A. Adams.

Type, A. Adamsii, Gray. *Lon.* 4 inches.

Animal elongated; dorsal tentacles retractile into branched sheaths; head with stellate processes; back with two rows of cylindrical, branched, gastric processes, to which small dendritic gills are attached;* foot very narrow.

Distr. 2 sp. Straits of Sunda, on floating weed; Borneo.

? Dendronotus, A. and H.†

Etym. Dendron, a tree, *notos*, the back.

Type, D. arborescens, Pl. XIII. fig. 10.

Animal elongated; tentacles laminated; front of the head with branched appendages; gills arborescent, in single series down each side of the back; foot narrow; lingual teeth 10.1.10; stomach and liver ramified.

Distr. Icy sea; Norway, Brit. On sea-weed and corallines; low-water—coralline zone.

? Doto, Oken.

Etym. Doto, a sea-nymph. *Ex.* D. coronata, Pl. XIII. fig. 11.

* This observation deserves further enquiry.

† This and the following genera are placed by Alder and Hancock in the family *Æolidæ;* they have a ramified stomach, but their external (*zoological*) characters agree better with *Tritonia* than *Æolis*.

Animal slender, elongated; tentacles linear, retractile into trumpet-shaped sheaths; veil small, simple; gills ovate, muricated, in single series down each side of the back; lingual membrane slender, with above 100 recurved, denticulated teeth, in single series; foot very narrow.

The stomach is ramified, and the liver is entirely contained in the dorsal processes, which fall off readily when the animal is handled, and are soon renewed.

Distr. Norway, Brit. On corallines in deep water — 50 fms.

? MELIBŒA, Rang.

Type, M. rosea, Rang; on floating weed, off the Cape.

Animal elongated, with a narrow, channelled foot and long slender tail; sides of the back with 6 pairs of tuberculated lobes, easily deciduous; tentacles cylindrical, retractile into long trumpet-shaped sheaths; head covered by a lobe-like veil; sexual orifices behind right tentacle, excretory behind first gill on the right side.

? LOMANOTUS, Verany.

Ex. L. marmoratus, Pl. XIII. fig. 12. *Syn.* Eumenis, A. and H.

Animal elongated, smooth; head covered with a veil; tentacles clavate, laminated, retractile into sheaths; gills filamentose, arranged along the sides of the back, on the wavy margins of the mantle; foot narrow, with tentacular processes in front; stomach ramified.

Distr. Brit. Medit. On corallines.

FAMILY VIII. ÆOLIDÆ.

Animal with papillose gills, arranged along the sides of the back; tentacles sheath-less, non-retractile; lingual teeth 0.1.0.; ramifications of the stomach and liver extending into the dorsal papillæ; excretory orifices on the right side; skin smooth, without spicula; no distinct mantle.

ÆOLIS, Cuvier.

Syn. Psiloceros, Menke. Eubranchus, Forbes. Amphorina, Quatref.

Type, Æ. papillosa, L. *Etym.* *Æolis*, daughter of Æolus.

Animal ovate; dorsal tentacles smooth, oval, slender; gills simple, cylindrical, numerous, depressed and imbricated; mouth with a horny upper jaw, consisting of two lateral plates, united above by a ligament; foot narrow; tongue with a single series of curved, pectinated teeth; spawn of numerous waved coils.

Sub-genera. *Flabellina*, Cuv. (Phyllodesmium, Ehr.) Body slender; dorsal tentacles laminated, buccal long; papillæ clustered; spawn multi-spiral. *Ex.* E. coronata, Pl. XIII. fig. 13. (also fig. 11, p. 23.)

Cavolina, Brug. (Montagua, Flem.) C. peregrina. Body lanceolate; tentacles smooth or wrinkled; papillæ in transverse, rather distant rows; spawn of 1 or 2 coils.

Tergipes, Cuv. T. lacinulata. Body linear; tentacles smooth; papillæ in a single row on each side; spawn kidney-shaped.

Distr. Norway, Brit. (33 sp.) U. States, Medit. S. Atlantic, Pacific. Found amongst rocks, at low-water; they are active animals, moving their tentacles continually, and extending and contracting their papillæ; they swim readily at the surface, inverted. They feed chiefly on sertularian zoophytes, and if kept fasting will devour each other; when irritated they discharge a milky fluid from their papillæ, which are very liable to fall off.

GLAUCUS, Forster.

Etym. *Glaucus*, a sea-deity. *Syn.* Laniogerus, Bl. Pleuropus, Raf.

Ex. G. Atlanticus, Pl. XIII. fig. 14.

Animal elongated, slender: foot linear, channelled; tentacles 4, conical; jaws horny; teeth in single series, arched and pectinated; gills slender, cylindrical, supported on 3 pairs of lateral lobes; stomach giving off large cœca to the tail and side lobes; liver contained in the branchial papillæ; sexual orifice beneath first dextral gill, vent behind second gill; spawn in a close spiral coil.

Distr. 6 sp. Atlantic, Pacific. Found on floating sea-weed; devours small sea-jellies, *Porpitæ* and *Velellæ*. (Bennet.)

FIONA, Alder and Hancock.

Type, F. nobilis, A. and H. *Syn.* Oithona, A. and H. (not Baird).

Animal elongated; oral and dorsal tentacles linear; mouth armed with horny jaws; gills papillary, clothing irregularly a sub-pallial expansion on the sides of the back, each with a membranous fringe running down its inner side.

Distr. Falmouth. Under stones at low-water. (Dr. Cocks.)

EMBLETONIA, A. and H.

Etym. Dedicated to Dr. Embleton, of Newcastle.

Syn. Pterochilus, A. and H. ? Clœlia (formosa) Loven.

Type, E. pulchra, Pl. XIII. fig. 15.

Animal slender; tentacles 2, simple; head produced into a flat lobe on each side; papillæ simple, subcylindrical, in a single row down each side of the back.

Distr. Scotland (2 sp.) In the litoral and laminarian zones.

Calliopæa (bellula) D'Orb. Brest; has 2 rows of papillæ down each side of the back; cephalic lobes subulate; vent dextral. Lon. 3 lines.

PROCTONOTUS, A. and H.

Type, P. mucroniferus, Pl. XIII. fig. 16. Dublin, shallow water.

Syn. Venilia, A. and H. Zephrina, Quatref.

Animal oblong, depressed, pointed behind; dorsal tentacles 2, linear, simple, with eyes at their base, behind; oral tentacles short; head covered by a small semilunar veil; mouth with horny jaws; gills papillose, on ridges down the sides of the back, and round the head in front; vent dorsal.

ANTIOPA, A. and H.

Type, A. splendida, A. and H. *Syn.* Janus, Verany.

Animal ovate-oblong, pointed behind; dorsal tentacles lamellated, united at the base by an arched crest; head with a small veil and two labial tentacles; gills ovate, placed along the lateral ridges of the back and continuous above the head; vent central, posterior, sexual orifice at the right side; lingual teeth numerous. ?

Distr. Brit. Medit.

HERMÆA, Lovén.

Type, H. bifida, Pl. XIII. fig. 17. Norway, Brit.

Animal elongated, tentacles folded longitudinally; gills numerous, papillose, arranged down the sides of the back; sexual orifice below right tentacles; vent dorsal, or sub-lateral, anterior.

ALDERIA, Allman.

Etym. Named after Joshua Alder, one of the authors of the Monograph on the British Nudibranchiate Mollusca.

Type, A. modesta, Pl. XIII. fig. 18. Norway, S. Ireland and S. Wales.

Animal oblong, without tentacles; head lobed at the sides; gills papillose, arranged down the sides of the back; vent dorsal, posterior.

? *Stiliger* (ornatus) Ehrenberg; Red Sea. Vent dorsal, anterior.

FAMILY IX. PHYLLIRHOIDÆ.

Animal pelagic, foot-less (*apodal*), compressed, swimming freely with a fin-like tail; tentacles 2, dorsal; no branchiæ; lingual teeth in a single series; stomach furnished with elongated cœca; orifices on the right side; sexes united.

PHYLLIRHOE, Péron and Lesueur.

Etym. Phyllon, a leaf, *rhoë*, the wave. *Syn.* Eurydice, Esch.

Type, P. bucephala, Péron. *Distr.* 6 sp. Medit. Moluccas, Pacific.

Animal translucent, fusiform, with a lobed tail; muzzle round, truncated; jaws horny; lingual teeth 3.0.3.; tentacles long and slender, with short sheaths; intromittent organ long, bifid.

FAMILY X. ELYSIADÆ.

Animal shell-less, limaciform, with no distinct mantle or breathing organ; respiration performed by the ciliated surface of the body; mouth armed with a single series of lingual teeth; stomach central, vent median, sub-central; hepatic organs branched, extending the length of the body and opening into the sides of the stomach; sexes united; male and ovarian orifices below the right eye; female orifice in the middle of the right side; heart with an auricle behind, and traces of an arterial and venous system, eyes sessile on the sides of the head, tentacles simple or obsolete.*

ELYSIA, Risso.

Type, E. viridis, Pl. XIII. fig. 19. *Syn*. Actæon, Oken.

Animal elliptical, depressed, with wing-like lateral expansions; tentacles simple, with sessile eyes behind them; foot narrow.

Distr. Brit. Medit. On *Zostera* and sea-weed, in the laminarian zone. *Placo-branchus* (ocellatus, Rang.) Hasselt, Java; described as 2 inches long, with four small tentacles; the lateral expansions much developed and meeting behind, the upper surface longitudinally plaited, and forming, when the side-lobes are rolled together, a sort of branchial chamber.

ACTEONIA, Quatrefages.

Ex. A. corrugata, Pl. XIII. fig. 20. British channel.

Animal minute, leach-like; head obtuse, with lateral crests proceeding from two short conical tentacles, behind which are the eyes.

CENIA, Alder and Hancock.

Type, C. Cocksii, Pl. XIII. fig. 21. *Etym*. *Cenia*, Falmouth.

Syn. ? Fucola (rubra) (Quoy).

Animal limaciform, back elevated, head slightly angulated, bearing two linear dorsal tentacles, with eyes at their outer bases behind.

LIMAPONTIA, Johnston.

Type, L. nigra, Pl. XIII. fig. 22. *Syn*. Chalidis, Qu. Pontolimax, Cr.

Animal minute, leach-like; head truncated in front, with arched lateral ridges on which are the eyes; foot linear.

Distr. Norway, England and France, between half-tide and high-water, feeding on *Confervæ*, in the spring and summer; spawn in small pear-shaped masses, each with 50-150 eggs; fry with a transparent nautiloid shell, closed by an operculum.

ORDER IV. NUCLEOBRANCHIATA. Bl.†

The present order consists entirely of pelagic animals, which swim at the surface, instead of creeping on the bed of the sea. Their rank and affi-

* Order *Dermi-branchiata*, Quatref. (*Pelli-branchiata*, A. and H.) M. Quatrefages erroneously described the *Elysiadæ* as wanting both heart and blood vessels, like the Ascidian zoophytes; with them he associated the family *Æolidæ*, which he described as having a heart and arteries, but no veins, their office being performed by lacunæ of the areolar tissue. In both families the product of digestion (*chyle*) was supposed to be aërated in the gastric ramifications, by the direct influence of the surrounding water. To this group, which has been since abandoned, he applied the name *Phlebenterata*, (*phlebs*, a vein, *entera*, the intestines).

† So called because the respiratory and digestive organs form a sort of *nucleus* on the posterior part of the back. See fig. 105, *s. b.*, and Pl. XIV. fig. 24.

nities entitle them to the first place in the class; but their extremely aberrant form, and unusual mode of progression, have caused us to postpone their description till after that of the ordinary and typical *gasteropoda.*

There are two families of nucleobranchiate mollusks; the *firolas* and *carinarias,* with large bodies and small or no shells, and the *Atlantas,* which can retire into their shells and close them with an operculum. Both animal and shell are symmetrical, or nearly so; the nucleus of the shell is minute and dextrally spiral.

The *nucleobranches* swim rapidly by the vigorous movements of their fin-like tails, or by a fan-shaped ventral fin; and adhere to sea-weed by a small sucker placed on the margin of the latter. Mr. Huxley has shown that these organs represent the three essential parts of the foot in the most highly developed sea-snails. The *sucker* represents the central part of the foot, or creeping disk (*meso-podium*) of the snail and whelk; the ventral fin is homologous with the anterior division of the foot, (*pro-podium*) which is very distinct in *Natica* (p. 123), and in *Harpa* and *Oliva*; but is only marked by a groove in *Paludina* and *Dolium* (fig. 71.) The terminal fin (or tail of *Carinaria*) which carries the operculum of *Atlanta,* is the equivalent of the operculigerous lobe (*meta-podium*) of the ordinary gasteropods, such as *Strombus* (fig. 69).

The abdomen, or visceral mass, is small, whilst the anterior part of the body (or *cephalo-thorax,* M. Edw.) is enormously developed. The proboscis is large and cylindrical, and the tongue armed with recurved spines. The alimentary canal of *Firola* is bent up at a right angle posteriorly on the dorsal side; in *Atlanta* it is recurved, and ends in the branchial chamber. The heart is *proso-branchiate,* although in *Firola* the auricle is rather above than in front of the ventricle, owing to the small amount of the dorsal flexure.

The nucleobranches, and especially those without shells, "afford the most complete ocular demonstration of the truth of Milne Edwards' views with regard to the nature of the circulation in the *mollusca.* Their transparency allows the blood-corpuscles to be seen floating in the general cavity of the body—between the viscera and the outer integument—and drifting backwards to the heart; having reached the wall of the auricle they make their way through its meshes as they best can, sometimes getting entangled therein, if the force of the heart has become feeble. From the auricle they may be followed to the ventricle, and thence to the aorta and pedal artery, through whose open ends they pour into the tissues of the head and fin." (*Huxley.*)

Such delicate and transparent creatures would hardly seem to need any special breathing-organ, and in fact it is present or absent in species of the same genus, and even in specimens of the same species. *Carinaria* has fully-formed branchiæ; in *Atlanta* they are sometimes distinct, and wanting in others; in *Firoloides* they are only indicated by a ciliated sub-spiral band. The larvae are furnished with a shell, and with ciliated *vela.* (Gegenbaur.)

The nucleobranches are *diœcious;* some individuals (of *Firola*) have a leaf-like appendage, others a long slender egg-tube depending from the oviduct, and regularly annulated.* The larvæ are furnished with a shell, and with ciliated *vela.* (Gegenbaur.)

The nervous system is remarkable for the wide separation of the centres. The buccal ganglia are situated considerably in front of the cephalic, and the *pedal ganglia* are far behind, so that the commissures which unite them are nearly parallel with the œsophagus. The *branchial ganglia* are at the posterior extremity of the body, as in the bivalves. The eyes are hour-glass shaped, and very perfectly organized; the auditory vesicles are placed behind, and connected with the cephalic ganglia, they each contain a round otolite, which sometimes seems to oscillate. (*Huxley.*)

FAMILY I. Firolidæ.

Animal elongated, cylindrical, translucent, furnished with a ventral fin, and a tail fin used in swimming; gills exposed on the posterior part of the back, or covered by a small hyaline shell. Mouth with a circular lip; lingual membrane with few rows of teeth: central teeth transversely elongated, with 3 recurved cusps; laterals 3 on each side, the first a transverse plate with a hooked apex, 2 and 3 sickle-shaped.†

Firola, Peron and Lesueur.

Type, F. Coronata, Forsk. Medit. *Syn.* Pterotrachæa, Forsk.

Animal fusiform, elongated, with a long, slender, proboscidiform head; fin narrowed at the base, furnished with a small sucker; tail elongated, keeled, sometimes pinnate; nucleus prominent; branchial processes numerous, conical, slender; tentacles 4, short and conical; eyes black and distinct, protected by a rudimentary eyelid; lingual ribbon oblong. The female *firolæ* have a long moniliform oviduct. *Anops Peronii,* D'Orb. described and figured as having no head (!) was probably a mutilated *Firola.* "Such specimens are very common, and seem just as lively as the rest." (Huxley.)

Distr. 8 sp. Atlantic, Medit. Pacific.

Sub-genus, Firoloides, Lesueur. (*Cerophora,* D'Orb.) F. Desmarestii, Les. Body cylindrical; head tapering, furnished with two slender tentacles; nucleus at the posterior extremity of the body, with or without small branchial filaments; egg-tube regularly annulated; tail fin small and slender, ventral fin without a sucker. *Distr.* 6 sp. Atlantic.

* We can only call to mind one other example of a segmented organ in the *mollusca;* viz. the penniform styles of *Teredo bipalmulata..*

† The genus *Sagitta,* Q. and G. sometimes referred to this family, is an articulate animal. (Huxley.)

CARINÁRIA, Lamarck.

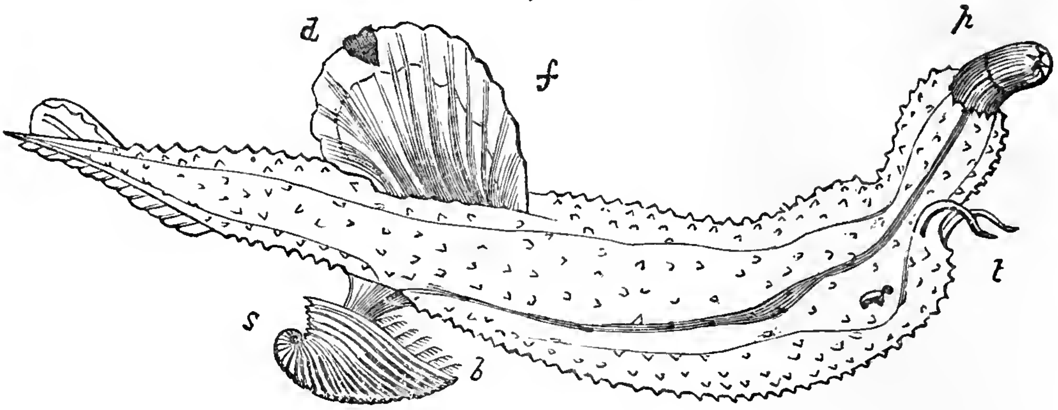


Fig. 105.*

Eym. Carina, a keel (or keeled vessel.)

Type. C. cymbium, L. fig. 105, Pl. XIV. fig. 19.

Shell hyaline, symmetrical, limpet-shaped, with a posterior sub-spiral apex and a fimbriated dorsal keel; nucleus minute, dextrally spiral.

Animal large, translucent, granulated; head thick, cylindrical; lingual ribbon triangular, teeth increasing rapidly in size, from the front backwards; tentacles long and slender, eyes near their base: ventral fin rounded, broadly attached, with a small marginal sucker; tail large, laterally compressed; nucleus pedunculated, covered by the shell, gills numerous, pinnate, projecting from beneath the shell.

Distr. 5 sp. Medit. and warmer parts of the Atlantic and Indian Oceans. They feed on small *Acalephæ,* and probably on the *pteropoda*; Mr. Wilton found in the stomach of a Carinaria two fragments of quartz rock, weighing together nearly 3 gr.

Fossil, 1 sp. Miocene. Turin.

CARDIÁPODA, D'Orbigny.

Ex. C. placenta, Pl. XIV. fig. 20.

Etym. Cardia, heart, *pous,* foot. *Syn.* Carinaroides, Eyd. and Souleyet.

Animal like *Carinaria. Distr.* 5 sp. Atlantic.

Shell minute, cartilaginous; peristome expanded and bi-lobed in front, enveloping the spire behind.

FAMILY II. ATLANTIDÆ.

Animal furnished with a well-developed shell, into which it can retire; gills contained in a dorsal mantle-cavity; lingual teeth similar to *Carinaria.*

Shell symmetrical, discoidal, sometimes closed by an operculum.

ATLANTA, Lesueur.

Type, A. Peronii, Pl. XIV. fig. 21-23. *Syn. Steira,* Esch.

Shell minute, glassy, compressed and prominently keeled; nucleus dex-

* Fig. 105. *p.* proboscis; *t,* tentacles; *b,* branchiæ; *s,* shell; *f,* foot; *d,* disk.

trally spiral; aperture narrow, deeply notched at the keel; operculum ovate, pointed, lamellar, with a minute, apical, dextrally spiral nucleus.

Animal 3-lobed; head large, sub-cylindrical; tentacles conical, with conspicuous eyes behind them; ventral fin flattened, fan-shaped, furnished with a small fringed sucker; tail pointed, operculigerous.

Distr. 15 sp. Warmer parts of the Atlantic, Canary Ids.

Sub-genus. Oxygyrus, Benson. *Syn.* Ladas, Cantraine; Helico-phlegma, D'Orb. O. Keraudrenii, Pl. XIII. figs. 24, 25. Shell milky, narrowly umbilicated on both sides; nucleus not visible; back rounded, keeled only near the aperture; body whirl, near the aperture, and keel cartilaginous; no apertural slit; operculum trigonal, lamellar. 2 sp. Atlantic. Medit.

The *Atlanta* was discovered by Lamanon, who supposed it to be the living analogue of the Ammonite. The operculum of *Oxygyrus* (Pl. XIII. fig. 25) is singularly like the *Trigonellites* (p. 80); that of Atlanta (fig. 22) is the only example of a *dextral* operculum to a dextral shell (p. 102).

Porcéllia, Léveille.

Ex. P. Puzosi, Pl. XIV. fig. 29.

Shell discoidal, many whirled; whirls keeled or coronated; nucleus spiral; aperture with a narrow dorsal slit.

Fossil, 10 sp. Devonian — Trias. Brit. Belgium

Bellérophon, Monfort.

Ex. B. bi-carinatus, Lév. Pl. XIV. fig. 27. *Syn.* Euphemus, M'Coy.

Shell symmetrically convoluted, globular, or discoidal, strong, few-whirled; whirls often sculptured; dorsally keeled; aperture sinuated and deeply notched on the dorsal side.

Fossil, 70 sp. L. Silurian — Carb. N. America, Europe, Australia. The name *Bucania* was given by Hall to the species with exposed whirls; in B. expansus, Pl. XIV. fig. 28, the aperture of the adult shell is much expanded, and the dorsal slit filled up. (*Salter.*)

Bellerophina, D'Orb (not Forbes) is founded on the *Nautilus minutus.* Sby. Pl. XIV. fig. 26, a small globular shell, spirally striated, and devoid of *septa.* It is found in the *gault* of England and France.

Cyrtolites, Conrad.

Type, C. ornatus, Pl. XIV. fig. 30.

Etym. Kurtos, curved, *lithos,* stone.

Shell thin, symmetrical, horn-shaped or discoidal, with whirls more or less separate, keeled and sculptured.

Fossil, 13 sp. L. Silurian — Carb, N. America, Europe.

? *Ecculiomphalus* (Bucklandi) Portlock, Pl. XIV. fig. 31. L. Silurian, Brit. U. States. Shell thin, curved, or discoidal with few widely separate whirls, slightly unsymmetrical, keeled.

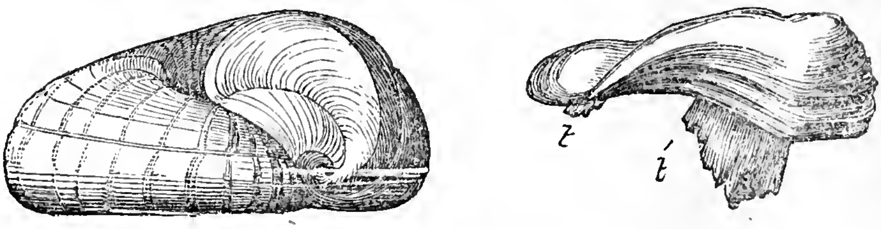


Fig. 106. *Maclurea Logani, (Salter) L. Silurian. Canada.*

? MACLUREA, Lesueur.

Named after Wm. Maclure, the first American geologist.

Shell discoidal, few whirled, longitudinally grooved at the back, and slightly rugose with lines of growth; dextral side convex, deeply and narrowly perforated; left side flat, exposing the inner whirls; operculum sinistrally sub-spiral, solid, with two internal projections (*t t*) one of them beneath the nucleus, very thick and rugose.

Fossil, 5 sp. L. Silurian. N. America; Scotland (Ayrshire, M'Coy).

This singular shell abounds in the "Chazy" limestone of the U. States and Canada; sections of it may be seen even in the pavement of New York; but specimens are very difficult to obtain. We are indebted to W. E. Logan, Esq., Geological Surveyor of Canada, for the opportunity of examining a large series of silicified specimens, and of figuring a perfect shell, with its operculum *in situ*. It has more the aspect of a bivalve, such as *Requienia Lonsdalii* (Pl. XVIII. fig. 12) than of a spiral univalve, but has no hinge. Many of the specimens are overgrown with a zoophyte, generally on the convex side only, rarely on both sides.

The Maclurea has been described as *sinistral;* but its operculum is that of a dextral shell; so that the spire must be regarded as deeply sunk and the umbilicus expanded, as in certain species of *Planorbis:* unless it is a case conversely parallel to *Atlanta*, in which both shell and operculum have dextral nuclei. The affinities of *Maclurea* can only be determined by careful examination and comparison with allied, but less abnormal forms, associated with it in the oldest fossiliferous rocks; its relation to *Euomphalus* (p. 145) is not supported by the evidence of Mr. Logan's specimens.

CLASS III. PTEROPODA.

This little group consists of animals whose entire life is passed in the open sea, far away from any shelter, save what is afforded by the floating gulf-weed, and whose organization is specially adapted to that sphere of existence. In appearance and habits they strikingly resemble the fry of the ordinary sea-snails, swimming like them by the vigorous flapping of a pair of fins. To the naturalist ashore they are almost unknown; but the voyager on the great ocean meets with them where there is little else to arrest his attention, and marvels at their delicate forms, and almost incredible numbers. They swarm in the tropics, and no less in arctic seas, where by their myriads the water is discoloured for leagues (*Scoresby*). They are seen swimming at the surface in the heat of the day, as well as in the cool of the evening. Some of the larger kinds have prehensile tentacles, and their mouths armed with lingual teeth, so that, fragile as they are, they probably feed upon still smaller and feebler creatures, (*e. g. entomostraca*). In high latitudes they are the principal food of the whale, and of many sea-birds. Their shells are rarely drifted on shore, but abound in the fine sediment brought up by the dredge from great depths. A few species occur in the tertiary strata of England and the continent; in the older rocks they are unknown, unless some comparatively gigantic forms (*conularia* and *theca*) have been rightly referred to this order.

In structure, the *Pteropoda* are most nearly related to the marine univalves, but much inferior to them. Their nervous *ganglia* are concentrated into a mass *below* the œsophagus; they have auditory vesicles, containing otolites; and are sensible of light and heat and probably of odours, although at most they possess very imperfect eyes and tentacles. The true foot is small or obsolete; in *cleodora* it is combined with the fins, but in Clio it is sufficiently distinct, and consists of two elements; in *Spirialis* the posterior portion of the foot supports an *operculum*. The fins are developed from the sides of the mouth or neck, and are the equivalents of the side-lappets (*epipodia*) of the sea-snails. The mouth of *Pneumodermon* is furnished with two tentacles supporting miniature suckers; these organs have been compared with the dorsal arms of the cuttle-fishes, but it is doubtful whether their nature is the same.* A more certain point of resemblance is the ventral flexure of the alimentary canal, which terminates on the under surface, near the right side of the neck. The pteropods have a muscular gizzard, armed with gastric teeth; a liver; a pyloric cœcum; and a contractile renal organ opening into the cavity of the mantle. The heart consists of an auricle and a ventricle, and is essentially *opistho-branchiate,* although sometimes affected by the general flexure of the body. The venous system is extremely incomplete. The respiratory organ, which is little more than a *ciliated surface,* is either situated at the extremity of the body and unprotected by a mantle, or included in a branchial chamber with an opening in front. The shell, when present, is symmetrical, glassy, and translucent, consisting of a dorsal and a ventral plate united, with an anterior opening for the head, lateral slits for long filiform processes of the mantle, and terminated behind in one or three points; in other cases it is conical, or spirally coiled and closed by a spiral operculum. The sexes are united, and the orifices situated on the right side of the neck. According to Vogt, the embryo Pteropod has deciduous *vela,*

* The figures of Eydoux and Souleyet represent them as being supplied with nerves from the *cephalic ganglia;* whereas the arms of the cuttle-fish, and all other parts or modifications of the foot, in the *mollusca,* derive their nerves from the *pedal ganglia* (Huxley).

like the sea-snails, before the proper locomotive organs are developed (*Huxley*).

From this it would appear that while the Pteropoda present some analogical resemblances to the *Cephalopoda*, and permanently *represent* the larval stage of the sea-snails, they are developed on a type sufficiently peculiar to entitle them to rank as a distinct group; not indeed of equal value with the *Gasteropoda*, but with one of its orders.

This group, the lowest of the univalve or encephalous orders, makes no approach towards the bivalves or *acephala*. Forskahl and Lamarck indeed compared *Hyalæa* with *Terebratula;* but they made the ventral plate of one answer to the dorsal valve of the other, and the anterior cephalic orifice of the pteropodous shell, correspond with the *posterior*, byssal foramen of the bivalve!

SECTION A. Thecosomata, Bl.*

Animal, furnished with an external shell; head indistinct: foot and tentacles rudimentary, combined with the fins; mouth situated in a cavity formed by the union of the locomotive organs; respiratory organ contained within a mantle-cavity.

FAMILY I. Hyaleidæ.

Shell straight or curved, globular or needle-shaped, symmetrical.

Animal with two large fins, attached by a columellar muscle passing from the apex of the shell to the base of the fins; body inclosed in a mantle; gill represented by a transversely plaited and ciliated surface, within the mantle cavity, on the *ventral* side; lingual teeth (of *Hyalea*) 1.1.1, each with a strong recurved hook.

Hyálea, Lamarck.

Etym. Hyalëos, glassy. *Syn.* Cavolina, Gioeni not Brug.

Type, H. tridentata, fig. 107. Pl. XIV. fig. 32.

Shell globular, translucent; dorsal plate rather flat, produced into a hood; aperture contracted, with a slit on each side; posterior extremity tridentate. In H. trispinosa (*Diacria*, Gray) the lateral slits open into the cervical aperture.

Animal, with long appendages to the mantle, passing through the lateral slits of the shell; tentacles indistinct; fins united by a semicircular ventral lobe, the equivalent of the posterior element of the foot.

Distr. 19. sp. Atlantic, Medit. Indian Ocean.

Fossil, 5 sp. Miocene —. Sicily, Turin, Dax.

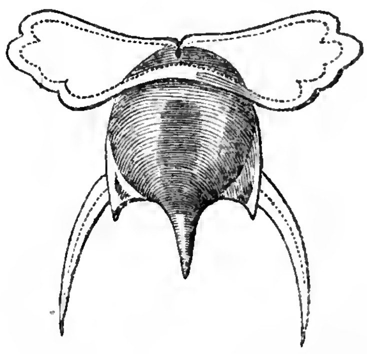


Fig. 107. H. tridentata.

* *Theke* a case, *soma* a body; several of the genera have no shells.

CLEODORA, Peron and Lesueur.

Syn. Clio, L. (part) not Müller. Balantium, Leach MS.

Type, C. pyramidata, Pl. XIV. fig. 33.

Shell pyramidal, 3 sided, striated transversely; ventral side flat, dorsal keeled; aperture simple, triangular, with the angles produced; apex acute.

Animal with rudimentary eyes; tentacles obsolete; mantle-margin with a siphonal (?) process; fins ample, united ventrally by a rounded lobe; lingual teeth 1.1.1. The transverse bars of the gill, the heart, and other organs are visible through the pellucid shell. In C. curvata and pellucida (*Pleuropus,* Esch.) the mantle is furnished with two long filaments on each side.

Distr. 12 sp. Atlantic, Medit. Indian Ocean, Pacific, C. Horn.

Fossil. Miocene —. Brit. (C. *infundibulum,* Crag.)

Sub-genus. Creseis, Rang. (Styliola, Lesueur). C. aciculata, Pl. XIV. fig. 34. Slender, conical, pointed, straight or curved. Fins rather narrow, truncate, with small tentacles projecting from their dorsal edges, and rudiments of the *mesopodium* on their surface; mantle-margin with a spiral process on the left side. M. Rang states that he has seen these pteropods clustering round floating seaweed. *Distr.* 5 sp. (like *Cleodora.*)

CUVIERIA, Rang.*

Dedicated to Baron Cuvier. *Type,* C. columnella, Rang, Pl. XIV. fig. 35.

Shell cylindrical, transparent; aperture simple, transversely ovate; apex acute in the young, afterwards partitioned off, and usually deciduous.

Animal with simple narrow fins, united ventrally by two small lobes; lingual teeth 1.1.1.

Distr. 4 sp. Atlantic, India, Australia.

Fossil 1 sp. (C. Astesana, Rang.) *Pliocene,* Turin.

Sub-genus, Vaginella, Daud. V. depressa, Pl. XIV. fig. 36. *Shell* oblong, with a pointed apex; aperture contracted, transverse. *Fossil,* 1 sp. *Miocene.* Bordeaux, Turin.

THECA, Morris. 1845.

Type, T. lanceolata. *Syn.* Crescis, Forbes.† Pugiunculus, Barr.

Shell straight, conical, tapering to a point, back flattened, aperture trigonal. Lon. 1-8 inches.

Fossil, 6 sp. *Silurian.* N. America, Brit., New South Wales.

PTEROTHECA, Salter.

Type, P. transversa, Portlock, 3 sp. L. Silurian; Ireland, Wales, Canada.

Shell bi-lobed, transversely oval, with a dorsal keel projecting slightly at each end; ventral plate small triangular.

* Under the name of "triptère," M.M. Quoy and Gaimard described the fragment of a pteropod, since ascertained to have been a *Cuvieria.*

† *Creseis Sedgwicki,* Forbes, is an orthoceras with very thin septa, belonging to the same group with (*Conularia*) *teres,* Sby. *Tentaculites,* Schl. is anellidous. (*Salter.*)

? CONULARIA, Miller.

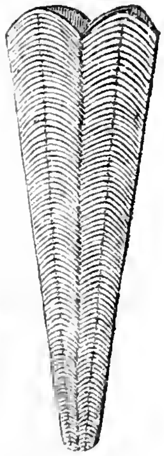


Fig. 108.*

Etym. Conulus, a little cone. *Type*, C. quadrisulcata, fig. 108.

Shell four-sided, straight, and tapering, the angles grooved, sides striated transversely, apex partitioned off.

Fossil, 15 sp. Silurian — Carb. N. America, Europe, Australia.

Sub-genus, *Coleoprion* (gracilis) Sandberger; Devonian, Germany. *Shell* round, tapering, sides obliquely striated, striæ alternating along the dorsal line.

EURYBIA, Rang. 1827.†

Etym. Eurybia, a sea-nymph.

Ex. E. Gaudichaudi, Pl. XIV. fig. 37. (after Huxley.)

Animal globular; fins narrow, truncated and notched at the ends, united ventrally by a small lobe (metapodium); mouth with two elongated tentacles, behind which are minute eye-peduncles and a two-lobed rudimentary foot (*mesopodium*); body inclosed in a cartilaginous integument, with a cleft in front, into which the locomotive organs can be retracted. Lingual teeth 1.0.1.

The animal has no proper gill, but Mr. Huxley has observed two ciliated circles surrounding the body, as in the larva of *Pneumodermon*.

Distr. 3 sp. Atlantic, Pacific.

Sub-genus, *Psyche*, Rang. P. globulosa, Pl. XIV. fig. 38. *Animal* globular, with two simple oval fins. *Distr.* 1 sp. Off Newfoundland.

CYMBULIA, Peron and Lesueur.

Etym. Diminutive of *cymba*, a boat.

Type, C. proboscidea, Pl. XIV. fig. 39. (after Adams).

Shell cartilaginous, slipper-shaped, pointed in front, truncated posteriorly; aperture elongated, ventral.

Animal with large rounded fins connected ventrally by an elongated lobe; mouth furnished with minute tentacles; lingual teeth 1.1.1; stomach muscular, armed with two sharp plates.

Distr. 3 sp. Atlantic, Medit. India Ocean.

TIEDEMANNIA, Chiaje.

Type, T. Neapolitana, Pl. XIV. fig. 40. Named after Fr. Tiedemann.

Animal naked, transparent, fins united, forming a large rounded disk; mouth central; tentacles elongated, connate; eye-tubercles minute. Larva shell-bearing. *Distr.* 2 sp. Medit. Australia.

* Carboniferous limestone, Brit. Belgium.

† This name had been previously employed for four different genera of plants and animals.

FAMILY II. LIMACINIDÆ.

Shell minute, spiral, sometimes operculate.

Animal with fins attached to the sides of the mouth, and united ventrally by an operculigerous lobe; mantle-cavity opening dorsally; excretory orifices on the right side.

The shells of the true *limacinidæ* are sinistral, by which they may be known from the fry of *Atlanta, Carinaria,* and most other Gasteropods.

LIMACINA, Cuvier.

Etym. Limacina, snail-like. *Syn.* Spiratella, Bl.

Ex. L. antarctica (drawn by Dr. Joseph Hooker), Pl. XIV. fig. 41.

Shell sub-globose, sinistrally spiral, umbilicated; whirls transversely striated; umbilicus margined; no operculum.

Animal with expanded fins, notched on their ventral margins; operc. lobe divided; lingual teeth 1.1.1.

Distr. 2 sp. Arctic and Antarctic Seas; gregarious.

SPIRIALIS, Eydoux and Souleyet.

Ex. S. bulimoides, Pl. XIV. fig. 42. *Syn.* Heterofusus, Flem. Heliconoides, D'Orb. Peracle, Forbes. Scaea, Ph.

Shell minute, hyaline, sinistrally spiral, globose or turrited, smooth or reticulated; operculum thin, glassy, semilunar, slightly spiral, with a central muscular scar.

Animal with narrow, simple fins, united by a simple, transverse operculigerous lobe; mouth central, with prominent lips.

Distr. 12 sp. Greenland and Norway to C. Horn, Indian Ocean, Pacific.

? CHELETROPIS, Forbes.

Etym. Chele, a claw, *tropis,* a keel. *Syn.* Sinusigera, D'Orb.

Type, C. Huxleyi, Pl. XIV. fig. 43.

Shell dextrally spiral, imperforate, double-keeled; nucleus sinistral; aperture channelled in front; peristome thickened, reflected, with two claw-like lobes.

Animal pteropodous ? gregarious in the open sea.

Distr. 2 sp. S. America, S. E. Australia.

Another minute spiral shell, recently discovered, may be noticed here:

MACGILLIVRAYIA. Forbes.

Named after its discoverer, the Naturalist to H. M. S. Rattlesnake.

Type, M. pelagica, Pl. XIV. fig. 44.

Shell minute, dextrally spiral, globular, imperforate, thin, horny, translucent; spire obtuse; aperture oblong, entire; peristome thin, incomplete, operc. thin horny, concentric, nucleus sub-external.

Animal with 4 long tentacles, mantle with a siphonal process; foot expanded, truncated in front, furnished with a float after the manner of *Ianthina;* lingual dentition closely resembling *Jeffreysia.*

Distr. 2 sp. Taken in the towing-net off C. Byron, E. coast Australia, 15 miles from shore; floating, and apparently gregarious. (J. Macgillivray.) Mindoro. (Adams.)

SECTION B. GYMNOSOMATA, Bl.

Animal naked, without mantle or shell; head distinct; fins attached to the sides of the neck; gill indistinct.

FAMILY III. CLIIDÆ.

Body fusiform; head with tentacles often supporting suckers; foot small, but distinct, consisting of a central and posterior lobe; heart *opistho-branchiate;* excretory orifices distant, on the right side; lingual teeth (in *Clio*) 12.1.12, central wide, denticulated, uncini strongly hooked and recurved.

CLIO (L.)* Müller.

Etym. Clio, a sea-nymph. *Syn.* Clione, Pallas.

Type, C. borealis, Pl. XIV. fig. 45. (C. caudata, L. part.)

Head with 2 eye tubercles and 2 simple tentacula; mouth with lateral lobes, each supporting 3 conical retractile processes, furnished with numerous microscopic suckers; fins ovate; foot lobed. In swimming, the Clio brings he ends of its fins almost in contact, first above and then below. (*Scoresby.*)

Distr. 4 sp. Arctic and Antarctic Seas, Norway, India.

Sub-genus ? *Cliodita* (fusiformis), Quoy and Gaimard. Head supported on a narrow neck; tentacles indistinct. 3 sp. Cape, Amboina.

PNEUMODERMON, Cuvier.

Etym. Pneumon, lung (or gill), *derma*, skin.

Type, P. violaceum, Pl. XIV. fig. 46.

Body fusiform; head furnished with ocular tentacles; lingual teeth 4.0.4; mouth covered by a large hood supporting two small, simple, and two large acetabuliferous tentacles, suckers numerous, pedicillate, neck rather contracted; fins rounded; foot oval, with a pointed posterior lobe; excretory orifice situated near the posterior extremity of the body, which has small branchial processes and a minute, rudimentary shell.

* This name was employed by Linnæus for all the Pteropoda then known; his definition is most suited to the "northern clio," probably the only species with which he was personally acquainted. The first species enumerated in the Syst. Nat. is *C. caudata*, and reference is made to an indeterminable figure in Brown's Jamaica, and to Marten's account of the Spitzbergen mollusk (*C. borealis.*) In cases like this the rule is to adopt the practice of the next succeeding naturalist who defines the limits of the group more exactly.

In the fry of *Pneumodermon* the end of the body is encircled with ciliated bands. (Müller.)

Distr. 4 sp. Atlantic, India, Pacific Ocean.

Sub-genus ? *Spongiobranchæa,* D'Orbigny. S. Australis, Pl. XIV. fig. 47. Gill (?) forming a spongy ring at the end of the body; tentacles each with 6 rather large suckers. *Distr.* 2 sp. S. Atlantic (Fry of *Pneumodermon* ?). *Trichocyclus,* Eschscholtz, T. Dumerilii, Pl. XIV. fig. 48. *Animal* without acetabuliferous tentacles ? mouth proboscidiform; front of the head surrounded with a circle of cilia, and two others round the body.

? Pelagia, Quoy and Gaimard.

Etym. Pelagus, the deep sea: (not = *Pelagia,* Peron and Les.)

Type, P. alba, Pl. XIV. fig. 49. Amboina.

Animal fusiform, truncated in front, rough; neck slightly contracted; fins small, fan-shaped.

Cymodocèa, D'Orbigny.

Etym. Kumodoke, a Nereid. *Type,* C. diaphana, Pl. XIV. fig. 50.

Animal fusiform, truncated in front, pointed behind; neck slightly contracted; fins 2 on each side, first pair large and rounded, lower pair ligulate; foot elongated; mouth proboscidiform. *Distr.* 1 sp. Atlantic.

CLASS IV. BRACHIOPODA, Cuvier, 1805,
(= Order *Pallio-branchiata,* Blainville, Prodr. 1814.)

The *Brachiopoda* are bivalve shell-fish which differ from the ordinary mussels, cockles, &c. in being always *equal-sided,* and never quite *equivalve.* Their forms are symmetrical, and so commonly resemble antique lamps, that they were called *lampades,* or "lamp-shells," by the old naturalists (Meuschen, 1787, Humphreys, 1797); the hole which in a lamp admits the wick, serves in the lampshell for the passage of the pedicle by which it is attached to submarine objects.*

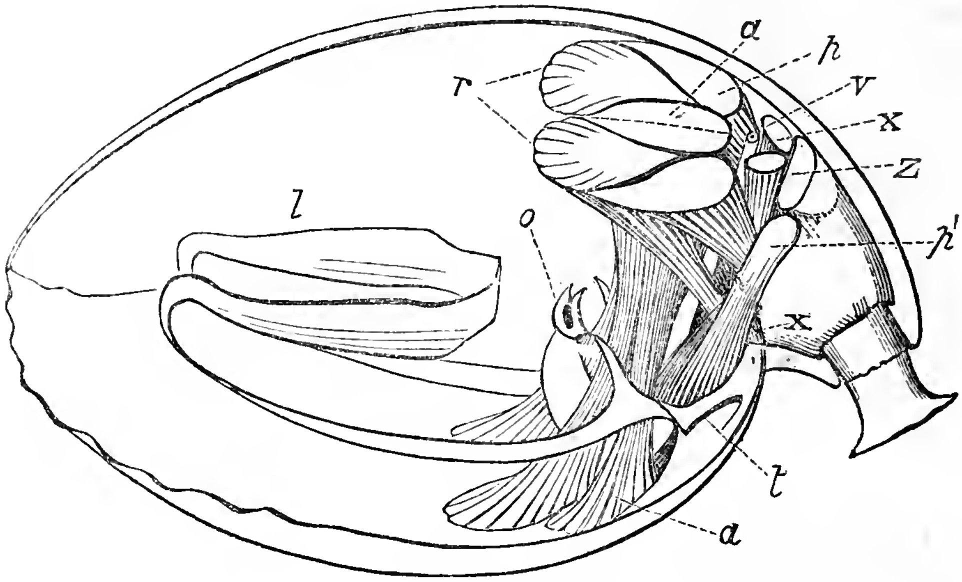
The valves of the *Brachiopoda* are respectively dorsal and ventral; the ventral valve is usually largest, and has a prominent beak, by which it is attached, or through which the organ of adhesion passes. The dorsal, or smaller valve, is always free and imperforate. The valves are articulated by two curved teeth, developed from the margin of the ventral valve, and received by sockets in the other; this hinge is so complete that the valves cannot be separated without injury.† A few, abnormal genera, have no

* The principal modifications of external form presented by these shells, are given in plate 15; the internal structure of each genus is illustrated in the woodcuts, which are the same with those in Mr. Davidson's Introduction, and in the British Museum Catalogue. They are from original studies by the author, unless otherwise stated.

† The largest recent *Terebratula* cannot be opened more than ⅛ of an inch, except by applying force.

hinge; in *Crania* and *Discina* the lower valve is flat, the upper like a limpet; the valves of *Lingula* are nearly equal, and have been compared to a duck's bill. (Petiver).

Ventral valve.



Dorsal valve.

Fig. 109. *Muscular system of Terebratula.**

a. a. adductor-muscles; *r.* cardinal-muscles; x. accessory cardinals; *p.* ventral pedicle-muscles; *p.'* dorsal pedicle-muscles; z. capsular-muscles; *o.* mouth; v. vent; *l.* loop; *t.* dental socket.

The valves are both opened and closed by muscles; those which open the shell (*cardinales*) originate on each side the centre of the ventral valve, and converge towards the hinge-margin of the free valve, behind the dental sockets, where there is usually a prominent *cardinal process*.† The teeth form the *fulcrum* on which the dorsal valve turns. The *adductor* muscles are four in number, and quite distinct in *Crania* and *Discina;* in *Lingula* the posterior pair are combined, and in *Terebratula* the four muscles are separate at their dorsal terminations, but united at their insertion in the centre of the larger valve. The pedicle is fixed by a pair of muscles (each doubly-attached) to the dorsal hinge-plate, and by another pair to the ventral valve, outside the cardinal muscles.‡ In the hinge-less genera the contraction of the cardinal muscles must tend to slide the free valve forwards, and in *Crania* and *Discina* these muscles are attached to a prominent ventral

* *Waldheimia Australis, Quoy.* $\frac{2}{1}$. From a drawing by Albany Hancock, Esq.

† The term "retractors" used at p. 8 is relinquished for the more appropriate term "cardinal muscles,"' given by Prof. King. They are particularly interesting from their function, as antagonists of the adductor muscles, like the ligament of ordinary bivalves.

‡ The muscular system of *Terebratula* presents a considerable amount of resemblance to that of *Modiola* (fig. 177); the anterior and posterior pedal muscles may be compared to the dorsal and ventral pedicle muscles.

process, which renders them less oblique; the upper valve is restored to its place by two pairs of *retractor* sliding-muscles, which are perhaps the equivalents of the dorsal pedicle muscles of *Terebratula*.* The muscles are remarkably glistening and tendinous, except at their expanded ends, which are soft and fleshy; their impressions are often deep, and always characteristic; but difficult of interpretation from their complexity, their change of position, and the occasional suppression of some and combination of others.†

On separating the valves of a recent *Terebratula*, the digestive organs and muscles are seen to occupy only a very small space near the beak of the shell, partitioned off from the general cavity by a strong membrane, in the centre of which is placed the animal's mouth. The large cavity is occupied by the fringed arms, which have been already alluded to (page 8) as the characteristic organs of the class. Their nature will be better understood by comparing them with the lips and labial tentacles of the ordinary bivalves (pp. 24, 27, fig. 171, *p.p.*); they are in fact lateral prolongations of the lips supported on muscular stalks, and are so long as to require being folded or coiled up. In *Rhynchonella* and *Lingula* the arms are spiral and separate; in *Terebratula* and *Discina* they are only spiral at the tips, and are united together by a membrane, so as to form a lobed disk. It has been conjectured that the living animals have the power of protruding their arms in search of food; but this supposition is rendered less probable by the fact that in many genera they are supported by a brittle skeleton of shell. The internal skeleton consists of two spiral processes in the *Spiriferidæ* (fig. 132), whilst in *Terebratula* and *Thecidium* it takes the form of a *loop*, which supports the brachial membrane, but does not strictly follow the course of the arms. The mode in which the arms are folded is highly characteristic of the genera of *Brachiopoda;* the extent to which they are supported by a calcarious skeleton is of less importance, and liable to be modified by age. That margin of the oral arms which answers to the lower lip of an ordinary bivalve, is fringed with long filaments (*cirri* ‡), as may be seen even in dry specimens of recent *Terebratulæ*. In some fossil examples the *cirri* themselves were supported by slender processes of shell; § they cannot therefore be vibratile organs, but are probably themselves covered with microscopic *cilia*, like the oral tentacles of the ascidian polypes (*cilio-brachiata* of Farre). The anterior lip and inner margin of the oral arms is plain, and forms a

* In *Discina* one pair of the retractor muscles seems to be actually inserted in the pedicle. Mr. Hancock compares the pedicle muscles with the *retractors* of the Bryozoa; he objects to the hypothesis of the sliding movement of the valves.

† Prof. King has shown that the compound nature of a muscular impression is often indicated by the mode in which the vascular markings proceed from it (as in figs. 140, 145.)

‡ Called *cilia* at p. 8, but this term should be restricted to the microscopic organs which clothe the *cirri*.

§ *Spirifera rostrata* and *Terebratula pectunculoides*, in the British Museum.

narrow gutter along which the particles collected by the ciliary currents may be conveyed to the mouth. The object of the folding of the arms is obviously to give increased surface for the disposition of the *cirri.*

The mouth conducts by a narrow œsophagus to a simple stomach, which is surrounded by the large and granulated liver; the intestine of *Lingula* is reflected dorsally, slightly convoluted, and terminates between the mantle lobes on the *right* side (fig. 165). In *Orbicula* it is reflected ventrally, and passes straight to the right, ending as in *Lingula.* In *Terebratula, Rhynchonella,* and probably all the *normal* Brachiopoda, the intestine is simple and reflected ventrally, passing through a notch or foramen in the hinge-plate, and ending behind the ventral insertion of the adductor muscle (fig. 109, v.)*

The interior of the valves is lined by the two lobes of the mantle, which are often fringed with fine horny bristles (*setæ*); these are quite straight, brittle, and deeply implanted between the laminæ of the mantle; they serve to guard the opening of the valves. The mantle-lobes of the *Brachiopoda* are not only organs by which the shell is formed, they are also provided with large veins by which respiration is effected; in the *Terebratulidæ* there are two great venous trunks in the dorsal mantle-lobe, four in the ventral; in *Rhynchonella* and *Discina* the lobes are similar, and the *Orthidæ* have four large veins in the dorsal lobe and only two in the ventral. The first indication of a special breathing organ is presented by *Lingula,* in which the veins develope parallel rows of small vascular processes. (*Cuvier.*) The veins open into the visceral cavity,† which is itself a great vascular sinus. There are two organs which Prof. Owen regards as hearts, each consisting of an auricle and a ventricle, situated near the sides of the mouth in *Terebratula*; but in *Lingula* (fig. 165, *h.*) they are more posterior, and quite at the sides. The ventricles propel the blood into the visceral and pallial arteries, and are therefore both branchial and systemic. The pallial arteries are very slender, and accompany the veins on their outer surfaces, forming linear impressions along the centre of the vascular markings in some fossil shells (fig. 141).

The *ova* of *Terebratula* are developed within the large veins, which they accompany as far as the secondary branches. In the *Rhynchonellidæ,* and probably in the extinct *Orthidæ,* the ovaria do not extend into the venous trunks, but occupy large sinuses on each side of the body; and in *Discina* and *Lingula* they (or the testes) fill the interstices of all the viscera, but do not appear to extend into the mantle. The ova are supposed to escape by two orifices, situated at the sides of the mouth in *Terebratula.* (Hancock.)

* The position at which the intestine terminates in the *Terebratulæ* and *Rhynchonellæ,* seems to necessitate the escape of the fæces by the umbonal opening; in those extinct genera which have the foramen closed at an early age, there is still an opening between the valves (e. g. in *Uncites*) which has been mistaken for a byssal notch.

† The veins do not terminate in hearts as formerly supposed; the statement at p. 30, line 27, should be erased.

Recent *Discinæ* often have minute fry attached to their valves, and Mr. Suess, of Vienna, has noticed a specimen of the fossil *Stringocephalus*, which contained numerous embryo shells.

Nothing is yet known respecting the development of the *Brachiopoda*, but there can be no doubt that in their first stage they are free and able to swim about, until they meet with a suitable position. It is probable that in the second stage they all adhere by a byssus, which in most instances becomes consolidated, and forms a permanent organ of attachment. Some of the extinct genera (e. g. *Spirifera* and *Strophomena*) appear to have become free when adult, or to have fixed themselves by some other means. Four genera, belonging to very distinct families, cement themselves to foreign objects by the substance of the ventral valve.

The Lamp-shells are all natives of the sea. They are found hanging from the branches of corals, the under sides of shelving rocks, and the cavities of other shells. Specimens obtained from rocky situations are frequently distorted, and those from stony and gravelly beds, where there is motion in the waters, have the beak worn, the foramen large, and the ornamental sculpturing of the valves less sharply finished. On clay beds, as in the deep clay strata, they are seldom found; but where the bottom consists of calcarious mud they appear to be very abundant, mooring themselves to every hard substance on the sea-bed, and clustering one upon the other.

Some of the *Brachiopoda* appear to attain their full growth in a single season, and all, probably, live many years after becoming adult. The growth of the valves takes place chiefly at the margin; adult shells are more globular than the young, and aged specimens still more so. The shell is also thickened by the deposit of internal layers, which sometimes entirely fill the beak, and every portion of the cavity of the interior which is not occupied by the animal, suggesting the notion that the creature must have died from the plethoric exercise of the calcifying function, converting its shell into a mausoleum, like many of the ascidian zoophytes.

The intimate structure of the shell of the *Brachiopoda* has been investigated by Mr. Morris, Prof. King, and more recently by Dr. Carpenter; according to the last observer, it consists of flattened prisms of considerable length, arranged parallel to each other with great regularity, and obliquely to the surfaces of the shell, the interior of which is imbricated by their out-crop (fig. 110.) This structructure only is found in the *Rhynchonellidæ*; but in most—perhaps all the other *Brachiopoda**— the shell is traversed by canals, from one surface

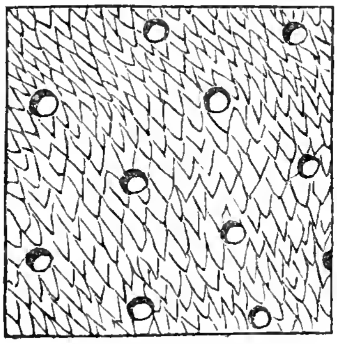


Fig. 110. *Terebratula.*

* The fossil shells of the older rocks are so generally pseudomorphous, or partake of the metamorphic character of the rock itself, that it is difficult to obtain speci mens in a state fit for microscopic examination.

to the other, nearly vertically, and regularly, the distance and size of the perforations varying with the species. Their external orifices are trumpet-shaped, the inner often very small; sometimes they bifurcate towards the exterior, and in *Crania* they become arborescent. The canals are occupied by cœcal processes of the outer mantle-layer,* and are covered externally by a thickening of the epidermis. Mr. Huxley has suggested that these cœca are analogous to the vascular processes by which in many ascidians the *tunic* adheres to the *test;* the extent of which adhesion varies in closely allied genera. The large tubular spines of the *Productidæ* must have been also lined by prolongations of the mantle; but their development was more probably related to the maintenance of the shell in a fixed position, than to the internal economy of the animal. (*King.*) Dr. Carpenter states that the shell of the *Brachiopoda* generally contains less animal matter than other bivalves; but that *Discina* and *Lingula* consist almost entirely of a horny animal substance, which is laminar, and penetrated by oblique tubuli of extreme minuteness. He has also shown that there is not in these shells that distinction between the outer and inner layers, either in structure or mode of growth, which prevails among the ordinary bivalves; the inner layers only differ in the minute size of the perforations, and the whole thickness corresponds with the outer layer only in the *Lamellibranchiata.* The loop, or brachial processes, are always impunctate.

Of all shell-fish the *Brachiopoda* enjoy the greatest range both of climate, and depth, and time; they are found in tropical and polar seas; in pools left by the ebbing tide, and at the greatest depths hitherto explored by the dredge. At present only 70 recent species are known; but many more will probably be found in the deep-sea, which these shells mostly inhabit. The number of living species is already greater than has been discovered in any *secondary* stratum, but the vast abundance of fossil *specimens* has made them seem more important than the living types, which are still rare in the cabinets of collectors, though far from being so in the sea. Above 1,000 extinct species of Brachiopoda have been described, of which more than half are found in England. They are distributed throughout all the sedimentary rocks of marine origin from the Cambrian strata upwards, and appear to have attained their maximum, both of generic and specific development, in the Devonian age.* The oldest form of organic life at present known, both in the old and new world, is a *Lingula.* Some species (like *Atrypa reticularis*)

* Called the "lining membrane of the shell," by Dr. Carpenter. (Davidson Intr. Mon. Brach.) Mr. Quekett states that the perforations are closed externally by disks, surrounded by radiating lines, supposed to indicate the existence of vibratile cilia in the living specimens.

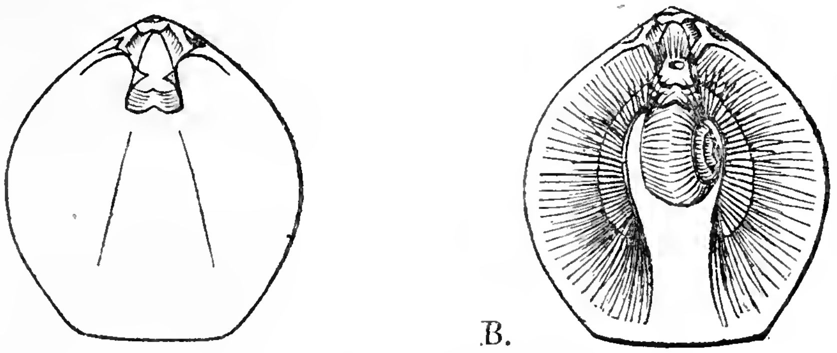
† The number of Devonian species amounts to 300; but these were not all living *at one time,* they are obtained from a whole series of deposits, representing a succession of periods.

extend through a whole "system" of rocks, and abound equally in both hemispheres; others (like *Spirifera striata*) range from the Cordillera to the Ural mountains. One recent Terebratula (*caput-serpentis*) made its appearance in the Miocene Tertiary; whilst others, scarcely distinguishable from it, are found in the Upper Oolite, and throughout the Chalk series and London Clay.*

FAMILY I. TEREBRATULIDÆ.

Shell minutely punctate; usually round or oval, smooth or striated; ventral valve with a prominent beak, and two curved hinge-teeth; dorsal valve with a depressed umbo, a prominent cardinal process between the dental sockets, and a slender shelly loop.

Animal attached by a pedicle, or by the ventral valve: oral arms united to each other by a membrane, variously folded; sometimes spiral at their extremities.



A. B.

Fig. 111. *Terebratula vitrea, Born.*

TEREBRATULA, (Llhwyd.) Brug. Lamp-shell.

Etym. Diminutive of *terebratus*, perforated.

Syn. Lampas, Humph. Gryphus, Muhlfeldt. Epithyris, Phil.

Types, T. maxillata, Pl. XV. fig. 1, (= Ter. minor-subrubra, Llhwyd. Anomia terebratula, L.) T. vitrea, fig. 3.

Shell smooth, convex; beak truncated and perforated; foramen circular; deltidium of two pieces, frequently blended; loop very short, simple, attached by its crura to the hinge-plate. (Fig. 111, A.)

Animal attached by a pedicle; brachial disk tri-lobed, centre lobe elongated and spirally convoluted. (Fig. 111, B.) The young of *T. diphya* (Pygope of Link) has bi-lobed valves, (Pl. XV. fig. 2.); when adult the lobes unite, leaving a round hole through the centre of the shell.

Distr. 1 sp. Medit. 90—250 fathoms on nullipore mud. (*Forbes.*)

Fossil, 100 sp. Devonian —. World-wide.

* The author has to ackowledge his obligation to Mr. Davidson for the use of the notes, drawings and specimens, assembled during the preparation of his great work on the British Fossil Brachiopoda, printed for the Palæontographical Society; to which work the student is referred for more copious descriptions and illustrations.

Sub-genera. *Terebratulina* (caput-serpentis) D'Orb. Pl. XV. fig. 3. Fig. 112. *Shell* finely striated, auriculate, deltidium usually rudimental;

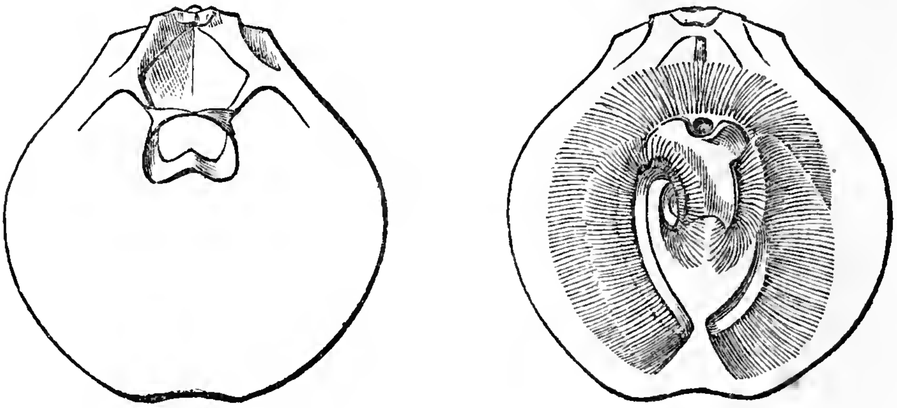


Fig. 112. *Dorsal valve:* *Animal.* $\frac{2}{1}$

foramen incomplete; loop short, rendered annular in the adult by the union of the oral processes. *Dist.* 7 sp. U. States, Norway, Cape, Japan. 10—120 fms. *Fossil*, 20 sp. Oxfordian —. U. S. Europe.

Waldheimia (australis) King. Pl. XV. fig. 4 (p. 8, figs. 4, 5.) figs. 109, 113, 114.

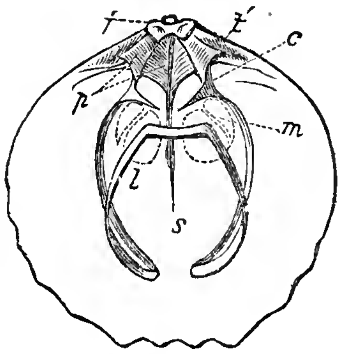


Fig. 113. *Dorsal valve.*

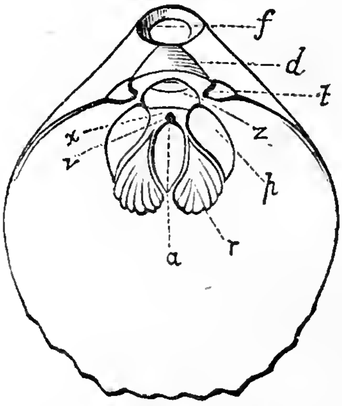


Fig. 114. *Ventral valve.*

Fig. 113. *j*, cardinal process; *t'*, dental sockets; *p*, hinge-plate; *s*, septum; *c*, crura of the loop; *l*, reflected portion of the loop; *m*, quadruple adductor-impression.

Fig. 114. *f*, foramen; *d*, deltidium; *t*, teeth; *a;* single adductor-impression; *r*, cardinal muscles; *x*, accessory muscles; *p*, pedicle muscles; *v*, position of the vent; *z*, attachment of pedicle-sheath.

Shell smooth or plaited, dorsal valve frequently impressed; foramen complete; loop elongated and reflected; septum (*s*) of smaller valve elongated. *Distr.* 9 sp. Norway, Java, Australia, California, Cape Horn. Low-water—100 fms. *Fossil*, 60 sp. Trias —. S. America, Europe. *Eudesia* (cardium) King, includes 1 recent, and 6 fossil species which are sharply plaited. *T. impressa* (Pl. XV. fig. 5) is the type of a group which has the external shape of *Terebratella*.

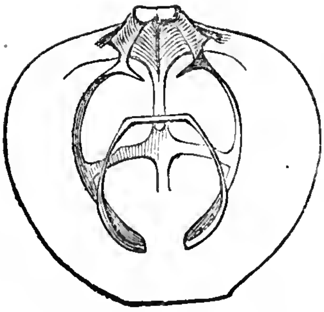


Fig. 115. *Terebratella.*

TEREBRATELLA, D'Orbigny.

Type, T. dorsata, Gmel. (= Magellanica, Chemn.) Pl. XV. fig. 7. Fig. 115.

Shell smooth or radiately plaited; dorsal valve longitudinally impressed; hinge-line straight, or not much curved; beak with a flattened area on each side of the deltidium; foramen large; deltidium incomplete; loop attached to the septum (*s*).

Animal like *Terebratula;* the spiral lobe of the brachial disk becomes very diminutive in some species, and is obsolete in *Morrisia* and *T. Cumingii. Distr.* excluding sub-genera, 16 sp. Cape Horn, Valparaiso (90 fms.), New Zealand, Japan, Ochotsk, Spitzbergen, Labrador. *Fossil,* 16 sp. Lias —. U.S. Europe. In *T. crenulata* and *Evansii* (fig. 116) the dorsal septum sometimes projects so far as to touch the opposite valve, but in other examples it remains undeveloped. (*Davidson.*)

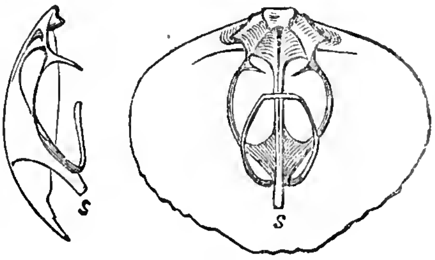


Fig. 116. *Ter: Evansii.* Dav.

Sub-genera. Trigonosemus (elegans) König. *Syn.* Delthyridæa (pectiniformis) M'Coy. Fissirostra, D'Orb. *Ex.* T. Palissii, Pl. XV. fig. 8. *Shell* finely plaited, beak prominent, curved, with a narrow apical foramen; cardinal area large, triangular; deltidium solid, flat; cardinal process very prominent. *Distr.* 5 sp. Chalk, Europe.

Lyra (Meadi) Cumberland, Min. Con. 1816. Pl. XV. fig. 6. *Syn.* Terebrirostra, D'Orb. Rhynchora, Dalman.* *Shell* ornamented with rounded ribs; beak very long, divided lengthwise internally, by the dental plates; loop doubly attached? *Distr.* 4 sp. cretaceous: Europe. Three species of similar form are found in the Trias of St. Cassian.

Magas (pumila) Sby. Fig. 117. Shell smooth, conspicuously punctate, dorsal valve impressed, foramen angular, deltidium rudimentary; internal septum (*s*) prominent, touching the ventral valve; reflected portions of the loop disunited (*l*). 2 sp. U. Green-sand — Chalk. Europe. The recent *Ter. Cumingii,* of New Zealand,

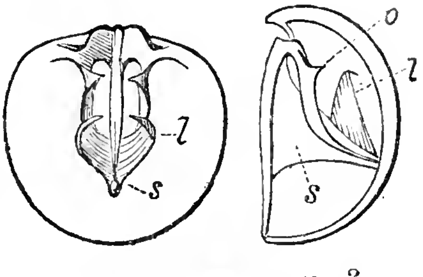


Fig. 117. *M. pumila.* $\frac{2}{1}$

* The name *Rhynchora* was given by Dalman to the Ter. costata. Wahl. (= T. pectinata, L.) on the supposition that it was identical with Sowerby's *T. Lyra*; and as no specimen could be found with a long beak, an artificial one was manufactured for it, of which there is a cast in the Brit. M. The second species of "Rhynchora," *Ter. spatulata,* Wahl. has no beak whatever: in shape it is like an *Argiope,* but measures an inch each way. The ventral valve is a simple bent plate with the teeth at the angles; the dorsal valve is flat, with a very wide hinge-plate, and sockets at the angles, whilst a single septum projects from the centre, with portions of a loop attached.

resembles *Bouchardia* externally, but has the diverging processes of the loop as in Magas.

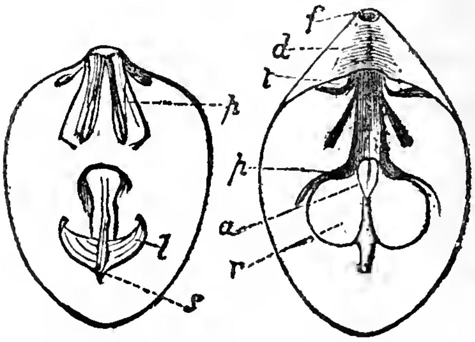


Fig. 118. *B. tulipa, Bl.**

Bouchardia (tulipa) Davidson, fig. 118. Beak prominent, with a minute apical foramen (*f*) deltidium blended with the shell (*d*) apophysis anchor-shaped, the septum (*s*) being furnished with two short lamellæ. Brazil, 13 fms.

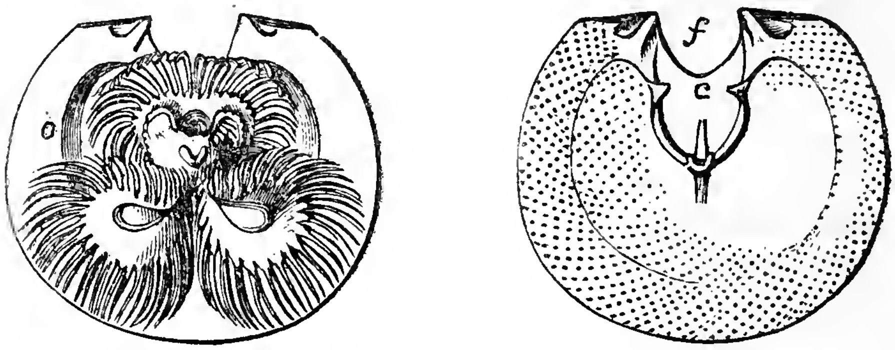


Fig. 119. *Animal.* $\frac{10}{1}$ *Dorsal valve.*†

Morrisia (anomioides, Scacchi) Davidson. Fig. 119. *Shell* minute, conspicuously punctate; foramen large, encroaching equally on both valves; hinge area small, straight; loop not reflected, attached to a small forked process in the centre of the valve. *Animal* with sigmoid arms, destitute of spiral terminations; cirri in pairs. *Distr.* 2 sp. Medit. 95 fms. (*Forbes.*) ? *Fossil.* 1 sp. Pliocene, Palermo.

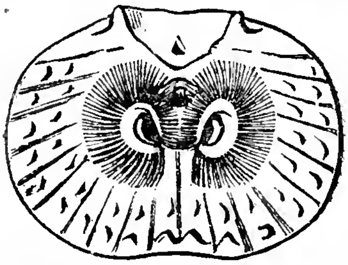


Fig. 120. *Dorsal valve with animal.* $\frac{2}{1}$

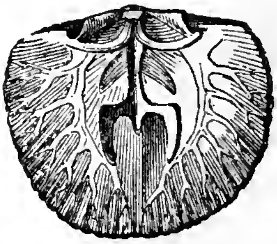


Fig. 121. *Dorsal valve.*

* The muscular impressions in *Bouchardia* have been compared with those of *Ter. Cumingii*, of which the animal is known. The large impressions (*r*) in the disk of the ventral valve appear to be formed by the cardinal muscles; *a.* by the adductor; *p.* by the pedicle muscles.

† Fig. 119. *c.* loop; *f.* pedicle notch; *o.* the ovaries. From the originals in Mr. Davidson's collection; magnified ten diameters.

Kraussia (rubra) Dav. Cape. Fig. 121. K. Lamarckiana, Dav. Australia. Fig. 120. *Shell* transversely oblong; hinge-line nearly straight; beak truncated, laterally keeled; area flat; foramen large, deltidium rudimentary; dorsal valve longitudinally impressed, furnished inside with a forked process rising nearly centrally from the septum; interior often strongly tuberculated. The apophysis is sometimes a little branched, indicating a tendency towards the form it attains in fig. 122. *Animal* with rather small oral arms, the spiral lobe very diminutive. *Distr.* 6 sp. S. Africa, Sydney, N. Zealand; low-water to 120 fms.

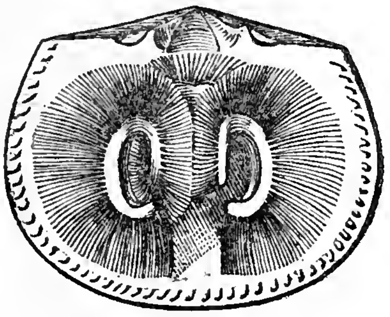
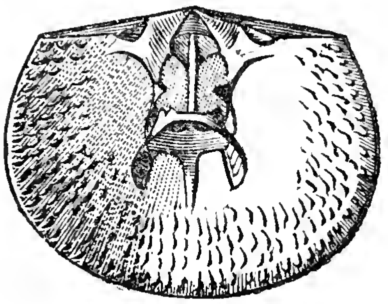


Fig. 122. *Animal.*



Dorsal valve.

? *Megerlia* (truncata) King, 1850. Pl. XV. fig. 9. Fig. 122. *Loop* trebly attached; to the hinge-plate by its crura, and to the septum by processes from the diverging and reflected portions of the loop. *Distr.* 2 sp. Medit. Philippines. These species belong to the same natural group with *Kraussia.*

? *Kingena* (lima) Dav. Cretaceous, Europe, Guadaloupe. Valves spinulose; loop trebly attached.

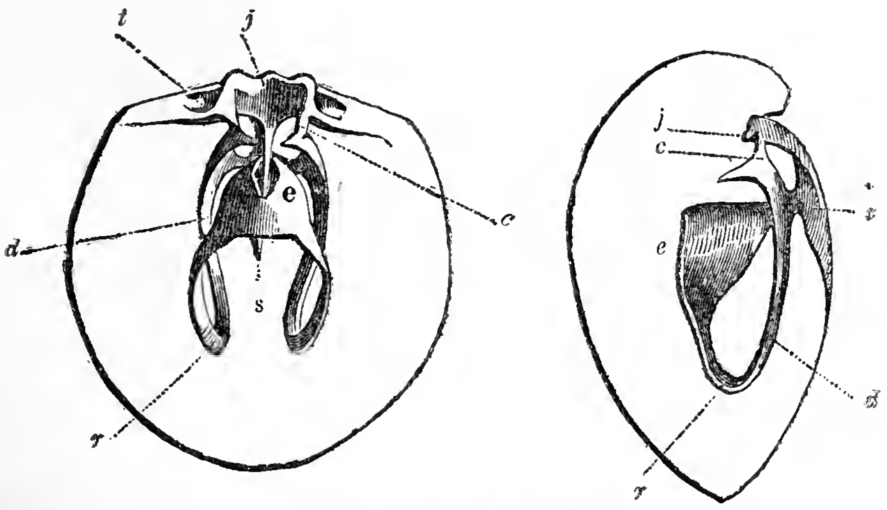


Fig. 123. *Ter.* (*Kingena*) *lima*; (*after* Davidson.)

t. dental sockets; *j.* cardinal process, *c.* crura; *d.* diverging processes of loop; *r*, reflected portion; *e.* third attachment of loop; *s.* dorsal septum.

? *Ismenia* (pectunculus) King. Coral rag, Europe. Valves ornamented with corresponding ribs; loop trebly attached.

? *Waltonia* (Valenciennei) Dav. New Zealand. Perhaps the fry of *Ter. rubicunda,* with the reflected part of the loop wanting.

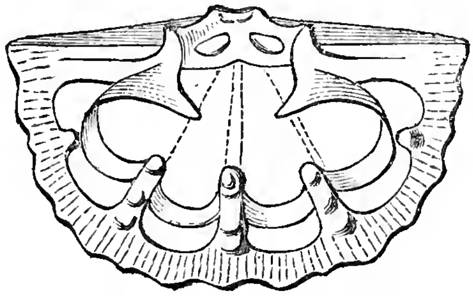


Fig. 124. *Argiope decollata.* $\frac{4}{1}$

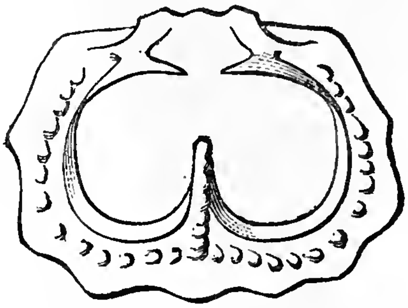


Fig. 125. *A. Neapolitana,* Sc.* $\frac{8}{1}$

ARGIOPE, Eudes Deslongchamps.

Etym. Argiope, a nymph. *Syn.* Megathyris, D'Orb.

Type, A. decollata, Pl. XV. fig. 10. Fig. 124—126.

Shell minute, transversely oblong or semi-ovate, smooth or with corresponding ribs; hinge line wide and straight, with a narrow area to each valve; foramen large, deltidium rudimentary; interior of dorsal valve with one or more prominent, sub-marginal septa; loop two or four-lobed, adhering to the septa, and more or less confluent with the valve.

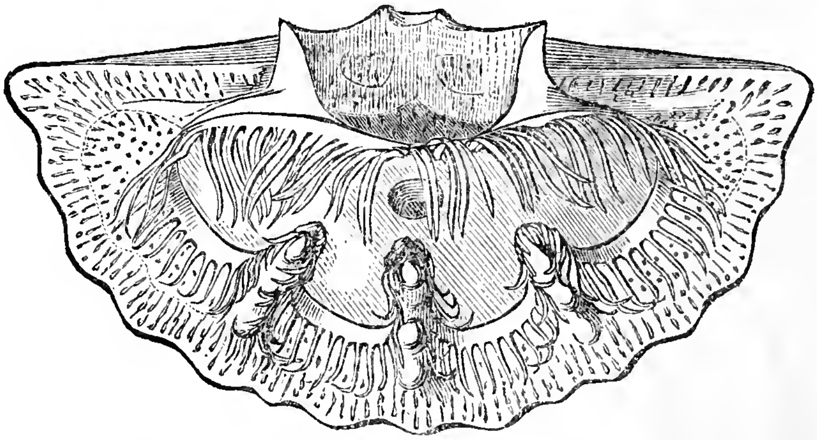


Fig. 126. *A. decollata,* $\frac{40}{1}$; dorsal valve with the animal, from a specimen dredged by Prof. Forbes in the Ægean. The oral aperture is seen in the centre of the disk.

Animal with oral arms folded into two or four lobes, united by membrane, forming a brachial disk fringed with long cirri: mantle extending to the margins of the valves, closely adherent.

Distr, 4 sp. N. Brit. Madeira, Canaries, Medit. 40—105 fathoms.

Fossil. 5 sp. U. Greensand —. Europe.

* Interiors of dorsal valves magnified, from the originals in Coll. Davidson.

Fig. 127. *T. radians.*

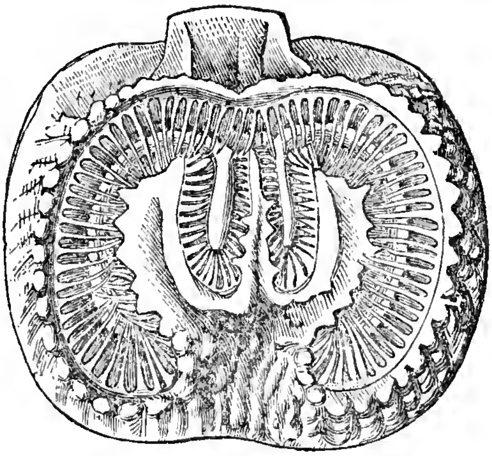


Fig. 128. *T. Mediterraneum.** $\frac{4}{1}$

THECIDIUM, Defrance.

Etym. Thekidion, a small pouch. *Type,* T. radians, Pl. XV. fig. 11.

Shell small, thick, punctate, attached by the beak; hinge-area (*h*) flat; deltidium (*d*) triangular, indistinct: *dorsal valve* (fig. 127) rounded, depressed; interior with a broad granulated margin; cardinal process prominent, between the dental sockets; oral processes united, forming a bridge over the small and deep visceral cavity; disk grooved for the reception of the loop, the grooves separated by branches from a central septum; loop often unsymmetrical, lobed, and united more or less intimately with the sides of the grooves: *ventral valve* (fig. 129) deeply excavated, hinge-teeth prominent; cavities for the adductor (*a*) and pedicle muscles (*p*) small; disk occupied by two large smooth impressions of the cardinal muscles, bordered by a vascular line. *Animal* (fig. 128) with elongated oral arms, folded on themselves and fringed with long cirri; mantle extending to the margin of the valves and closely adherent; epidermis distinct.

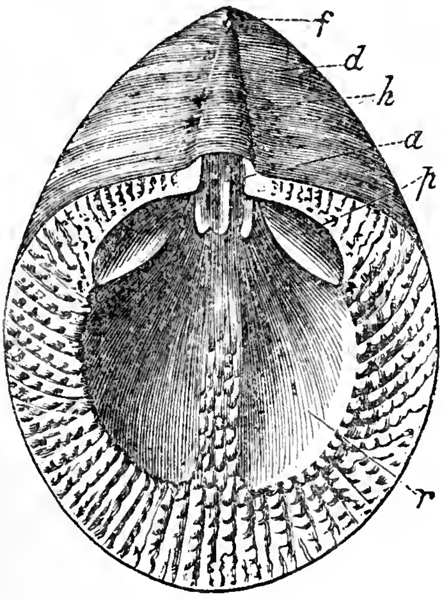


Fig. 129. *T. radians,* $\frac{4}{1}$.

T. radians is the only un-attached species, it is supposed to be fixed by a pedicle when young (D'Orb.)

T. hieroglyphicum, Pl. XV. fig. 12, has a very complicated interior; whilst in several others there are but two brachial lobes. The Liassic species form the subject of a monograph by M. Eugene Deslongchamps; they are often minute, and attached in numbers to sea-urchins, corals, and terebratulæ.

Distr. 1 sp. Medit. *Fossil,* 27 sp. Trias —. Europe.

* Dorsal valve with the animal, magnified. Coll. Davidson.

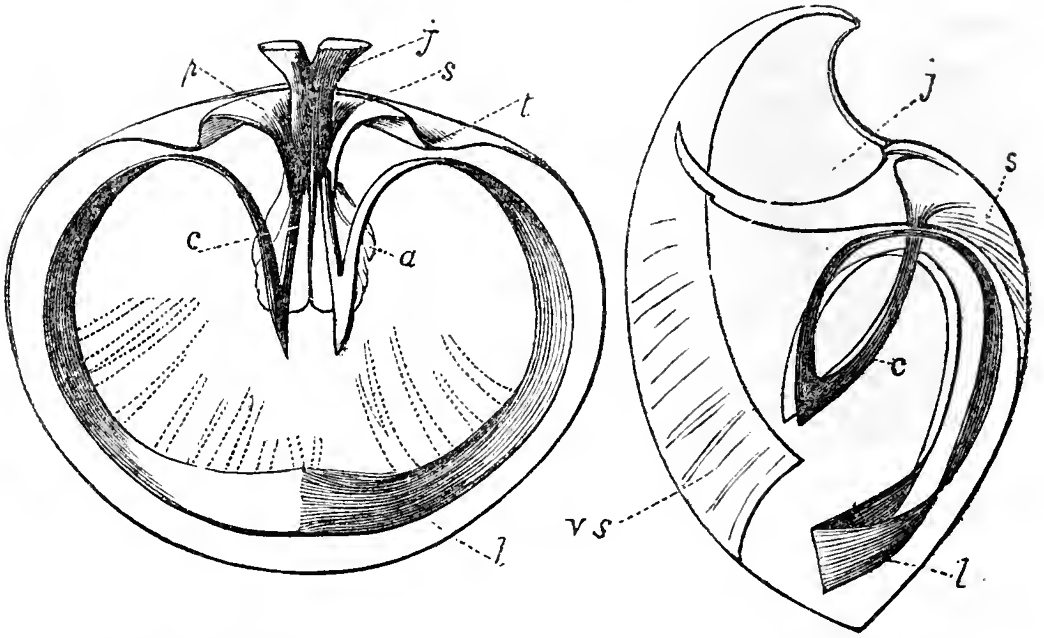


Fig. 130. *Dorsal valve.* *Profile.**
a, adductor; *c*, crura; *l*, loop; *j*, cardinal process; *p*, hinge-plate; *s*, dorsal septum; *v. s.* ventral septum; *t*, dental sockets.

? STRINGOCEPHALUS, Defrance.

Etym. Strinx (*stringos*) an owl, *cephale* the head.†

S. Burtini, Pl. XV. fig. 13. Fig. 130, 131. Devonian, Europe.

Shell punctate; sub-orbicular, with a prominent beak: *ventral* valve with a longitudinal septum (*v. s.*) in the middle; hinge-area distinct; foramen large and angular in the young shell, gradually surrounded by the deltidium and rendered small and oval in the adult; deltidium composed of three elements; teeth prominent; *dorsal* valve depressed, cardinal process (*j*) very prominent, sometimes touching the opposite valve, its extremity forked to receive the ventral septum (*v.s.*); hinge-plate (*p*) supporting a shelly loop, after the manner of *Argiope.*

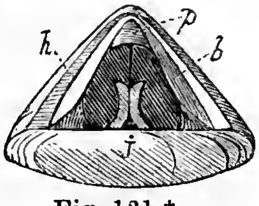


Fig. 131.‡

FAMILY II. SPIRIFERIDÆ.

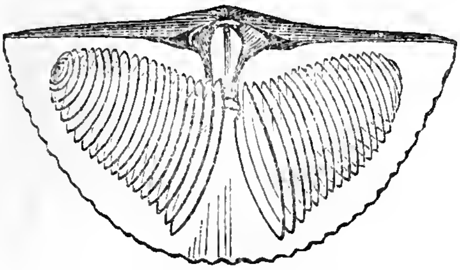
Shell furnished internally with two calcarious spiral processes (*apophyses*) directed outwards, towards the sides of the shell, and destined for the support of the oral arms; which must have been fixed immoveably; the spiral lamellæ

* The loop (which was discovered by Prof. King) has a distinct suture in the middle; the dotted lines proceeding from its inner edge are added from a drawing by Mr. Suess, and represent what he regards as shelly processes for supporting a membranous disk. They may be portions of spirals, whose outer whirls are confluent.

† Internal casts of *Producta gigantea* are called "owl-heads" by quarrymen in the North of England. (*Sowerby*).

‡ Fig. 131. Young shell, magnified 4 diameters; *h*, hinge area; *b*, deltidium: *p*, pseudo-deltidium.

are sometimes spinulose, indicating the existence of rigid cirri, especially on the front of the whirls; valves articulated by teeth and sockets.



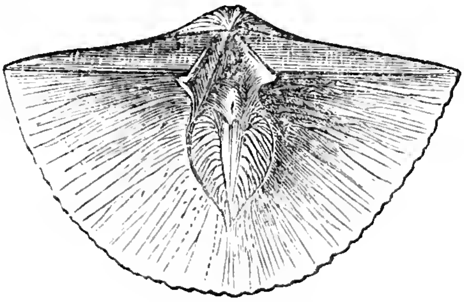


Fig. 132. *Dorsal; Ventral valve.* ½

SPIRIFERA, Sowerby.

Type, S. striata, Sby. fig. 132. *Syn.* Trigonotreta, König. Choristites. Fischer. Delthyris, Dalman. Martinia &c. M'Coy.

Shell impunctate,* transversely oval or elongated, tri-lobed, beaked, bi-convex, with a dorsal ridge and ventral furrow; hinge-line wide and straight; area moderate, striated across; foramen angular, open in the young, afterwards progressively closed; *ventral* valve with prominent hinge-teeth, and a central muscular scar, consisting of the single adductor flanked by two cardinal impressions: *dorsal* valve with a small cardinal process, a divided hinge-plate, and two conical spires directed outwards and nearly filling the cavity of the shell; crura united by an oral loop. The shell and spires are sometimes silicified, in limestone, and may be developed by means of acid. In *S. mosquensis* the dental plates are prolonged nearly to the front of the ventral valve.

Distr. 200 sp. L. Sil. — Trias. Arctic America — Chile, Falkland Ids. Europe; China; Thibet; Australia; Tasmania. In China these and other fossils are used as medicine.

Sub-genera. Spiriferina, D'Orb. S. Walcotti, Pl. 15, f. 14. *Shell* punctate, external surface spinulose; foramen covered by a pseudo-deltidium; interior of ventral valve with a prominent septum, rising from the adductor scar. *Distr.* 6 sp. Trias — L. Oolites. Brit. France, Germany, S. America.

Cyrtia, Dalman. C. exporrecta, Pl. XV. fig. 15. *Shell* impunctate, pyramidal, beak prominent, area equiangular, deltidium with a small tubular foramen. *Fossil,* 7 sp. Silur. — Trias. Europe. In *C. Buchii, heteroclyta, calceola,* &c. the shell is punctate.

ATHYRIS, M'Coy.

Etym. A, without, *thuris,* a door.† (i. e. deltidium).

Syn. Spirigera, D'Orb. Cleiothyris, King (not Phil.)

* Prof. King attributes this to metamorphism; *S. Demarlii.* Bouch. from the Devonian limestone, is punctate. (*Carpenter*).

† Sometimes employed, *incorrectly,* in the sense of a door-*way* or foramen.

Types, A. concentrica, Buch. A. Roissyi, fig. 133, 134. A. lamellosa, Pl. XV. fig. 16.

Shell impunctate, transversely oval, or sub-orbicular, bi-convex, smooth, or ornamented with squamose lines of growth, sometimes developed into wing-like expansions, (fig. 134*); hinge-line curved, area obsolete, foramen

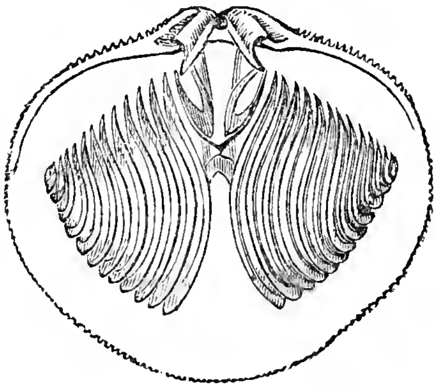


Fig. 133. *Interior of dorsal valve.*

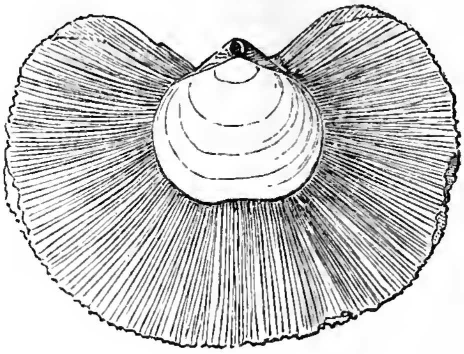


Fig. 134. *Specimen with fringe.*

round, truncating the beak, deltidium obsolete; hinge-plate of dorsal valve with four muscular cavities, perforated by a small round foramen, and supporting a small complicated loop (?) between the spires; spires directed outwards, crura united by a prominent oral loop.

The foramen in the hinge-plate occupies the situation of the notch through which the intestine passes in the recent *Rhynchonellæ;* in *A. concentrica* a slender curved tube is sometimes attached to the foramen, beneath the hinge-plate. *A. tumida* has the hinge-plate merely grooved, and the byssal foramen is angular.

Fossil, about 20 sp. Silurian — Lias. N. and S. America; Europe.

Sub-genus? Merista, Suess. Ter. scalprum, Rœmer, (A. cassidea, Quenst. Sp. plebeia. Ph.) Silurian — Devonian; Europe. *Shell* impunctate, dental plates (*v*) and dorsal septum (*d*) supported by arched plates ("shoe-lifter" processes, of King) which readily detach, leaving cavities (as in fig. 135); spiral arms have been observed in all the species.

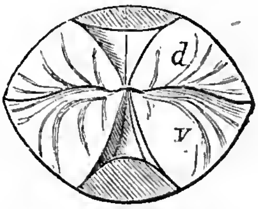


Fig. 135. *Merista.*

Retzia, King.

Dedicated to the distinguished Swedish naturalist, Retzius.

Type, Ter. Adrieni, Vern. *Ex.* R. serpentina, Carb. L. Belgium. Fig. 136.

Shell punctate, terebratula-shaped; beak truncated by a round foramen rendered complete by a distinct deltidium: hinge-area small, triangular, sharply defined; interior with diverging shelly spires.

Fossil, about 20 species. Silurian — Trias. S. America. U. S. Europe.

* The spurious genus *Actinoconchus* (M'Coy) was founded on this character; similar expansions are formed by species of Atrypa, Camarophoria, and Producta.

Prof. King first pointed out the existence of calcarious spires in several *Terebratulæ* of the older rocks, and others have been discovered by MM. Quenstedt, De Koninck, and Barrande. In form they resemble Terebratulina, Eudesia, and Lyra.

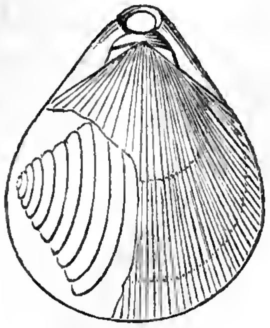
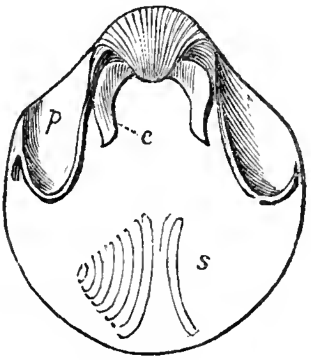


Fig 136. *Retzia serpentina, D. K.*



Fig, 137, *Uncites gryphus.*

UNCITES, Defrance.

Type, U. gryphus, Pl. XV. fig. 17. Fig 137. *Fossil*, Devonian. Europe.

Shell impunctate; oval, bi-convex, with a long incurved beak; foramen apical, closed at an early age; deltidium, large, concave; spiral processes directed outwards; no hinge-area.

The large, concave deltidium of Uncites so much resembles the channel formed by the dental plates of *Pentamerus*, that Dalman mistook the shell for a member of that genus. The discovery of internal spires, by Prof. Beyrich, shows that it only differs from *Retzia* in being impunctate and destitute of hinge-area. Some of the specimens have corresponding depressions in the sides of the valves (fig. 137, *p*) forming pouches which do not communicate with the interior.

FAMILY III. RHYNCHONELLIDÆ.

Shell impunctate, oblong, or trigonal, beaked; hinge-line curved; no area; valves articulated, convex, often sharply plaited; foramen beneath the beak, usually completed by a deltidium, sometimes concealed; hinge-teeth supported

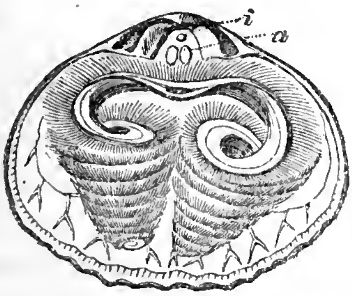


Fig. 138. *R. nigricans.*

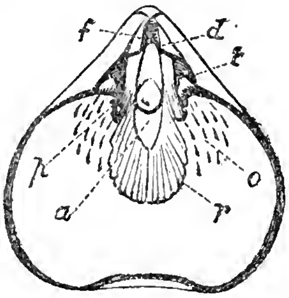
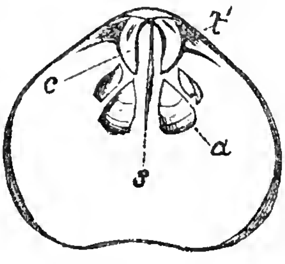


Fig. 139. *Ventral:*



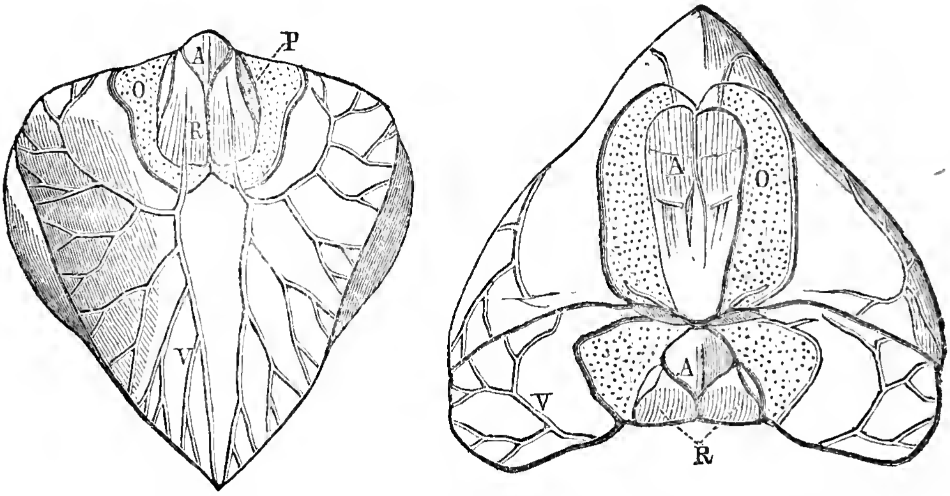
Dorsal.

Fig. 138. Dorsal valve with the animal; *a*, adductor muscles: *i*, intestine.

Fig. 139. R. psittacea, interiors. *s*, septum; *f*, foramen; *d*, deltidium; *t*, teeth; *t'*, sockets; *c*, oral lamellæ; *a*, adductor impressions; *r*, cardinal; *p*, pedicle muscles; *o*, ovarian spaces.

by dental plates; hinge-plate deeply divided, supporting oral lamellæ, rarely provided with spiral processes; muscular impressions grouped as in *Terebratula;* vascular impressions consisting of two principal trunks in each valve, narrow, dichotomising, angular, the principal posterior branches inclosing ovarian spaces.

Animal (of *Rhynchonella*) with elongated spiral arms, directed inwards, towards the concavity of the dorsal valve; alimentary canal terminating behind the insertion of the adductor in the ventral valve; mantle not adhering, its margin fringed with a few short setæ.



Ventral aspect. *Umbonal aspect.*

Fig. 140. *Rh. acuminata, internal casts.*

Fig. 140. Umbonal aspect, with the dorsal valve above (Coll. Prof. King). Ventral aspect (Coll. Prof. Morris). A, adductor; R, cardinal; P, pedicle; V, vascular; O, ovarian impressions.

RHYNCHONELLA. Fischer.

Syn. Hypothyris, Phil. Hemithyris (psittacea) D'Orb. Acanthothyris (spinosa) D'Orb. Cyclothyris (latissima) M'Coy. Trigonella (part) Fischer (not L. nor Da Costa).

Types, R. acuta, Pl. XV. fig. 18: furcillata, fig. 19: spinosa, fig. 20: acuminata, fig. 140: nigricans, fig. 138; psittacea, fig. 139 (p. 8, fig. 3).

Shell trigonal, acutely beaked, usually plaited; dorsal valve elevated in front, depressed at the sides; ventral valve flattened, or hollowed along the centre, hinge plates supporting two slender curved lamellæ; dental plates diverging.

The foramen is at first only an angular notch in the hinge-line of the ventral valve, but the growth of the deltidium usually renders it complete in the adult shell; in the cretaceous species it is tubular. In *R. acuminata* and many other palæozoic examples, the beak is so closely incurved as to allow no space for a pedicle. Both the recent *Rhynchonellæ* are black; *R. octoplicata* of the Chalk sometimes retains six dark spots.

Distr. 2 sp. *R. psittacea,* Labrador (low water?) Hudson's Bay, 100 fms.: Melville Id. Sitka; Icy Sea. *R. nigricans,* New Zealand, 19 fms.

Fossil, 250 sp. L. Silurian —. N. and S. America, Europe, Thibet, China.

Sub-genera. ? *Porambonites,* Pander. P. æquirostris, Schl. *Shell* impunctate; surface minutely pitted; each valve with a minute hinge-area and indications of two septa; foramen angular, usually concealed. *Distr.* 4 sp. L. Silurian. Russia, Portugal.

Camarophoria, King. T. Schlotheimi, Buch. Figs. 141, 142. Ventral valve with converging dental plates (*d*) supported on a low septal ridge (*s*); dorsal valve with a prominent septum (*s*) supporting a spoon-shaped central process (*v*); oral lamellæ long and slender (*o*). Foramen angular, cardinal process distinct (*j*). *Fossil,* 9 sp. ? Carb. — Permian (Magnesian limestone). Germany; England.

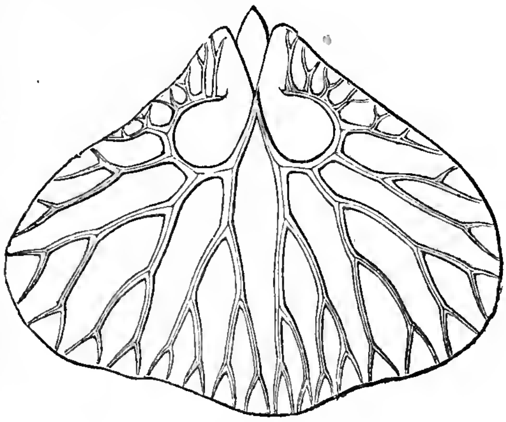


Fig. 141. Internal cast.*

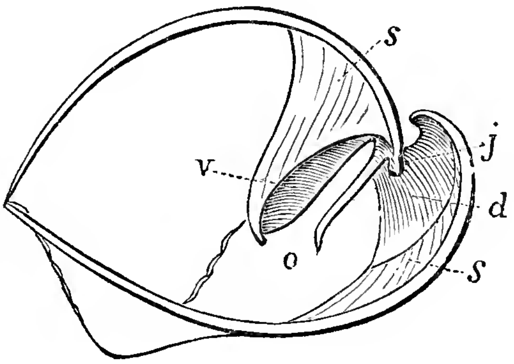


Fig. 142. Section.

PENTAMERUS, Sowerby.

Etym. *Pentameres,* 5-partite.

Syn. Gypidia (conchydium) Dalman.

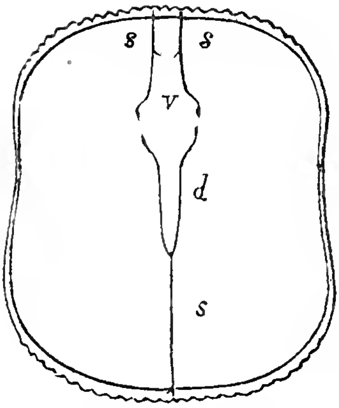
Type, P. Knightii, Pl. XV. fig. 22. Fig. 143.

Shell impunctate, ovate, ventricose, with a large incurved beak; valves usually plaited; foramen angular; no area or deltidium; dental plates (*d*) converging, trough-like, supported on a prominent septum (*s*); dorsal valve with two contiguous longitudinal septa (*s s*) opposed to the plates of the other valve.

Oral lamellæ have been detected by Mr. Salter in *P. liratus;* in *P.* ? *brevirostris* (Devonian, Newton) the dorsal valve has a long trough-like process supported by a single low septum.

Fossil, 20 sp. Arctic America, U.S. Europe.

* Ventral side of cast, showing the V shaped cavity of the dental plates, and the impressions of branchial veins, accompanied by arteries; (after King.)



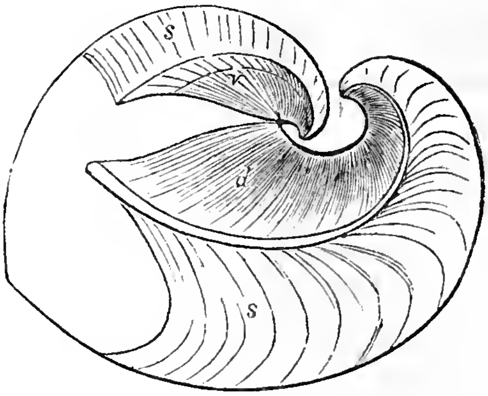
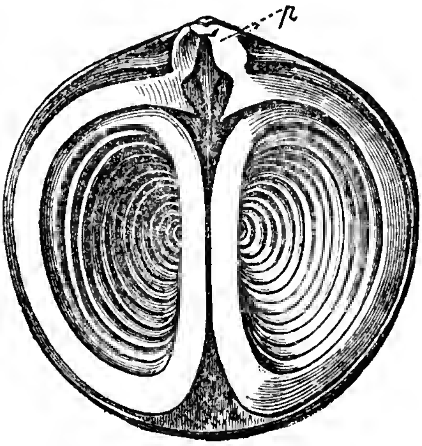


Fig. 143. *Longitudinal;* *Transverse section.*

The relations of the animal to the shell, in such a species as *P. Knightii* can only be inferred by comparison with other species in which the internal plates are less developed, and with other genera, such as *Cyrtia* and *Camarophoria*. In fig. 143, the small central chamber (*v*) must have been occupied by the digestive organs. the large lateral spaces (*d s*) by the spiral arms: it is doubtful whether any muscles were attached to these plates; in *Porambonites* the adductor impression is situated beyond the point to which the dental plates converge, and in *Camarophoria* the muscular impressions occupy the same position as in *Rhynchonella*.

Atrypa, Dalman.

Syn. Cleiothyris, Phillips. Spirigerina, D'Orb.* Hipparionyx, Vanuxem.
Type, A. reticularis, Pl. XV. fig. 17. Figs. 144, 145.



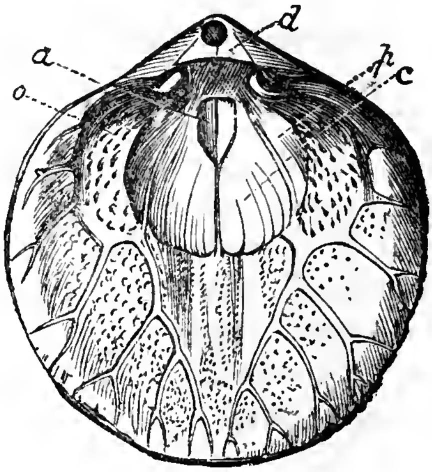


Fig. 144, *Dorsal valve.* Fig. 145, *Ventral valve; interiors.*
p, hinge-plate; *a*, impressions of adductor muscle; *c*, cardinal muscle *p*, pedicle muscle; *o*, ovarian sinus; *d*, deltidium.

Shell impunctate: oval, usually plaited and ornamented with squamose lines of growth; dorsal valve gibbose; ventral depressed in front; beak

* The term *Atrypa* (*a*, without, *trupa*, foramen) is objectionable, like all Dalman's names; but M. D'Orbigny has made no improvement by proposing *Spirigerina*, in addition to Spirifera, Spirigera, and Spiriferina!

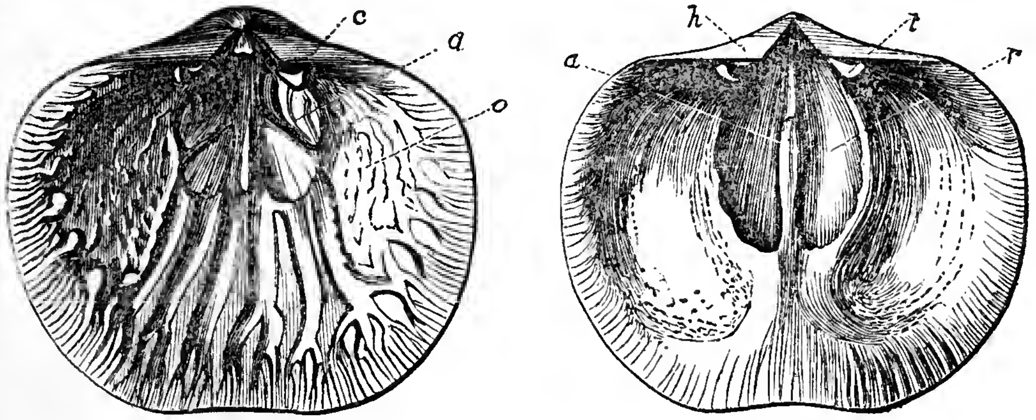
small, often closely incurved: foramen round, sometimes completed by a deltidium, often concealed: dorsal valve with a divided hinge-plate, supporting two broad spirally coiled lamellæ; spires vertical, closely appressed, and directed towards the centre of the valve; teeth and impressions like *Rhynchonella.*

The shells of this genus differ from *Rhynchonella* chiefly in the calcification of the oral supports, a character of uncertain value.

Fossil, 15 sp. L. Silurian — Trias. America (Wellington Channel! Falkland Ids.), Europe, Thibet.

FAMILY IV. ORTHIDÆ.*

Shell transversely oblong, depressed, rarely foraminated; hinge-line wide and straight; beaks inconspicuous; valves plano-convex, or concavo-convex, each with a hinge-area (*h*) notched in the centre; *ventral* valve with prominent teeth (*t*); muscular impressions occupying a saucer-shaped cavity with a raised margin; adductor (*a*) central; cardinal and pedicle impressions (*r*) conjoined, lateral, fan-like: *dorsal* valve with a tooth-like cardinal-process between two curved brachial processes (*c*); adductor impression (*a*) quadruple: vascular impressions consisting of six principal trunks in the dorsal valve, two in the ventral, the external branches turned outwards and backwards inclosing wide ovarian spaces (*o*). Indications have been observed, in several genera, of horizontally-coiled spiral arms; the space between the valves is often very small. The shell-structure is punctate, except in a few instances, where the original texture is probably obliterated.



Dorsal valve.† *Ventral valve.*

Fig. 147. *Orthis, striatula. Devonian, Eifel.*

ORTHIS, Dalman.

Etym. Orthos, straight. *Type,* O. rustica, Pl. XV. fig. 23.

Syn. Dicœlosia (biloba) King. Platystrophia (biforata) King. Gonambonites (inflexa) Pander. Orthambonites (calligramma) Pander.

* The names of the Families are formed from those of the *typical* genera, by substituting *idæ* for the last syllable of the genitive case.

† From a specimen presented by M. De Koninck to the British Museum; internal casts of this fossil were called *hysterolites* by old authors.

Shell transversely oblong, radiately striated or plaited, bi-convex, hinge-line narrower than the shell, cardinal process simple, brachial processes tooth-like, prominent and curved.

Fossil, 100 sp. L. Silurian — Carb. Arctic America, U.S. S. America, Falkland Ids. Europe, Thibet.

? *Sub-genera, Orthisina,* D'Orb. O. anomala, Schl. Fig. 148. *Syn.* Pronites (ascendens) and Hemipronites, Pander. *Shell* impunctate ? widest at the hinge-line; cardinal notch closed, byssal notch (*fissure*) covered by a convex pseudo-deltidium, sometimes perforated by a small round foramen. *Fossil.* L. Silúrian, Europe.

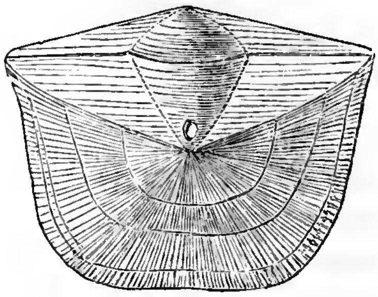


Fig. 148, *Orthisina.*

O. pelargonatus (Streptorhynchus, King) from the Magnesian limestone, *O. senilis,* Carb limestone, and some Devonian species, have the beak twisted, as it if had been attached; there is no foramen.

STROPHOMENA, Blainville.*

Etym. Strophos bent, *mene* crescent.

Ex. S. rhomboidalis, Pl. XV. fig. 24. (= Leptæna depressa, Sby.)

Syn. Leptæna (depressa) Dalman. Leptagonia, M'Coy. Enteletes, Fischer.

Shell semi-circular, widest at the hinge-line, concavo-convex, depressed, radiately striated; area double; ventral valve with an angular notch, progressively covered by a convex pseudo-deltidium; umbo depressed, rarely (?) perforated, in young shells, by a minute foramen (fig. 149, *e*); muscular depressions 4, central pair narrow, formed by the adductor: external pair (*m*) fan-like, left by the cardinal and pedicle muscles; *dorsal* valve with a bi-lobed cardinal process, between the dental sockets, and four depressions for the adductor muscle.

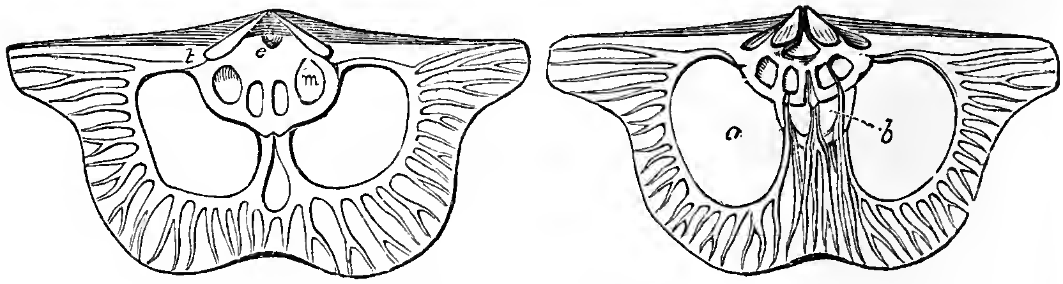


Fig. 149. *Ventral valve.* *Dorsal valve.*
Interior of S. analoga, Carb. limestone (after King).
e, foramen; *t*, teeth; *o*, ovarian spaces; *b*, brachial pits?

* The name *Strophomena* (rugosa) was originally given by Rafinesque to some unknown or imaginary fossil; it has, however, been adopted both in America and Europe for the group typified by *S. alternata* and *planumbona.*

There are no apparent brachial processes in the dorsal valve of *Strophomena,* and it is possible that the spiral arms may have been supported at some point near the centre of the shell (*b*) as in *Producta; S. rhomboidalis* occasionally exhibits traces of spiral arms, in the ventral valve. *S. latissima* Bouch. has plain areas, like *Calceola.*

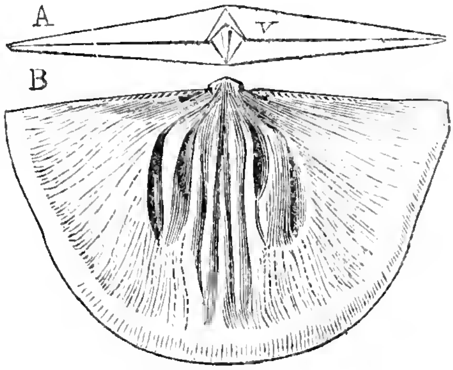


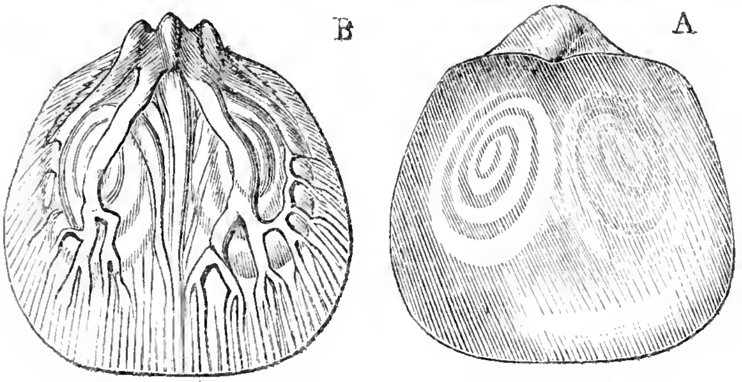
Fig. 150. *Leptæna.* $\frac{2}{1}$
A, hinge areas; v, ventral. B, interior of dorsal valve.

The valves of the Strophomenas are nearly flat until they approach their full growth, they then bend abruptly to one side; the dorsal valve becomes concave in S. alternata and rhomboidalis, whilst in S. planumbona and euglypha it becomes convex; these distinctions are not even sub-generic.

Fossil, 100 sp. L. Silurian — Carb. N. America, Europe, Thibet.

S. demissa, Conr. (Stropheodonta, Hall). *S. Dutertrii,* and several other species have a denticulated hinge-line.

Sub-genera ? *Leptæna* (part) Dalman. L. transversalis, fig. 150. (Plectambonites, Pander.) Valves regularly curved; dorsal concave, thickened, muscular impressions elongated. *Fossil,* L. Silurian —Lias. N. America, Europe. The lias Leptænas resemble *Thecidia* internally; they are free shells, with sometimes a minute foramen at the apex of the triangular deltidium; *L. liassina,* Pl. XV. fig. 25.



Fig, 145. *Producta ? Leonhardi,* $\frac{2}{1}$.*

Koninckia, Suess. Producta Leonhardi, Wissm. (*P. alpina,* Schl.) fig. 145. Trias, St. Cassian. *Shell* orbicular, concavo-convex, smooth; valves articulated ? closely appressed; ventral valve convex, dorsal concave; beak incurved, no hinge-area nor foramen ? interior of each valve furrowed by two spiral lines of four volutions, directed inwards, and crossing the vascular impressions; umbo with 3 diverging ridges. The small spiral cavities, once occupied by the arms, and now filled with spar, may be seen in specimens with both valves, by holding them to the light. Mr. Suess of Vienna states

* A, Translucent specimen; B, interior of dorsal valve.

that he has found traces of very slender spiral lamellæ occupying the furrows. This curious little shell most resembles the Triassic *Leptæna dubia* (Producta) Münster (= *Crania Murchisoni*, Klipst. !)

DAVIDSONIA, Bouchard.

Dedicated to the author of the Monograph of British Fossil Brachiopoda.

Type, D. Verneuili, Bouch. Fig. 151. Devonian, Eifel.

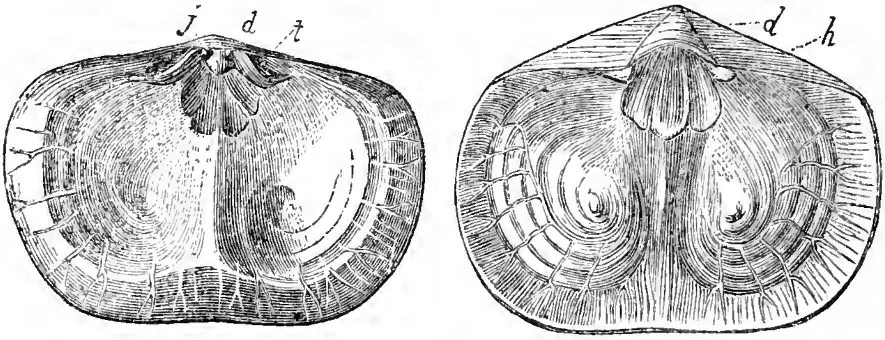


Fig. 151. *Dorsal valve.* *Ventral valve*, $\frac{2}{1}$.

Shell solid, attached by outer surface of the ventral valve to rocks, shells, and corals; valves plain, articulated; *ventral* valve with a wide area (*h*); foramen angular, covered by a convex deltidium (*d*): disk occupied by two conical elevations, obscurely grooved by a spiral furrow of 5-6 volutions; *dorsal valve* with two shallow lateral cavities; vascular impressions consisting of two principal sub-marginal trunks, in each valve, with diverging branches; cardinal and adductor impressions distinct. The furrowed cones undoubtedly indicate the existence of spiral arms, similar to those of *Atrypa* (fig. 144), but destitute of calcified supports. The mantle-lobes seem to have continued depositing shell until the internal cavity was reduced to the smallest possible limit.

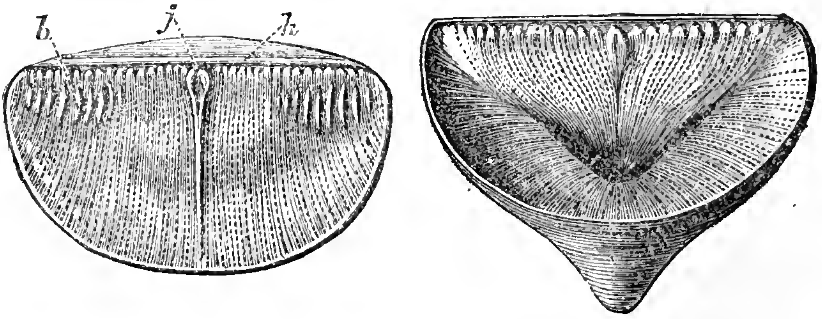


Fig. 152. *Dorsal valve.* *Ventral valve.*

? CALCEOLA, Lamarck.

Etym. Calceola, a slipper. *Type*, C. sandalina, Pl. XV. fig. 26. Fig. 152.

Shell thick, triangular; valves plain, not articulated: *ventral* valve pyramidal; area large, flat, triangular, with an obscure central line; hinge-line straight, crenulated, *dorsal* valve flat, semi-circular, with a narrow area (*h*), a small cardinal process (*j*), and two lateral groups of small apophysary (?) ridges (*b*); internal surface punctate-striate. *Fossil*, Devonian, Eifel, Brit.

The supposed Carboniferous species (*Hypodema*, D.K.) is, perhaps, related to *Pileopsis*. *Calceola* is shaped like *Cyrtia*, and its hinge-area resembles that of some Strophomenas.

FAMILY V. PRODUCTIDÆ.

Shell concavo-convex, with a straight hinge-line; valves rarely articulated by teeth; closely appressed, furnished with tubular spines; ventral valve convex; dorsal concave; internal surface dotted with conspicuous, funnel-shaped punctures; *dorsal* valve with a prominent cardinal process; brachial processes (?) sub-central; vascular markings lateral, broad and simple; adductor impressions dendritic, separated by a narrow central ridge; *ventral* valve with a slightly notched hinge-line; adductor scar central, near the umbo; cardinal impressions lateral, striated.

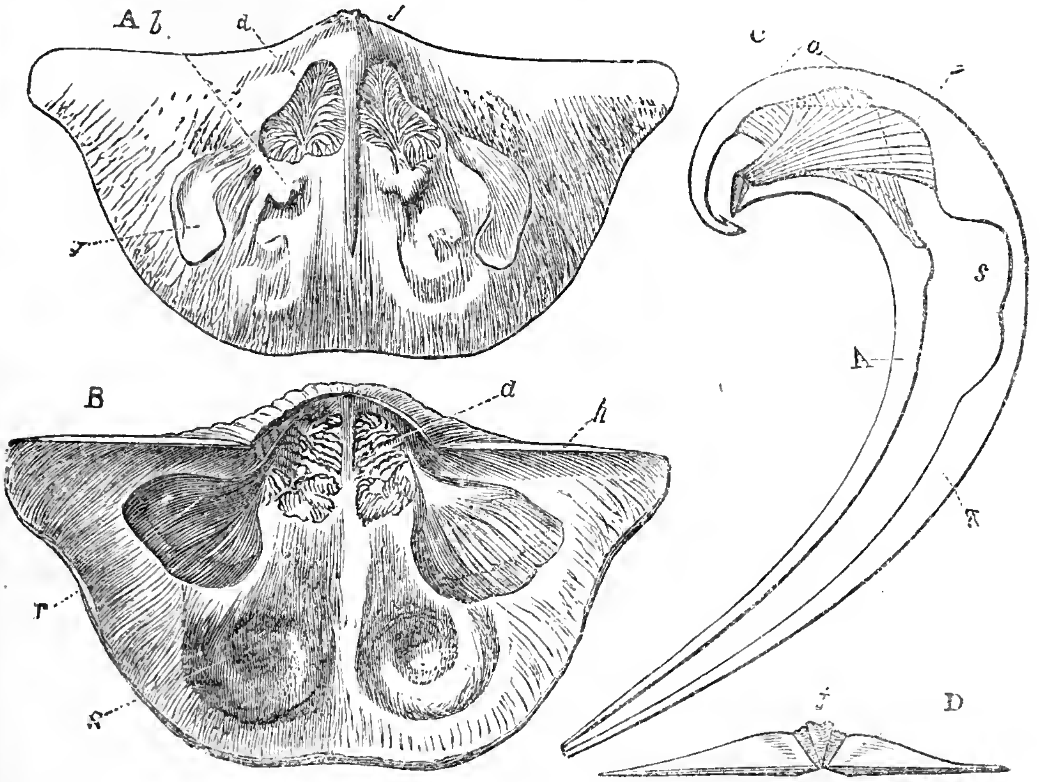


Fig. 153. *Producta gigantea*, ¼ *Carb. limestone.*

A, interior of dorsal valve; B, interior of ventral valve, with the umbo removed; C, ideal section of both valves; D, hinge-line of A; *j*, cardinal process; *a*, adductor; *r*, cardinal muscles; *b*, oral processes ?; *s*, hollows occupied by the spiral arms; *v*, vascular impressions; *h*, hinge-area.

PRODUCTA, Sowerby.

Type, P. gigantea, Sby, = *Anomia producta*, Martin.

Ex. P. horrida, Pl. XV. fig. 27. P. proboscidea, Pl. XV. fig. 28.

Shell free, auriculate, beak large and rounded; spines scattered; hinge area in each valve linear, indistinct; no hinge-teeth; cardinal process lobed, striated; vascular impressions simple, curved; ventral valve deep, with two rounded or sub-spiral cavities in front. These shells may have been attached by a pedicle when young, the impressions of the pedicle-muscle blending with those of the hinge-muscles (*c*) in the ventral valve. A few species appear to have been permanently fixed. *P. striata* is irregular in its growth, elongated and tapering towards the beak, and occurs in numbers packed closely together. *P. proboscidea* seems to have lived habitually in cavities, or half-buried in mud, as suggested by M. D'Orbigny; its ventral valve is prolonged several inches beyond the other, and has its edges rolled together and united, forming a large permanently open tube for the brachial currents. The large spines are most usually situated on the ears of the ventral valve, and may have served to moor the shell; being tubular they were permanently susceptible of growth and repair. Although edentulous, the dorsal valve must have turned on its long hinge-line with as much precision as in those genera which are regularly articulated by teeth.

Fossil, 60 sp. Devonian — Permian. N. and S. America, Europe, Spitzbergen, Thibet, Australia.

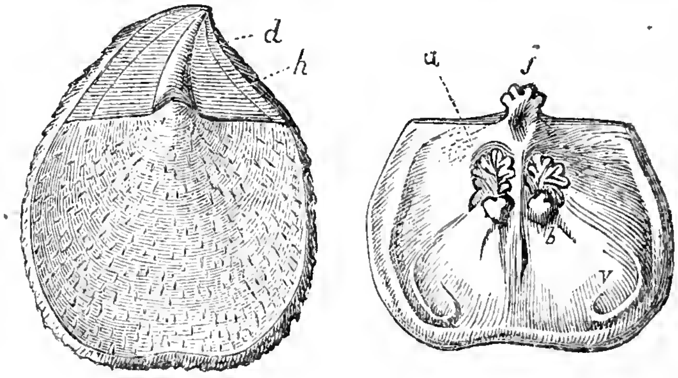


Fig. 154. *Exterior.* *Interior.*

Sub-genus, Aulosteges, Helmersen. A. Wangenheimii, Vern. fig. 154. Permian, Russia. *Shell* like Producta; ventral valve with a large flat triangular hinge-area (*h*), with a narrow convex pseudo-deltidium (*d*) in the centre: beak a little distorted, as if attached when young; dorsal valve slightly convex near the umbo; interior as in *Producta* (*longi-spina.*)

STROPHALOSIA, King.

Ex. S. Morrisii, King. fig. 155.

Syn. Orthothrix, Geinitz.

Shell attached by the umbo of the ventral valve; sub-quadrate; covered with long slender spines; valves articulated, dorsal moderately concave, ventral convex, each with a small area; fissure covered; vascular impressions conjoined, reniform.

Fossil, 8 sp. Devonian — Trias. Europe; Himalaya (Gerard).

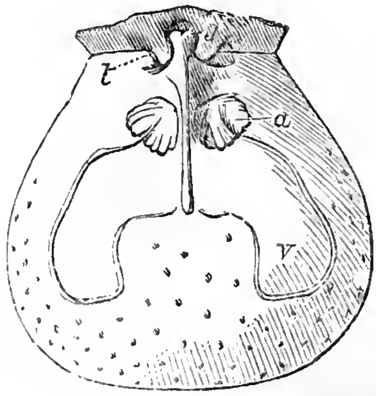


Fig. 155. *S. Morrisii.*

CHONETES, Fischer.

Ex. C. striatella, Pl. XV. fig. 29. *Etym.* *Chone,* a cup.

Shell transversely oblong, with a wide and straight hinge-line; area double; valves radiately striated, articulated; hinge-margin of ventral valve with a series of tubular spines; fissure covered; interior punctate-striate; vascular impressions (*v*) very small. (*Davidson*).

Fossil, 24 sp. Silurian — Carboniferous. Europe, N. America, Falkland Ids.

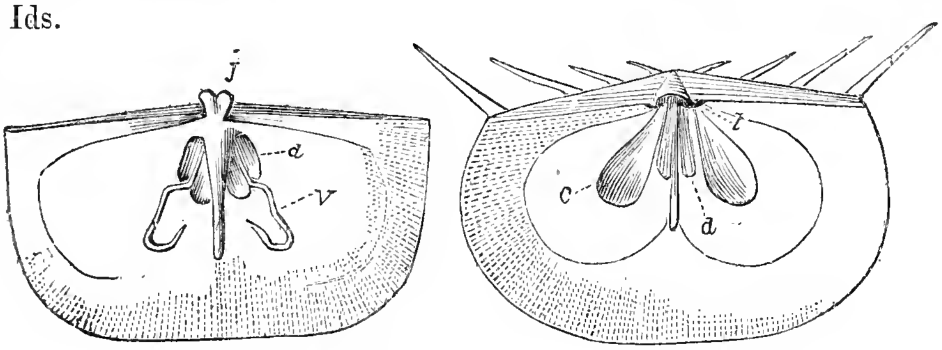


Fig. 156. *Dorsal valve.* *Ventral valve.**

FAMILY VI. CRANIADÆ.

Shell orbicular, calcarious, hinge-less; attached by the umbo, or whole breadth of the ventral valve, rarely free; dorsal valve limpet-like; interior of each valve with a broad granulated border; disk with four large muscular impressions, and digitated vascular impressions; structure punctate.

Animal with free spiral arms, directed towards the concavity of the dorsal valve, and supported by a nose-like prominence in the middle of the lower valve; mantle extending to the edges of the valves, and closely adhering, its margins plain. (Fig. 159.)

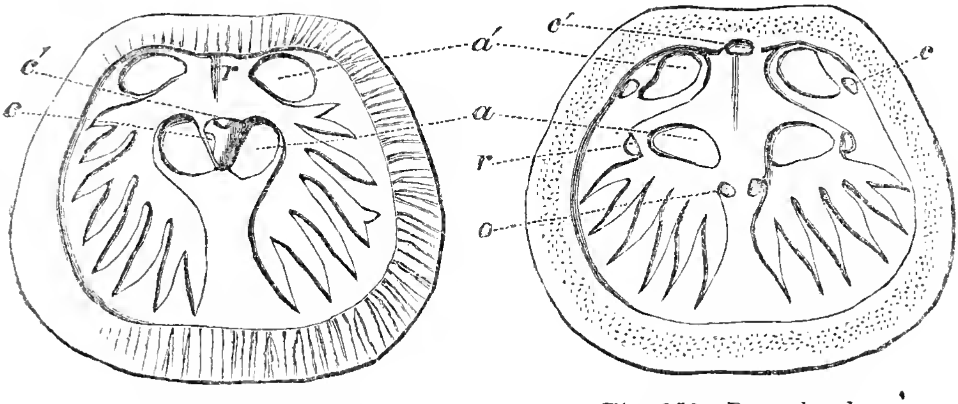


Fig. 157. *Ventral valve.* Fig. 158. *Dorsal valve.*

Crania anomala, Muller. $\frac{2}{1}$ *Zetland.*

a, anterior adductors; *a'*, posterior adductors; *c*, protractor sliding muscles; *c'*, cardinal muscle, *r*, *o*, retractor sliding muscles.

* Interiors of two sp. of *Chonetes* from Nehou and the Eifel, after Davidson; *a*, adductor: *c*, cardinals.

CRANIA, Retzius.

Etym. *Kraneia,* capitate. *Type,* Anomia craniolaris, L.

Ex. C. Ignabergensis, Pl. XV. fig. 30. C. anomala, figs. 157—159.

Syn. Criopus, Poli. Orbicula (anomala) Cuvier, = O. Norvegica, Lam.

Shell smooth or radiately striated; umbo of dorsal valve sub-central: of ventral valve sub-central, marginal, or prominent and cap-like, with an obscure triangular area traversed by a central line.

The large muscular impressions of the attached valve are sometimes convex, in other species deeply excavated; those of the upper valve are usually convex, but in *C. Parisiensis* the anterior (central) pair are developed as prominent diverging apophyses. In *C. tripartita,* Münster, the nasal process divides the fixed valve into three cells.*

C. Ignabergensis is equivalve, and either quite free or very slightly attached. *C. anomala* is gregarious on rocks and stones in deep water, both in the North Sea and Mediterranean (40—90 fathoms, *living;* 150 fms. *dead;* Forbes): the animal is orange-coloured, and its labial arms are thick, fringed with cirri, and disposed in a few horizontal gyrations (fig. 159.)

Distr. 5 sp. Spitzbergen, Brit. Medit. India, New S. Wales. — 150 fms.

Fossil, 28 sp. L. Silurian —. Europe.

C. antiquissima, Eichw. (Pseudo-crania M'Coy) is free, and has the internal border of the valves smooth; the branchial impressions blend in front. *Spondylobolus craniolaris,* M'Coy, is a small and obscure fossil, from the L. Silurian shale of Builth. The upper valve appears to have been like *Crania,* the lower to have had a small grooved beak, with blunt, tooth-like processes at the hinge-line.

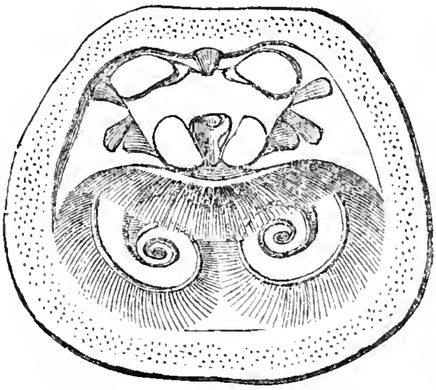


Fig. 159. *Crania.*†

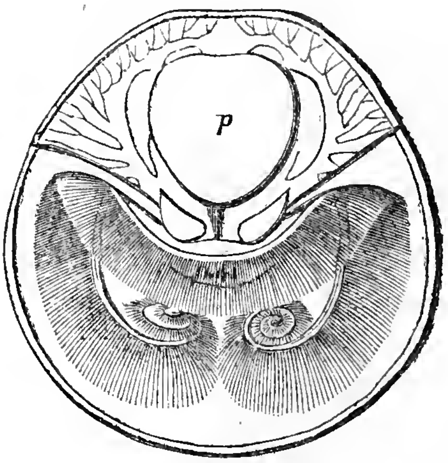


Fig. 160. *Discina.*‡

* M. Quenstedt has placed the Oolitic Cranias in *Siphonaria!*

† Dorsal valve with the animal, seen by removing the mantle.

‡ The animal as seen on the removal of part of the lower mantle-lobe; the extremities of the labial arms are displaced forwards, in order to show their spiral terminations: *p*, is the expanded surface of the pedicle; the mouth is concealed by the overhanging cirri. The mantle-fringe is not represented.

FAMILY VII. Discinidæ.

Shell attached by a pedicle, passing through a foramen in the ventral valve; valves not articulated; minutely punctate.

Animal with a highly vascular mantle, fringed with long horny setæ: oral arms curved backwards, returning upon themselves, and ending in small spires directed downwards, towards the ventral valve.

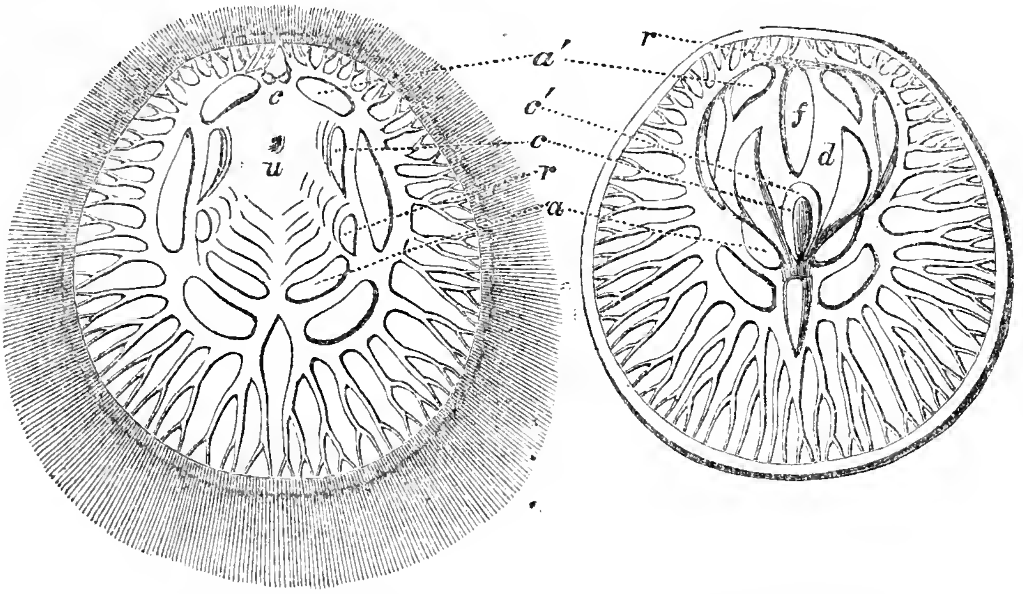


Fig. 161. *Dorsal.* Fig. 162. *Ventral lobe.*

Discina lamellosa, Brod. $\frac{2}{1}$.

u, umbo; *f*, foramen; *d*, disk; *a*, anterior adductors; *a'*, posterior adductors; *c*, *c'*, protractor sliding muscles; *r*, retractor muscles. The mantle-fringe is not represented in fig. 162.

Discina, Lamarck.

Syn. Orbicula, Sby (not Cuvier*). Orbiculoidea (elliptica) D'Orb.

Type, D. lamellosa, Pl. XV. fig. 31. (= D. ostreoides, Lam.)

Shell orbicular, horny; upper valve limpet-like, smooth or concentrically lamellose, apex behind the centre; lower valve flat or conical, with a sunk and perforated disk on the posterior side; interior polished; lower valve with a central prominence in front of the foramen.

Animal transparent; mantle lobes distinct all round; labial folds united, not extensile; alimentary canal simple, bent upon itself ventrally, and terminating between the mantle-lobes on the right side. There are four distinct adductor muscles, as in *Crania;* and the same number of sliding muscles, viz. two pairs for the protraction and two for the retraction of the dorsal valve, but some of these are probably inserted in the pedicle. The oral cirri are extremely tender and flexible, contrasting with the stiff and brittle setæ of the mantle, which are themselves more like the bristles of certain anne-

* The *Orbicula* of Cuvier was the *Patella anomala*, Müll (= Crania) as pointed out by Dr. Fleming, in the "History of British Animals," 1828.

lides (e. g. the sea-mouse, *Aphrodite*). The relation of the animal to the perforate and imperforate valves is shown to be the same as in *Terebratula*, by the labial fringe; but the only process which can *possibly* have afforded support to the oral arms, is developed from the centre of the ventral valve, as in *Crania*. Baron Ryckholt has represented a Devonian fossil from Belgium, with a fringed border; but if this shell is the *Crania obsoleta* of Goldfuss, the fringe must belong to the shell, and not to the mantle.

Distr. 7 sp. W. Africa, Malacca, Peru, Panama.

Fossil, 29 sp. Silurian —. Europe, U. States, Falkland Ids. The (27) Palæozoic and secondary species constitute the genus *Orbiculoidea,* D'Orb. (*Schizotreta,* Kutorga.) In some species the valves are equally convex, and the foramen occupies the end of a narrow groove.

Sub-genus, Trematis, Sharpe. (= Orbicella, D'Orb.) *T. terminalis,* Emmons. Valves convex, superficially punctate; dorsal valve with a thickened hinge-margin (and three diverging plates, indicated on casts; *Sharpe.*) *Fossil,* 14 sp. L. and U. Silurian. N. America, Europe.

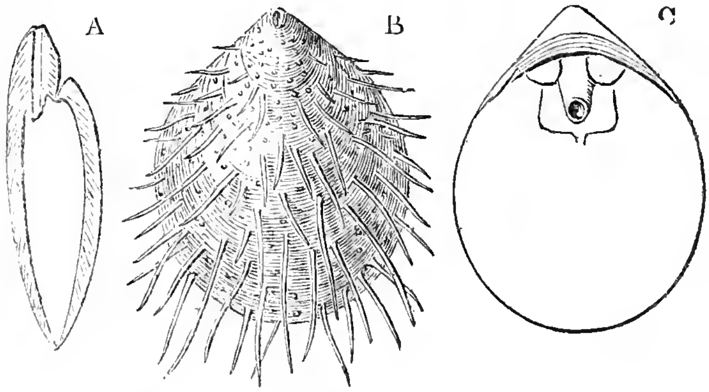


Fig. 163. Fig. 164. *Exterior.* Fig. 163, a, *Interior.*

SIPHONOTRETA, Verneuil.

Etym. *Siphon* a tube, *tretos* perforated.

Types, S. unguiculata, Eichw. fig. 163, 163, a. S. verrucosa, fig. 164.

Shell oval, bi-convex, slightly beaked, conspicuously punctate, or spiny; beak perforated by a tubular foramen; hinge-margins thickened; ventral valve with four close adductor scars surrounding the foramen. The spines are tubular, and open into the interior of the shell by prominent orifices. (*Carpenter.*) *S. anglica,* Morris, has moniliform spines.

Fossil, 6 sp. L. and U. Silurian. Brit. Bohemia, Russia.

? *Acrotreta* (sub-conica) Kutorga, L. Silurian, Russia. Shaped like *Cyrtia,* with an apical foramen; no hinge.

FAMILY VIII. LINGULIDÆ.

Shell oblong or orbicular, sub-equivalve, attached by a pedicle passing out between the valves; texture horny, minutely tubular.

Animal with a highly vascular mantle, fringed with horny setæ; oral arms thick, fleshy, spiral, the spires directed inwards, towards each other; valves opened and closed by sliding muscles.

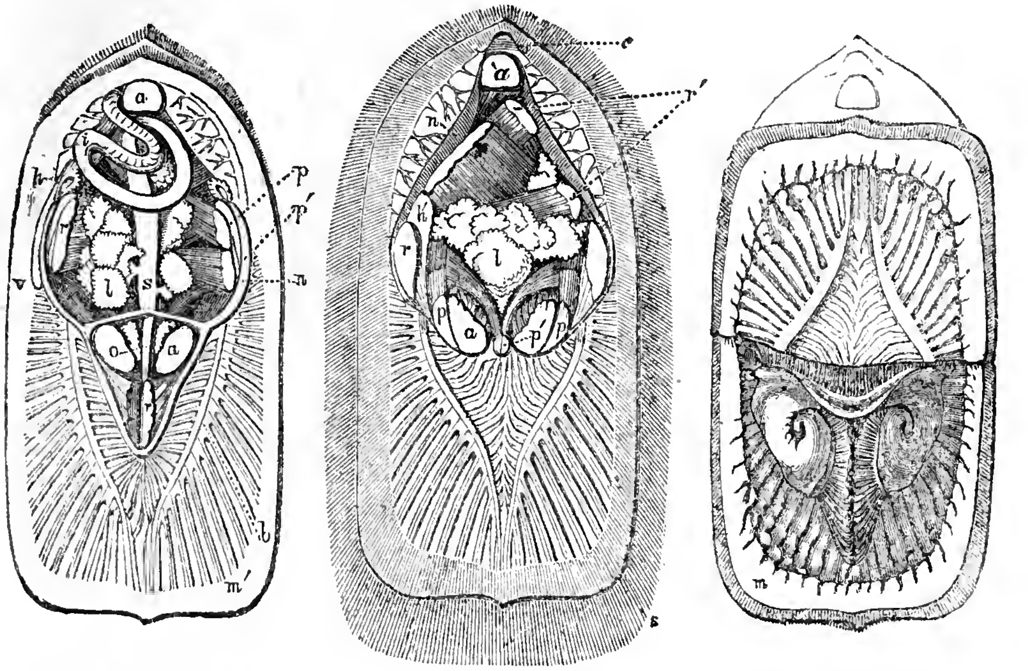


Fig. 165. *Dorsal.** 166. *Ventral.* 167. *Ventral.*

Lingula anatina, Lam (original). *Syn.* Patella unguis, L. (part.)

a a, anterior adductors; *a'*, posterior adductor; *p p*, external protractors; *p'p'*, central protractors; *r r*, anterior retractors; *r'r'r'*, posterior retractors; *c*, capsule of pedicle; *n n*, visceral sheath; *o*, œsophagus; *s*, stomach; *l*, liver; *i*, intestine; *v*, vent; *h h*, auricles; *h'*, left ventricle; *b*, branchial vessels; *m'*, mantle margin; *m*, inner lamina of mantle-margin retracted, showing bases of setæ; *s*, setæ.

LINGULA, Bruguière.

Etym. Lingula, a little tongue. *Type*, L. anatina, Pl. XV. fig. 32.

Shell oblong, compressed, slightly gaping at each end, truncated in front, rather pointed at the umbones; dorsal valve rather shorter, with a thickened hinge-margin, and a raised central ridge inside.

Animal with the mantle-lobes firmly adhering to the shell, and united to the epidermis, their margins distinct, and fringed all round; branchial veins giving off numerous free, elongated, narrow loops from their inner surfaces; visceral cavity occupying the posterior half of the shell, and surrounded by a strong muscular sheath; pedicle elongated, thick; adductor muscles 3, the posterior pair combined; two pairs of retractors, the posterior pair unsym-

* In fig 165 a small portion of the liver and visceral sheath have been removed, to show the course of the stomach and intestine. In some specimens the whole of the viscera, except a portion of the liver, are concealed by the ovaries. In fig. 167, the front half of the ventral mantle-lobe is raised, to show the spiral arms; the black spot in the centre is the mouth, with its upper and lower lips, one fringed, the other plain. The mantle-fringe has been omitted in figs. 165-7.

metrical, one of them dividing; protractor sliding muscles, two pairs; stomach long and straight, sustained by inflections of the visceral sheath; intestine convoluted dorsally, terminating between the mantle-lobes on the right side; oral arms disposed in about six close whirls, their cavities opening into the prolongation of the visceral sheath in front of the adductors.

Observations on the living Lingula are much wanted; the oral arms probably extended as far as the margins of the shell; and the pedicle, which is often nine inches long in preserved specimens, is doubtless much longer, and contractile when alive. The shell is horny and flexible, and always of a greenish colour.

Distr. 7 sp. India, Philippines, Moluccas, Australia, Feejees, Sandwich Ids. W. America.

Fossil, 34 sp. L. Silurian —. N. America, Europe, Thibet.

Lingulæ existed in the British Seas as late as the period of the Coralline Crag. The recent species have been found at small depths, and even at low-water half buried in sand. *L. Davisii*, L. Silurian, Tremadoc, has a pedicle-groove like *Obolus*, fig. 168. (Salter).

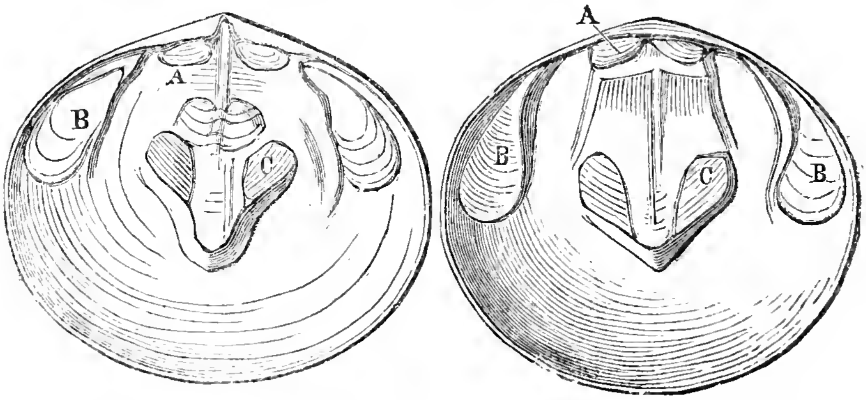


Fig. 168. *Ventral valve.* Fig. 169. *Dorsal valve.*
Obolus Davidsoni (Salter). Wenlock limestone, Dudley.
A, posterior adductors; B, sliding muscles; C, Anterior adductors.
The *pedicle-scar* in the centre of fig. 168 has no letter.

Obolus, Eichwald.

Syn. Ungula, Pander; Aulonotreta, Kutorga.

Etym. *Obolus*, a small Greek coin. *Type*, O. Apollinis, Eichw.

Shell orbicular, calcario-corneous, depressed, sub-equivalve, smoot; hinge-margin thickened inside, and slightly grooved in the ventral valve; posterior adductor impressions separate; anterior pair sub-central; impressions of sliding-muscles lateral. Fig. 168, 169 (after Davidson.)

Fossil, 4 sp. L. and U. Silurian. Sweden, Russia, England, U. States.

CLASS V. CONCHIFERA, Lamarck.

(*Lamelli-branchiata*, Blainville.)

The bivalve shell-fish, or *Conchifera*, are familiar to every one, under the form of oysters, scallops, mussels, and cockles.* They come next to the univalves (*gasteropoda*) in variety and importance, and though less numerous specifically, are far more abundant individually.† The bivalves are all aquatic, and excepting a few widely-dispersed and prolific genera, are all inhabitants of the sea; they are found on every coast, and in every climate, ranging from low-water mark to a depth of more than 200 fathoms.

In their native element the Oyster and Scallop lie on one side, and the lower valve is deeper and more capacious than the upper; in these the foot is wanting, or else small, and not used for locomotion. Most other bivalves live in an erect position, resting on the edges of their shells, which are of equal size. Those which move about much, like the river-mussel, maintain themselves nearly horizontally,‡ and their keel-shaped foot is adapted for ploughing through sand or mud. The position of those bivalves which live half-buried in river-beds or at the bottom of the sea, is often indicated by the darker colour of the part exposed; or by deposits of tufa, or the growth of sea-weed on the projecting ends of the valves.

In *Nucula* and some others the foot is deeply cleft, and capable of expanding into a disk, like that on which the snails glide: whilst in the mussel, pearl-oyster, and others which habitually spin a *byssus*, the foot is finger-like and grooved.

The burrowing species have a strong and stout foot with which they bore vertically into the sea-bed, often to a depth far exceeding the length of their valves; these never voluntarily quit their abodes, and often become buried and fossilized in them. They most usually burrow in soft ground, but also in coarse gravel, and firm sands and clays; one small *modiola* makes its hole in the cellulose tunic of Ascidians, and another in floating blubber.

The boring shell-fish have been distinguished from the mere burrowers, perhaps without sufficient reason, for they are found in substances of every degree of hardness, from soft mud to compact limestone, and the method employed is probably the same.§

The means by which bivalves perforate stone and timber has been the subject of much inquiry, both on account of its physiological interest, and the desire to obtain some remedy for the injuries done to ships and piers and breakwaters. The ship-worm (*teredo*) and some allied genera, perforate timber only; whilst the *pholas* bores into a variety of materials, such as

* They are the *Dithyra* of Aristotle and Swainson, and constitute the second or sub-typical group in the quinary system.

† It has been stated that the predatory *mollusca* are more numerous than the vegetable-feeders; but it is not so with the individuals constituting the species.

‡ This is the position in which they are always figured in English books, being best suited for the comparison of one shell with another.

§ See the admirable memoir by Mr. Albany Hancock, in the An. Nat. Hist. for October, 1848.

chalk, shale, clay, soft sandstone and sandy marl, and decomposing *gneiss*;* it has also been found boring in the peat of submarine forests, in wax, and in amber.† It is obvious that these substances can only be perforated alike by *mechanical* means; either by the foot or by the valves, or both together, as in the burrowing shellfish. The *pholas* shell is rough, like a file, and sufficiently hard to abrade limestone; and the animal is able to turn from side to side, or even quite round in its cell, the interior of which is often annulated with furrows made by the spines on the front of the valves. The foot of the *pholas* is very large, filling the great anterior opening of the valves; that of the ship-worm is smaller, but surrounded with a thick collar, formed by the edges of the mantle, and both are armed with a strong *epithelium.* The foot appears to be a more efficient instrument than the shell in one respect, inasmuch as its surface may be renewed as fast as it is worn away.‡ (*Hancock.*)

The mechanical explanation becomes more difficult in the case of another set of shells, *lithodomus, gastrochæna, saxicava,* and *ungulina,* which bore only into calcarious rocks, and attack the hardest marble, and still harder shells (fig. 25, p. 42). In these the valves can render no assistance, as they are smooth, and covered with *epidermis;* neither does the foot help, being small and finger-like, and not applied to the end of the burrow. Their power of movement also is extremely limited, their cells not being cylindrical, whilst one of them, *saxicava,* is fixed in its crypt by a *byssus.* These shell fish have been supposed to dissolve the rock by chemical means (*Deshayes*), or else to wear it away with the thickened anterior margins of the mantle. (*Hancock.*) §

The holes of the *lithodomi* often serve to shelter other animals after the

* There is a specimen from the coast of France, in the Brit. Museum.

† Highgate resin, in the cabinet of Mr. Bowerbank.

‡ The final polish to some steel goods is said to be given by the *hands* of work-women. In Carlisle Castle they point to the rude impression of a hand on the dungeon wall, as the work of Fergus M'Ivor, in the two years of his solitary imprisonment.

§ All attempts to detect the presence of an acid secretion have hitherto failed, as might be expected; for the hypothesis of an acid solvent supposes only a very feeble but continuous action, such as in nature always works out the greatest results in the end. See Liebig's Organic Chemistry, and Dumas and Boussingault on the "Balance of Organic Nature." Intimately connected with this question are several other phenomena; the removal of portions of the interior of univalves, by the animal itself, as in the genera *Conus, Auricula,* and *Nerita* (fig. 24, p. 40); the perforation of shells by the tongues of the carnivorous gasteropods and the formation of holes in wood and limestone by limpets. Some facts in surgery also illustrate this subject, (1) dead bone is removed when granulations grow into contact with it: (2) if a hole is bored in a bone, and an ivory peg driven into it, and covered up, so much of the peg as is imbedded in the bone will be removed. (*Paget.*) The "absorption" of the fangs of milk-teeth, previous to shedding, is well-known. In these cases the removal of the bone earth is effected without the development of an acid, or other disturbance of the neutral condition of the circulating fluid.

death of the rightful owners; species of *Modiola, Arca, Venerupis,* and *Coralliophaga,* both recent and fossil, have been found in such situations, and mistaken for the real miners.*

The boring shellfish have been called "stone-eaters" (*lithophagi*) and "wood-eaters" (*xylophagi*), and some of them at least are obliged to swallow the material produced by their operations, although they may derive no sustenance from it. The ship-worm is often filled with pulpy, impalpable sawdust, of the colour of the timber in which it worked. (*Hancock.*) No shellfish deepens or enlarges its burrow after attaining the full-growth usual to its species (p. 43).

The bivalves live by filtering water through their gills.† Whatever particles the current brings, whether organic or inorganic, animal or vegetable, are collected on the surface of the breathing-organ and conveyed to the mouth. In this manner they help to remove the impurities of turbid water.‡ The mechanism by which this is effected may be most conveniently examined in a bivalve with a closed mantle, like the great *Mya* (fig. 170), which lives in the mud of tidal rivers, with only the ends of its long combined siphons exposed at the surface.§ The siphons can be extended twice the length of the shell, or drawn completely within it; they are separated, internally, by a thick muscular wall. The branchial siphon (*s*) has its orifice surrounded by a double fringe; the exhalent siphon (*s'*) has but a single row of tentacles; these organs are very sensitive, and if rudely touched the orifices close and the siphon itself is rapidly withdrawn. When unmolested, a current flows steadily into the orifice of the branchial siphon, whilst another current rises up from the exhalent tube. There is no other opening in the mantle except a small slit in front (*p*) through which the foot is protruded. The body of the animal occupies the centre of the shell (*b*), and in front of it is the mouth (*o*) furnished with an upper and a lower lip, which are prolonged on each side into a pair of large membranous palpi (*t*). The gills (*g*) are placed two on each side of the body, and are attached along their upper, or dorsal margins; behind the body they are united to each other and to the siphonal partition. Each gill is composed of two laminæ, divided internally into a series

* Fossil univalves (*trochi*) occupying the burrows of a *pholas*, were discovered by Mr. Bensted in the Kentish-rag of Maidstone. See Mantell's Medals of Creation. M. Buvignier has found several species of *Arca* fossilized in the burrows of *lithodomi.*

† It seems scarcely necessary to remark that the bivalves do not feed upon prey caught between their valves. Microscopists are well aware that sediment taken from the alimentary canal of bivalve shellfish contains the skeletons of animalcules and minute vegetable organisms, whose geometrical forms are remarkably varied and beautiful; they have also been obtained (in greater abundance than ordinary) from mud filling the interior of fossil oyster-shells.

‡ When placed in water coloured with indigo, they will in a short time render it clear, by collecting the minute particles and condensing them into a solid form.

§ Alder and Hancock on the branchial currents of *Pholas* and *Mya*. An. Nat. Hist. Nov. 1851.

of parallel tubes, indicated outside by transverse lines; these tubes open into longitudinal channels at the base of the gills, which unite behind the posterior adductor muscle at the commencement of the exhalent siphon (*c*). Examined by the microscope, the gill laminæ appear to be a network of blood-vessels whose pores opening into the gill-tubes, are fringed with vibratile *cilia.* These microscopic organs perform most important offices; they create the currents of water, arrest the floating particles, and mould them, mixed with the viscid secretion of the surface, into threads, in the furrows of the gill, and propel them along the grooved edge of its free margin, in the direction of the mouth; they are then received between the palpi in the form of ravelled threads. (*Alder* and *Hancock.*)

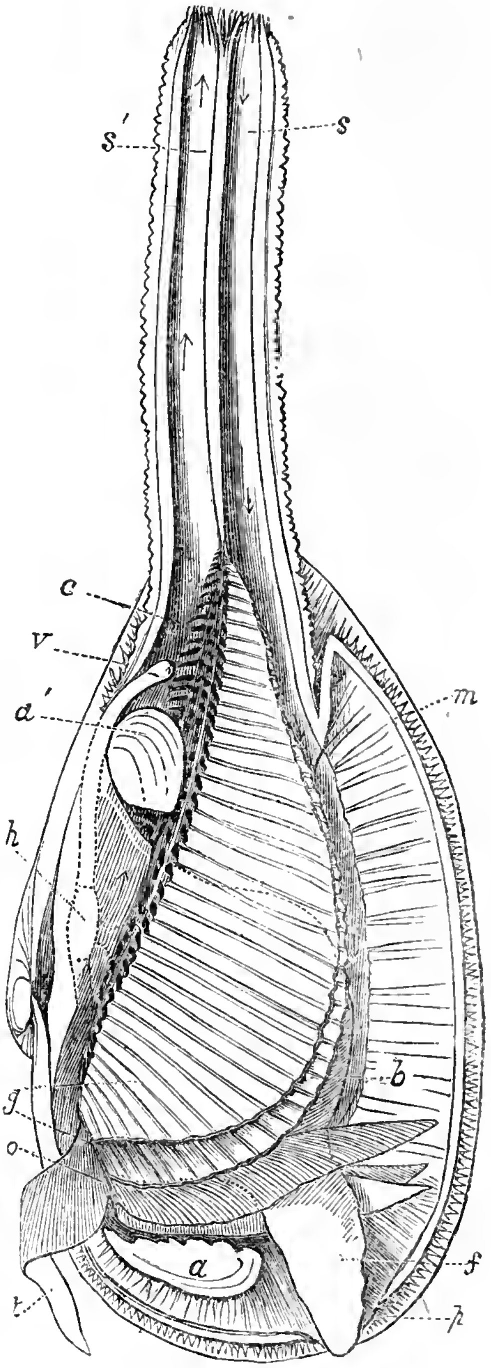


Fig. 170. *Mya arenaria.**

In *Mya*, therefore (and in other burrowers), the cavity of the shell forms a closed branchial chamber, and the water which enters it by the respiratory siphon can only escape by passing through the gills into the dorsal channels, and so into the exhalent siphon. In the river-mussel the gills are not united to the body, but a slit is left by which water might pass into the dorsal channel, were it not for the close apposition of the parts under ordinary circumstances (fig. 171, *b*). The gills of the oyster are united throughout, by their bases, to each other and to the mantle, completely separating the branchial cavity from the *cloaca.* In *Pecten* the gills and mantle are free, but the "dorsal channels" still exist, and carry out the filtered water.

* *Mya arenaria*, L. (original, from specimens obtained at Southend, and communicated by Miss Hume). The left valve and mantle lobe and half the siphons are removed. *a, a'*, adductor muscles; *b*, body; *c*, cloaca; *f*, foot; *g*, branchiæ; *h*, heart; *m*, cut edge of the mantle; *o*, mouth; *s, s'*, siphons; *t*, labial tentacles; *v*, vent. The arrows indicate the direction of the currents; the four rows of dots at the base of the gills are the orifices of the branchial tubes, opening into the dorsal channels.

In some genera the gills subserve a third purpose; the oviducts open into the dorsal channels, and the eggs are received into the gill-tubes and retained there until they are hatched. In the river-mussel the outer gills only receive the eggs, with which they are completely distended in the winter months (Fig. 171, *o*, *o*). In *Cyclas* the inner gills form the *marsupium*, and only from 10 to 20 of the fry are found in them at one time; these remain until they are nearly a quarter the length of the parent.*

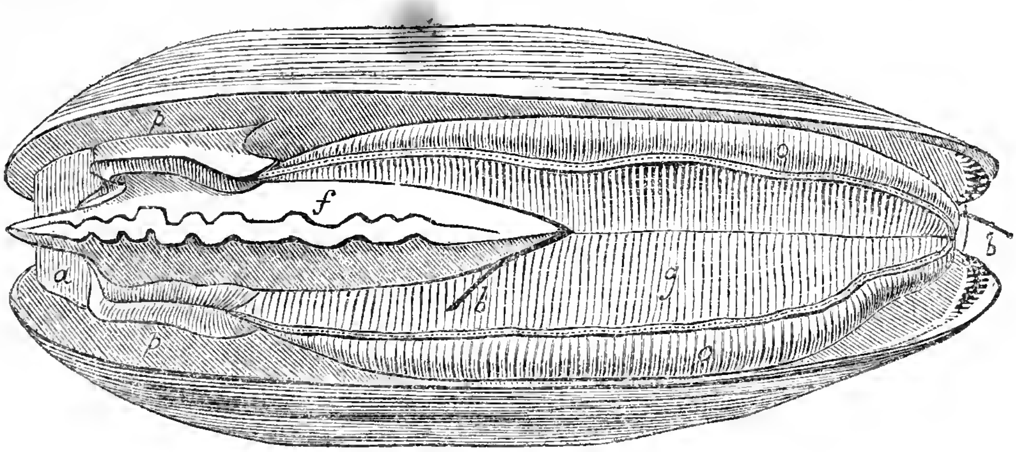


Fig. 171. River-mussel. (*Anodon cygneus* ♀)†

The *valves of the Conchifera* are bound together by an elastic *ligament*, and articulated by a hinge furnished with interlocking teeth. The shell is closed by powerful adductor muscles, but opens spontaneously by the action of the ligament, when the animal relaxes, and after it is dead.

Each valve is a hollow cone, with the apex turned more or less to one side; the apex is the point from which the growth of the valve commences, and is termed the beak, or *umbo* (p. 37.). The beaks (*umbones*) are near the hinge, because that side grows least rapidly, sometimes they are quite marginal; but they always tend to become wider apart with age. The beaks are either straight, as in *Pecten;* curved as in *Venus;* or spiral, as in *Isocardia* and *Diceras.* In the latter case each valve is like a spiral univalve, especially those with a large aperture and small spire, such as *Concholepas*; it is the left valve which resembles the ordinary univalve, the right valve being a *left-handed spiral* like the reversed gasteropods. When one valve is spiral and the other flat, as in *Chama ammonia* (fig. 185), the resemblance to an operculated spiral univalve becomes very striking (see p. 47).

* Some other particular respecting the organization and development of bivalve shell-fish are given in the introductory chapter. For an account of their vascular system see Milne-Edwards, An. Sc. Nat. 1847, Tom. VIII. p. 77.

† The valves are forcibly opened and the foot (*f*) contracted; *a*, anterior adductor-muscle, much stretched; *p*, *p*, palpi; *g*, inner gills; *o*, *o*, outer gills distended with spawn; *b*, *b*, a bristle passed through one of the dorsal channels.

The relation of the shell to the animal may be readily determined, in most instances, by the direction of the *umbones*, and the position of the ligament. The umbones are turned towards the front, and the ligament is posterior; both are situated on the back, or dorsal side of the shell. The *length* of a bivalve is measured from the anterior to the posterior side, its *breadth* from the dorsal margin to the base, and its *thickness* from the centres of the closed valves.*

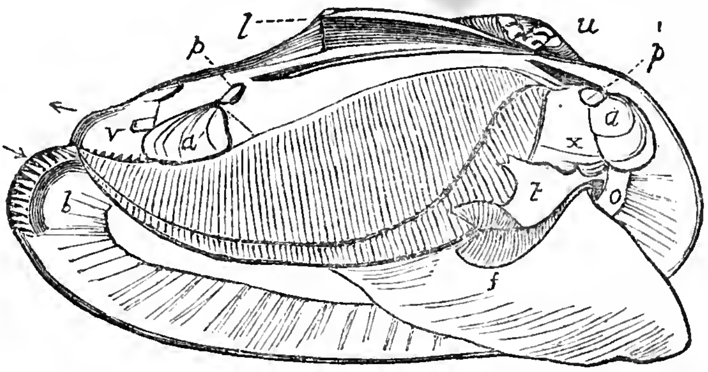


Fig. 172. *Unio pictorum*, L. (original) with the right valve and mantle-lobe removed; *a*, *a*, adductor muscles; *p*. *p*, pedal muscles; *x*, accessory pedal muscle; *u*, umbo; *l*, ligament; *b*, branchial orifice; *v*, anal opening; *f*, foot; *o*, mouth; *t*, palpi.

The *Conchifera* are mostly *equivalve*, the right and left valves being of the same size and shape, except in the *Ostreidæ* and a few others. In *Ostrea*, *Pandora* and *Lyonsia* the right valve is smallest; in *Chamostrea* and *Corbula*, the left; whilst the *Chamaceæ* follow no rule in this respect.

The bivalves are all more or less *inequilateral*, the anterior being usually much shorter than the posterior side. *Pectunculus* is nearly equilateral, and in *Glycimeris* and *Solemya*, the anterior is much longer than the posterior side The front of the smaller Pectens is shewn by the byssal notch; but in the large scallops, oysters and *Spondyli*, the only indication of the position of the animal is afforded by the large internal muscular impression, which is on the *posterior* side. The ligament is sometimes between the umbones, but is never anterior to them. The *siphonal impression*, inside the shell, is always posterior.

Bivalves are said to be *close*, when the valves fit accurately, and *gaping*

* Linnæus and the naturalists of his school, described the front of the shell as the back, the left valve as the right, and *vice versa*. In those works which have been compiled from "original descriptions" (instead of specimens) sometimes one end, sometimes the other, is called *anterior;* and the *length* of the shell is sometimes estimated in the direction of the length of the animal, but just as frequently in a line at right angles to it.

when they cannot be completely shut. In *Gastrochæna* (Pl. XXIII. fig. 15,) the opening is anterior, and serves for the passage of the foot; in *Mya* it is posterior and siphonal; in *Solen* and *Glycimeris* both ends are open. In *Bysso-arca* (Pl. XVII. fig, 13,) there is a ventral opening formed by corresponding notches in the margin of the valves, which serves for the passage of the byssus; in *Pecten*, *Avicula*, and *Anomia*, (fig. 176 *s*) the byssal notch (or *sinus*) is confined to the right valve.

The *surface* of bivalve shells is often ornamented with ribs which *radiate* from the umbones to the margin, or with *concentric* ridges, which coincide with the lines of growth. Sometimes the sculpturing is oblique, or wavy; in *Tellina fabula* it is confined to the right valve. In many species of *Pholas*, *Teredo* and *Cardium* the surface is divided into two areas by a transverse furrow, or by a change in the direction of the ribs. The *lunule* (see fig. 14, p. 26,) is an oval space in *front* of the beaks; it is deeply impressed in *Cardium retusum*, L. *Astarte excavata* and the genus *Opis*. When a similar impression exists behind the beaks it is termed the *escutcheon*.*

The *ligament* of the *Conchifera* forms a substitute for the muscles by which the valves of the *Brachiopoda* are opened. It consists of two parts, the ligament properly so called, and the *cartilage*; they exist either combined or distinct, and sometimes one is developed and not the other. The external ligament is a horny substance, similar to the *epidermis* which clothes the valves; it is usually attached to ridges on the posterior hinge-margins, behind the umbones, and is consequently stretched by the closing of the valves. The ligament is large in the river-mussels, and small in the Mactras and Myas, which have a large internal cartilage; in *Arca* and *Pectunculus* the ligament is spread over a flat, lozenge-shaped area, situated between the umbones, and furrowed with cartilage grooves. In *Chama* and *Isocardia* the ligament splits in front, and forms a spiral round each umbo. The *Pholades* have no ligament, but the anterior adductor is shifted to such a position on the hinge-margin that it acts as a hinge-muscle. (Pl. XXIII, fig. 13.)

The internal ligament, or *cartilage*, is lodged in furrows formed by the ligamental plates, or in pits along the hinge-line; in *Mya* and *Nucula* it is contained in a spoon-shaped proeess of one or both valves. It is composed of elastic fibres placed perpendicularly to the surfaces between which it is contained, and is slightly iridescent when broken; it is compressed by the closing of the valves, and tends forcibly to open them as soon as the pressure of the muscles is removed. The name *Amphidesma* (double ligament) was given to certain bivalves, on the supposition that the separation of the carti-

* Only those technical terms which are used in a *peculiar sense* are here referred to; for the rest, any Dictionary may be consulted, especially *Roberts's Etymological Dictionary of Geology*, by Longman and Co.

lage from the ligament was peculiar to them. The cartilage-pit of many of the *Anatinidæ* is furnished internally with a moveable ossicle.

The ligament is frequently preserved in fossil shells, such as the great Cyprinas and Carditas of the London Clay, the Unios of the Wealden, and even in some lower Silurian bivalves.

All bivalves are clothed with an *epidermis* (*v.* p. 40) which is organically connected with the margin of the mantle. It is developed to a remarkable extent in *Solemya* and *Glycimeris* (Pl. XXII. fig. 13, 17), and in *Mya* it is continued over the siphons and closed mantle-lobes, making the shell appear *internal.*

The *interior* of bivalves is inscribed with characters borrowed directly from the shell-fish, and affording a surer clue to its affinities than those which the exterior presents. The structure of the *hinge* characterizes both families and genera, whilst the condition of the respiratory and locomotive organs may be to some extent inferred from the muscular markings.

The margin of the shell on which the ligament and teeth are situated, is termed the *hinge-line.* It is very long and straight in *Avicula* and *Arca,* very short in *Vulsella,* and curved in most genera. The locomotive bivalves have *generally* the strongest hinges, but the most perfect examples are presented by *Arca* and *Spondylus.* The central teeth, those immediately beneath the *umbo,* are called hinge (or *cardinal*) teeth; those on each side are *lateral* teeth. Sometimes lateral teeth are developed, and not cardinal teeth (*Alasmodon; Kellia*): more frequently the hinge-teeth alone are present. In young shells the teeth are sharp and well-defined; in aged specimens they are often thickened, or even obliterated by irregular growth (*Hippopodium*) or the encroachment of the hinge-line (*Pectunculus*). Many of the fixed and boring shells are *edentulous.**

The *muscular impressions* are those of the adductors, the foot and byssus, the siphons, and the mantle (see p. 26.)

The *adductor impressions* are usually simple, although the muscles themselves may be composed of two elements,† as in *Cytherea chione* (fig. 14, p. 26) and the common oyster. The impression of the posterior adductor in *Spondylus* is double (Pl. XVI. fig. 15). In *Pecten varius* (fig. 173, *a, a,*) large independent impressions are formed by the two portions of the adductor, and in the *left* valve there is a third impression (*p*) produced by the foot, which in the byssiferous pectens is a simple conical muscle with a broad base.

* The dentition of bivalve shells may be stated thus:—cardinal teeth, 2.3 or $\frac{2}{3}$ —meaning 2 in the *right* valve, 3 in the *left;* lateral teeth 1—1, 2—2, or 1 anterior and 1 posterior in the *right* valve, 2 anterior and 2 posterior lateral teeth in the left valve.

† Compare the shell of *modiola,* Pl. XVII. fig. 5, with the woodcut, fig. 177.

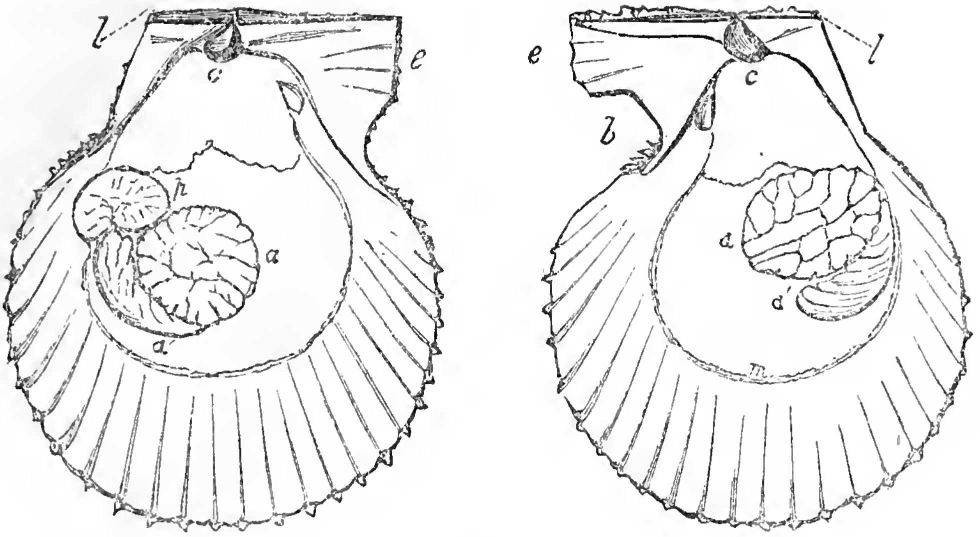


Fig. 173. *Left valve*. (*Pecten varius*): *Right valve*.
a, a, adductor; *p,* pedal impression; *m,* pallial line: *l,* ligamental margin; *c, c,* cartilage; *e, e,* anterior ears; *b.* byssal sinus.

In the *left* valve of *Anomia* there are four distinct muscular impressions (fig. 175). Of these, the small posterior spot alone is produced by the *adductor,* and corresponds with the solitary impression in the right valve.

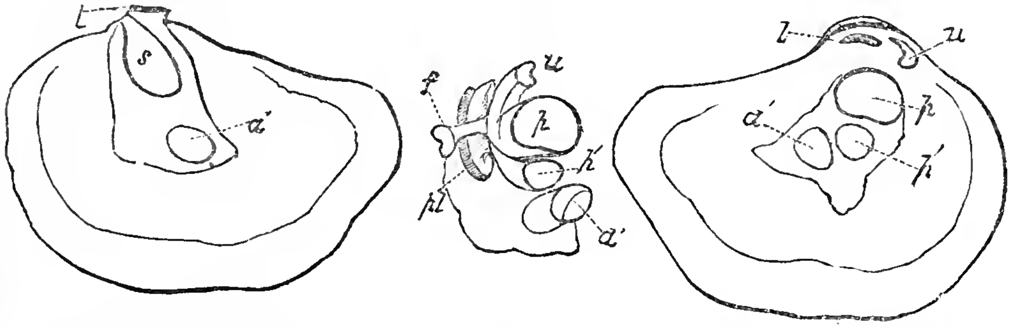


Fig. 176. *Right valve.* Fig. 174. Fig. 175. *Left valve.**

The adductor itself (fig. 174 *a'*) is double. The large central impression (*p*) is produced by the muscle of the *plug* (the equivalent of the *byssal* muscle in *Pinna* and *Modiola*). The small impression within the umbo (*u*) and the third impression in the disk (*p'*) (wanting in *Placunomia*) are caused by the retractors of the foot.

The term *monomyary,* employed by Lamarck to distinguish the bivalves with one adductor, applies only to the *Ostreidæ,* part of the *Aviculidæ,* and to the genera *Tridacna* and *Mülleria.*

The *dimyary* bivalves have a second adductor, near the anterior margin,

* Fig. 176. Right valve of *Anomia ephippium,* L. *l,* ligamental process; *s,* sinus. Fig. 175, Left valve; *l,* ligament pit. Fig. 174. Muscular system, from a drawing communicated by A. Hancock, Esq. *f,* the foot; *pl,* the plug. The muscle *p* is generally described as a portion of the *adductor;* but it is certain, from a comparison of this shell with *Carolia* and *Placuna,* that *a'* represents the entire adductor, and *p* the byssal muscle.

which is small in *Mytilus* (fig. 30), but large in *Pinna*. The *retractor* muscles of the foot (already alluded to at p. 26) have their fixed points near those of the adductors; the anterior pair are attached within the umbones (fig. 177, *u*, *u*,) or nearer the adductor, as in *Astarte*, and *Unio* (fig. 172). The posterior pair (*p' p'*) are often close to the adductor, and leave no separate impression. The *Unionidæ* have two additional retractors of the foot, attached laterally behind the anterior adductors; in *Leda*, *Solenella*, and a few others, this lateral attachment forms a line extending from the anterior adductor backwards into the umbonal region of the shell. (See Pl. XVII. fig. 21, 22.)

In those shellfish like *Pinna* and the mussel, which are permanently moored by a strong *byssus*, the foot (*f*) serves only to mould and fix the threads of which it is formed. The fibres of the foot-muscles pass chiefly to the byssus (*b*), and besides these two additional muscles (*p*, *p*) are developed. In *Pinna*, *Modiola* and *Dreissena* the byssal muscles are equal to the great adductors in size.

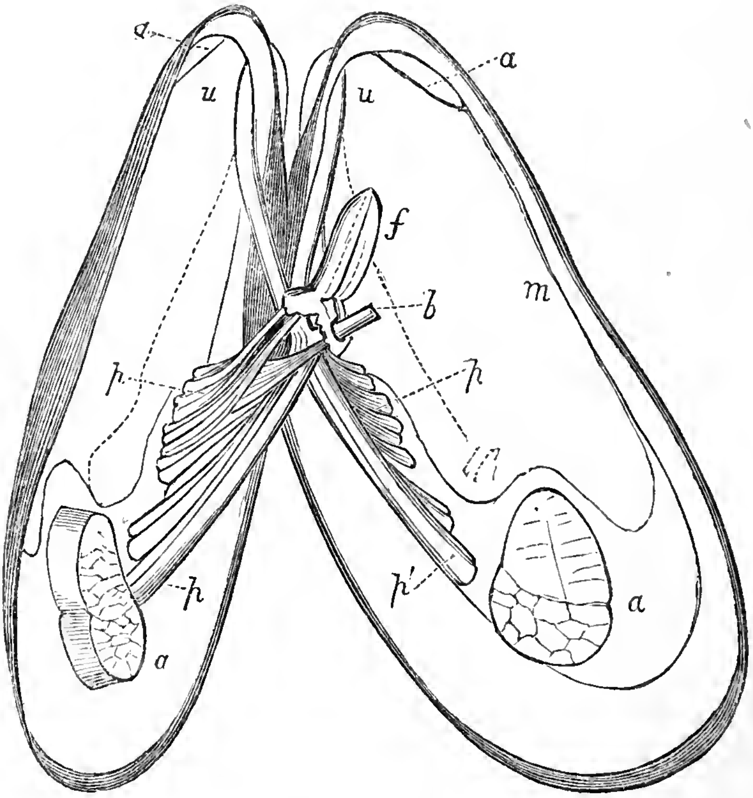


Fig. 177. Muscles of Modiola.*

In a few rare instances the muscles are fixed to prominent *apophyses*. The *falciform processes* of *Pholas* and *Teredo* (Pl. XXIII. fig. 19, 26) are developed for the attachment of the foot-muscle; the posterior muscular

* Fig, 177. Muscular system of *Modiola modiolus*, L. from a drawing communicated by A. Hancock, Esq. *aa*, anterior, *a'a'* posterior adductors; *uu* and *p'p'*, pedal muscles; *pp*, byssal muscles; *f*, foot; *b*, byssus; *m*, pallial line.

ridge of *Diceras* and *Cardilia* resembles a lateral tooth, and in the extinct genus *Radiolites* both adductors were attached to large tooth-like processes of the opercular valve; but, as a rule, the muscles deposit less shell than the mantle, and their impressions deepen with age.

The *pallial line* (fig. 177, *m*) is produced by the muscular fibres of the mantle-margin; it is broken up into irregular spots in the monomyary bivalves, and in *Saxicava* and *Panopæa Norvegica*.

The *siphonal impression*, or *pallial sinus* (fig. 14, p. 26,) only exists in those shells which have retractile siphons; its depth is an index to their length. The large combined siphons of *Mya* (fig. 170) are much longer than the shell; and those of some *Tellinidæ* three or four times its length, yet they are completely retractile. The small siphons of *Cyclas* and *Dreissena* cause no inflection of the pallial line. The *form* of the sinus is characteristic of genera and species.

In the *umbonal area* (within the pallial line) there are sometimes furrows produced by the viscera, which may be distinguished from the muscular markings by absence of polish and outline. (See *Lucina*, Pl. XIX. fig. 6.)

Fossil bivalves are of constant occurrence in all sedimentary rocks; they are somewhat rare in the oldest formations, but increase steadily in number and variety through the *secondary* and *tertiary* strata, and attain a maximum of development in existing seas.

Some families, like the *Cyprinidæ* and *Lucinidæ* are more abundant fossil than recent; whilst many genera, and one whole family (the *Hippuritidæ*), have become extinct. The determination of the affinities of fossil bivalves is often exceedingly difficult, owing to the conditions under which they occur. Sometimes they are found in pairs, filled up with hard stone; and frequently as casts, or moulds of the interior, giving no trace of the hinge, and very obscure indications of the muscular markings. Casts of single valves are more instructive, as they afford impressions of the hinge.*

Another difficulty arises from the frequent destruction of the nacreous or lamellar portion of the fossil bivalves, whilst the cellular layers remain. The *Aviculidæ* of the chalk have entirely lost their pearly interiors; the *Spondyli*, *Chamas*, and *Radiolites* are in the same condition, their inner layers are gone and no vacancy left, the whole interior being filled with chalk. As it is the inner layer alone which forms the hinge, and alone receives the impressions of the soft parts, the true characters of the shells could not be determined from such specimens. Our knowledge of the extinct *Radiolite* is derived from natural moulds of the interior, formed before the dissolution of

* These impressions may be conveniently moulded with *gutta-percha*. M. Agassiz published a set of plaster-casts of the interiors of the genera of recent shells, which may be seen in the Brit. Museum. [*Memoire sur les moules des Mollusques, vivans et fossiles, par L. Agassiz, Mem. Soc. Sc. Nat. Neuchatel, t.* 2.].

the inner layer of shell, or from specimens in which this layer is replaced by spar.

The necessities of geologists have compelled them to pay very minute attention to the markings in the interior of shells, to their microscopic texture, and every other available source of comparison and distinction. It must not, however, be expected that the entire structure and affinities of molluscous animals can be predicated from the examination of an internal mould or a morsel of shell, any more than that the form and habits of an extinct quadruped can be inferred from a solitary tooth or the fragment of a bone.*

The *systematic arrangement* of the bivalves now employed is essentially that of Lamarck, modified, however, by many recent observations. The families follow each other according to *relationship*, and not according to absolute rank; the *Veneridæ* are the highest organized, and from this culminating point the stream of affinities takes two courses, one towards the Myas, the other in the direction of the oysters; groups analogically related to the *Tunicaries* and *Brachiopoda.*

SECTION A. ASIPHONIDA.

a. Pallial line simple: Integro-pallialia.

Fam. 1. Ostreidæ.	4. Arcadæ.
2. Aviculidæ.	5. Trigoniadæ.
3. Mytilidæ.	6. Unionidæ.

SECTION B. SIPHONIDA.

7. Chamidæ.	11. Lucinidæ.
8. Hippuritidæ.	12. Cycladidæ.
9. Tridacnidæ.	13. Cyprinidæ.
10. Cardiadæ.	

b. Pallial line sinuated: Sinu-pallialia.

14. Veneridæ.	18. Myacidæ.
15. Mactridæ.	19. Anatinidæ.
16. Tellinidæ.	20. Gastrochænidæ.
17. Solenidæ.	21. Pholadidæ.

The characters which have been most relied on for distinguishing these groups and the genera of bivalves are the following, stated nearly in the order of their value:—

1. Extent to which the mantle-lobes are united.
2. Number and position of muscular impressions.
3. Presence or absence of a *pallial sinus.*
4. Form of the foot.
5. Structure of the *branchiæ.*

* *Etudes Critiques sur les Mollusques Fossiles, par L. Agassiz, Neuchatel,* 1840.

6. Microscopic structure of the shell. (*v.* p, 38.)
7. Position of the *ligament*, internal or external.
8. Dentition of the hinge.
9. Equality or inequality of the valves.
10. Regularity or irregularity of form.
11. Habit;—free, burrowing or fixed.
12. Medium of respiration, fresh or salt-water.

A few exceptions may be found, in which one or other of these characters does not possess its usual value.* Such instances serve to warn us against too implicit reliance on *single characters*. Groups, to be *natural*, must be based on the consideration of all these particulars—on "the totality of the animal organization." (Owen).

SECTION A. ASIPHONIDA.

Animal unprovided with respiratory siphons; mantle-lobes free, or united at only one point which divides the branchial from the exhalent chamber (*cloaca*); pallial impression simple.

Shell usually pearly or sub-nacreous inside; cellular externally; pallial line simple or obsolete.

FAMILY I. OSTREIDÆ.

Shell inequivalve, slightly inequilatural, free or adherent, resting on one valve; beaks central, straight; ligament internal; epidermis thin; adductor impression single, behind the centre; pallial line obscure; hinge usually edentulous.

Animal marine; mantle quite open; very slightly adherent to the edge

* 1. *Cardita* and *Crassatella* (Fam. 13) have the mantle more open, whilst in *Iridina* (6), and especially in *Dreissena* (3) it is more closed than in the most nearly allied genera.

2. *Mulleria* (6) and *Tridacna* (9) are monomyary.

3. *Leda* (4) and *Adacna* (10) have a pallial sinus; *Anapa* (16) has none.

4. The form of the foot is usually characteristic of the families; but sometimes it is *adaptively* modified.

5. *Diplodonta* (11) has four gills.

6. Pearly structure is variable even in species of the same genus.

7. *Crassatella* (13) and *Semele* (16) have an internal ligament; in *Solenella* and *Isoarca* (4) it is external.

8. *Anodon* (16), *Adacna*, *Serripes* (10), and *Cryptodon* (11) are edentulous.

9. *Corbula* (18) and *Pandora* (19) are more inequivalve than their allies; *Chama arcinella* (7) is equivalve.

10. *Hinnites* (1), *Ætheria* (6), *Myochama* and *Chamostrea* (19) are irregular.

11. *Pecten* is free, byssiferous, or fixed: *Arca* free or byssiferous. This character varies with *age* and *locality* in the same species. It does not always depend on the form of the foot, as *Ætheria*, though fixed, has a large foot, and *Lithodomus* and *Ungulina*—boring shells—have the foot like *Mytilus* and *Lucina*.

12. *Novaculina* is a river *Solen*, and *Scaphula* a fresh-water *Arca*.

of the shell; foot small and byssiferous, or obsolete; gills crescent-shaped, 2 on each side; adductor muscle composed of two elements, but representing only the *posterior* shell-muscle of other bivalves.

OSTREA, L. Oyster.

Syn. Amphidonta and Pycnodonta, Fischer. Peloris, Poli.

Type, O. edulis, L. *Ex.* O. diluviana, Pl. XVI. fig. 1.

Shell irregular, attached by the left valve; upper valve flat or concave, often plain; lower convex, often plaited or foliaceous, and with a prominent beak; ligamental cavity triangular or elongated; hinge toothless; structure sub-nacreous, laminated, with prismatic cellular substance between the margins of the laminæ.

Animal with the mantle-margin double, finely fringed; gills nearly equal, united posteriorly to each other and the mantle-lobes, forming a complete branchial chamber; lips plain; palpi triangular, attached; sexes distinct.*

Distr. 60 sp. Tropical and temperate seas. Norway, Black Sea, &c.

Fossil, 200 sp. Carb. —. U. States, Europe, India.

The interior of recent oyster-shells has a slightly nacreous lustre; in fossil specimens an irregular cellular structure is often very apparent on decomposed or fractured surfaces. Fossil oysters which have grown upon *Ammonites*, *Trigoniæ*, &c. frequently take the form of those shells.

In the "cock's-comb" oysters both valves are plaited; *O. diluviana* sends out long root-like processes from its lower valve. The "Tree oyster" (*Dendrostrea*, Sw.) grows on the root of the mangrove. Oyster shells become very thick with age, especially in rough water; the fossil oyster of the Tagus (*O. longirostris*) attains a length of two feet. The greatest enemy of oyster-banks is a sponge (*Cliona*), which eats into the valves, both of dead and living shells; at first only small round holes, at irregular intervals, and often disposed in regular patterns, are visible; but ultimately the shell is completely mined and falls to pieces. Natural oyster-banks usually occur in water several fathoms deep; the oysters spawn in May and June, and the fry ("spats") are extensively collected and removed to artificial grounds, or tanks, where the water is very shallow; they are then called "natives," and do not attain their full growth in less than 5 or 7 years, whilst the "sea-oysters" are full-grown in 4 years. Native oysters do not breed freely, and many sometimes die in the spawning season; they are also liable to be killed by frost. The season is from August 4 to May 12. From 20 to 30,000 bushels of "natives" and 100,000 bushels of sea-oysters are annually sent to the London market. Many other species of oysters are eaten in India, China, Australia, &c. "Green oysters" are those which have fed on *con-*

* The course of the alimentary canal in the common oyster is incorrectly represented by Poli, and copied in the Crochard ed. of Cuvier.

fervæ in the tanks. *Sub-genera. Gryphæa,* Lamarck. G. incurva, Sby (section) fig. 178. Free, or very slightly attached; left valve with a prominent, incurved umbo; right valve small, concave. *Fossil,* 30 sp. Lias — Chalk. Europe, India.

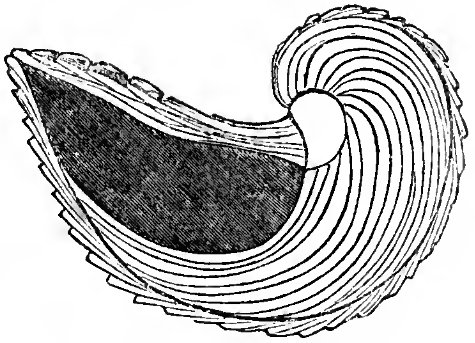


Fig. 178. Gryphæa.

Exogyra, Sby. E. conica, Pl. XVI. fig. 2. *Shell* chama-shaped, attached by the left valve; umbones sub-spiral, turned to the posterior side (i. e. reversed); right valve opercular. *Fossil,* 40 sp. L. Oolite — Chalk. U. States; Europe.

Anomia, L.

Etym. Anomios, unequal. *Ex.* A. Achæus, Pl. XVI. fig. 3.

Syn. Fenestrella, Bolten; Cepa, Humph. Aenigma, Koch.

Shell sub-orbicular, very variable, translucent, and slightly pearly within, attached by a plug passing through a hole or notch in the right valve: upper valve convex, smooth, lamellar or striated; interior with a sub-marginal cartilage-pit, and four muscular impressions, 3 sub-central, and one in front of the cartilage (see fig. 175, p. 249): lower valve concave, with a deep, rounded notch in front of the cartilage process; disk with a single (adductor) impression.

Animal with the mantle open, its margins with a short double fringe; lips membranous; palpi elongated, fixed, striated on both sides; gills 2 on each side, united posteriorly, the outer laminæ incomplete and free; foot small, cylindrical, subsidiary to a lamellar and more or less calcified byssal plug, attached to the upper valve by three muscles; adductor muscle behind the byssal muscles, small, composed of two elements; sexes distinct; ovary extending into the substance of the lower mantle-lobe

In *A. pernoides,* from California, there is an anterior (*pedal*) muscular impression in both valves.

"There is no relationship of *affinity* between *Anomia* and *Terebratula,* but only a resemblance through formal *analogy;* the parts which seem identical are not homologous." (Forbes).

The Anomiæ are found attached to oysters and other shells, and frequently acquire the form of the surfaces with which their growing margins are in contact. They are not edible.

Distr. 20 sp. N. America, Brit. Black Sea, India, Australia, W. America, Icy sea. Low-water — 100 fms.

Fossil, 30 sp. Oolite —, Chile, U. States, Europe.

Sub-genera. Placunomia (Cumingii) Broderip. *Syn.* Pododesmus, Phil. *P. macroschisma,* Pl. XVI. fig. 4. Upper valve with only two muscular impressions; the pedal scar radiately striated; the byssal plug is often fixed in the lower valve, and its muscle becomes (functionally) an adductor. *Distr.* 12 sp. W. Indies, Brit. (*P. patelliformis*), New Zealand, California, Behring's sea, Ochotsk. — 50 fms.

Limanomia (Grayana) Bouchard. Shell eared like *Lima*. *Fossil*, 4 sp. Devonian; Boulonnais, China?

PLACUNA, Solander. Window-shell.

Etym. Plakous a thin cake. *Ex.* P. sella, Pl. XVI. fig. 5.

Shell sub-orbicular, compressed, translucent, free, resting on the right valve; hinge area narrow and obscure; cartilage supported by two diverging ridges in the right valve and corresponding grooves in the left; muscular impressions double, the larger element round and central, the smaller distinct and crescent shaped, in front of it.

The Placunæ are very closely allied to *Anomia;* and many intermediate forms may be traced. The shell of each consists entirely of sub-nacreous, plicated laminæ, peculiarly separable, and occasionally penetrated by minute tubuli. (*Carpenter.*) *P. sella,* called, from its shape, the "saddle-oyster," is remarkably striated. In *P. placenta*, Pl. XVI. fig. 6, the anterior cartilage ridge is only half so long as the other, which appears to be connected with the economy of the shell when young; in specimens 1 inch across, there is a pedal impression below the cartilage grooves of the upper valve, and a shallow sinus in the margin of the lower valve, indicating a slight byssal attachment at that age.

Distr. 4 sp. Scinde, N. Australia, China.

Sub-genera. Carolia, Cantraine 1835, (after Prince Charles Bonaparte.) *Syn.* Hemiplacuna, G. Sby. *Type,* C. placunoides, Pl. XVI. fig. 7. *Shell* like *Placuna;* hinge, when young, like Anomia, with a byssal plug passing through a small deep sinus in front of the cartilage process, which is closed in the adult. *Distr.* 3 sp. (Brit. Mus.) Tertiary, Egypt, America?

Placunopsis, Morris and Lycett. P. Jurensis, Rœmer. Sub-orbicular, upper valve convex, radiately striated, or taking the form of the surface to which it adheres; lower valve flat; ligamental groove sub-marginal, transverse; muscular impression large, sub-central. *Fossil,* 4 sp. Lower Oolites, Europe.

PECTEN, O. F. Müller. Scallop.

Etym. Pecten, a comb. *Type,* P. maximus (Janira, Schum.)

Syn. Argus, Poli. Discites, Schl. Amusium, Muhlfeldt.

Shell sub-orbicular, regular, resting on the right valve, usually ornamented with radiating ribs; beaks approximate, eared; anterior ears most prominent; posterior side a little oblique; right valve most convex, with a notch below the front ear; hinge-margins straight, united by a narrow ligament; cartilage internal, in a central pit; adductor impression double, obscure; pedal impression only in the left valve, or obsolete (fig. 173).

Animal with the mantle quite open, its margins double, the inner pendent like a curtain (*m*) finely fringed; at its base a row of conspicuous round black eyes (*ocelli*) surrounded by tentacular filaments; gills (*br*) exceedingly delicate, crescent-shaped, quite disconnected posteriorly having separate excurrent canals; lips foliaceous; palpi truncated, plain outside, striated within; foot finger-like, grooved, byssiferous in the young.

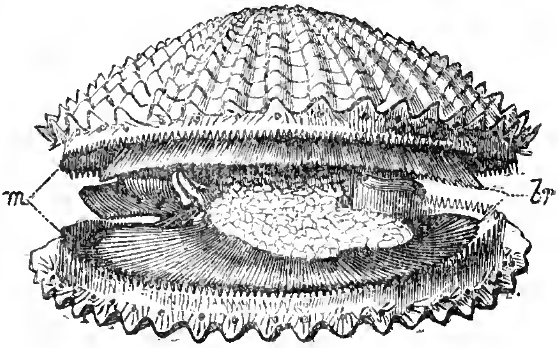


Fig. 179. Pecten varius.*

The Scallop (*P. maximus*) and "quin" (*P. opercularis*) are esteemed delicacies; the latter covers extensive banks, especially on the N. and W. of Ireland, in 15 to 25 fm. water. The scallop ranges from 3—40 fms.: its body is bright orange, or scarlet, the mantle fawn-colour, marbled with brown; the shell is used for "scalloping" oysters, formerly it was employed as a drinking cup, and celebrated as such in Ossian's "hall of shells." An allied species has received the name of "St. James's shell" (*P. Jacobœus*); it was worn by pilgrims to the Holy-land, and became the badge of several orders of knighthood.†

Most of the Pectens spin a byssus when young, and some, like *P. varius*, do so habitually; *P. niveus* moors itself to the fronds of the tangle (*Laminaria.*)

The Rev. D. Landsborough observed the fry of *P. opercularis*, when less than the size of a sixpence, swimming in a pool of sea-water left by the ebbing of the tide. "Their motion was rapid and zig-zag; they seemed, by the sudden opening and closing of their valves, to have the power of darting like an arrow through the water. One jerk carried them some yards, and then by another sudden jerk they were off in a moment on a different tack."

The shell of Pecten and the succeeding genera consists almost exclusively of membranous laminæ, coarsely or finely corrugated. It is composed of two very distinct layers, differing in colour (and also in texture and destructibility), but having essentially the same structure. Traces of cellularity are sometimes discoverable on the external surface; *P. nobilis* has a distinct prismatic-cellular layer externally. (*Carpenter.*)

* The Pectens do not open so wide as here represented; their "curtains" remain in contact at one point on the posterior side, separating the branchial from the exhalent currents.

† When the monks of the ninth century converted the fisherman of Gennesarat into a Spanish warrior, they assigned him the scallop-shell for his "cognizance."—*Moule's Heraldry of Fish.*

Sub-genera, Neithea, Drouet. P. quinque-costatus and other fossil sp. with concavo-convex valves and distinct hinge-teeth; the inner layers of these shells are wanting in all specimens from the English chalk.

Pallium, Schum. P. plica, Pl. XVI. fig. 8. Hinge obscurely toothed.

Hinnites (Cortesii) Defr. P. pusio, Pl. XVI. fig. 10. Shell regular and byssiferous when young; afterwards cementing its lower valve and becoming more or less irregular. *Distr.* 2 sp. *Fossil,* Trias ? Miocene —, Europe.

Hemipecten, A. Adams. H. Forbesianus, Pl. XVI. fig. 9. Shell hyaline, posterior ears obsolete, anterior prominent; right valve flat, byssal sinus deep; structure permeated by microscopic tubuli, as in *Lima.*

Distr. 120 sp. World-wide; Nova-Zembla — C. Horn; — 200 fms.

Fossil, 450 sp. (including Aviculo-pecten). Carb. —. World-wide.

LIMA, Bruguiere.

Etym. Lima, a file. *Ex.* L. squamosa, Pl. XVI. fig. 11. (Ostrea lima, L.)

Syn. Plagiostoma (Llhwyd) Sby. P. cardiiforme, Pl. XVI. fig. 12.

Shell equivalve, compressed, obliquely oval; anterior side straight, gaping, posterior rounded, usually close; umbones apart, eared; valves smooth, punctate-striate, or radiately ribbed and imbricated; hinge area triangular, cartilage pit central; adductor impression lateral, large, double; pedal scars 2, small.

Animal, mantle-magins separate, inner pendent, fringed with long tentacular filaments, ocelli inconspicuous; foot finger-like, grooved; lips with tentacular filaments, palpi small, striated inside; gills equal on each side, distinct.

The shell is always white; its outer layer consists of coarsely-plicated membranous lamellæ; the inner layer is perforated by minute tubuli, forming a complete network. (*Carpenter.*)

The Limas are either free or spin a byssus; some make an artificial burrow when adult, by spinning together sand or coral-fragments and shells, but the habit is not constant. (*Forbes.*) The burrows of *L. hians* are several times longer than the shell, and closed at each end. (*Charlesworth.*) "This species is pale or deep crimson, with an orange mantle; when taken out of its nest it is one of the most beautiful marine animals to look upon, it swims with great vigour, like the scallop, by opening and closing its valves, so that it is impelled onwards or upwards in a succession of jumps. The filaments of the fringe are easily broken off, and seem to live many hours after they are detached, twisting themselves like worms." (*Landsborough.*) *L. spinosa* has conspicuous ocelli, and short filaments.

Sub-genera, Limatula, S. Wood. L. sub-auriculata, Pl. XVI. fig. 13. Valves equilateral; 8 sp. Greenland — Brit. *Fossil,* Miocene —. Europe.

Limæa, Bronn. L. strigilata, Pl. XVI. fig. 14.* Hinge minutely

* After Bronn; the figure in Brocchi does not show the teeth.

toothed. *Fossil*, 4 sp. Lias — Pliocene. The recent *Limæa ? Sarsii* (Lovén) Norway (= L. crassa of the Ægean ?) has the mantle-border plain. Some of the larger recent sp. have obscure lateral teeth.

Distr. 20 sp. Norway, Brit. W. Indies, Canaries, India, Australia; 1—150 fms. The largest living sp. (*L. excavata*, Chemn.) is found on the coast of Norway.

Fossil, 200 sp. Carb. ? Trias —. U. States, Europe, India. The so-called *Plagiostoma spinosum* is a Spondylus.

Spondylus, (Pliny) L. Thorny-oyster.

Type, S. gædaropus, L. *Ex.* S. princeps, Pl. XVI. fig. 15.

Syn. Dianchora, Sby. Podopsis, Lam. Pachytes, Dcfr.

Shell irregular, attached by the right valve, radiately ribbed, spiny or foliaceous; umbones remote, eared; lower valve with a triangular hinge-area, cartilage in a central groove, nearly or quite covered; hinge of 2 curved interlocking teeth in each valve; adductor impression double.

Animal, with the mantle open and gills separate, as in *Pecten;* lips foliaceous, palpi short; foot small, cylindrical, truncated.

In aged specimens the circular portion of the muscular scar exhibits dendritic vascular markings. The lower valve is always most spiny and least coloured; in some sp. (like *S. imperialis*) the shell is scarcely, if at all, attached by its beak or spines. The inner shell-layer is very distinct from the outer, and always wanting in fossil specimens from calcarious rocks, then called *Dianchoræ.* Specimens from the Miocene of St. Domingo, which have lost this layer, contain a loose mould of the original interior. Water-cavities are common in the inner layer, the border of the mantle having deposited shell more rapidly than the umbonal portion. (*Owen*, Mag. Nat. Hist. 1838, p. 409.)

Distr. 30 sp. W. Indies, Canaries, Medit. India, Torres Straits, Pacific, W. America:—105 fms.

Fossil, 45 sp. Inf. Oolite ? Neocomian —. Europe, U. States, India.

Sub-genus, Pedum, Brug. P. spondyloides, Pl. XVI. fig. 16. *Shell* thin, smooth, compressed, attached by a byssus passing through a deep notch in the right valve. Inhabits coral-reefs, where it is found half-imbeded; Red Sea, Indian Ocean, Mauritius, Chinese Seas.

Plicatula, Lamarck.

Etym. Plicatus, plaited.

Type, P. cristata, Pl. XVI. fig. 17.

Shell irregular, attached by the umbo of the right valve; valves smooth or plaited; hinge-area obscure; cartilage quite internal; hinge-teeth, 2 in each valve; adductor scar simple.

Distr. 6 sp. W. Indies, India, Philippines, Australia, W. America.

Fossil, 40 sp. Trias —. U. S. Europe, Algeria, India.

P. Mantelli (Lea) Alabama, has the valves eared.

FAMILY II. AVICULIDÆ. Wing-shells.

Shell inequivalve, very oblique, resting on the smaller (right) valve, and attached by a byssus; epidermis indistinct: outer layer prismatic-cellular, (fig. 180) interior nacreous; posterior muscular impression large, sub-central, anterior small, within the umbo; pallial line, irregularly dotted; hinge-line straight, elongated; umbones anterior, eared, the posterior ear wing-like; cartilage contained in one or several grooves; hinge edentulous, or obscurely toothed.

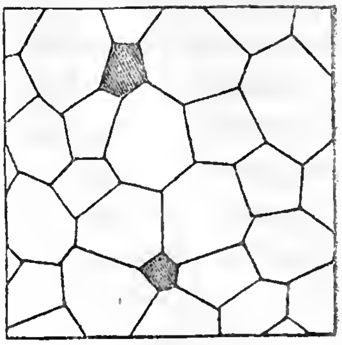


Fig. 180, Pinna.*

Animal with the mantle-lobes free, their margins fringed; foot small, spinning a byssus; gills 2 on each side, crescent-shaped, entirely free (*Desh.*) or united to each other posteriorly, and to the mantle (as in the Oyster, and not as in *Pecten*).

The wing-shells, or pearl-oysters, are natives of tropical and temperate seas; there are no living species in northern latitudes, where fossil forms are very numerous.

AVICULA (Klein) Bruguiere.

Etym. Avicula, a little bird. *Type*, A. hirundo, Pl. XVI. fig. 18.

Shell obliquely oval, very inequivalve; right valve with a byssal sinus beneath the anterior ear; cartilage pit single, oblique; hinge with 1 or 2 small cardinal teeth, and an elongated posterior tooth, often obsolete; posterior muscular impression (adductor and pedal) large, sub-central; anterior (pedal scar) small, umbonal.

Animal (of meleagrina) with mantle-lobes united at one point by the gills, their margins fringed and furnished with a pendent curtain; curtains fringed in the branchial region, plain behind; foot finger-like, grooved; byssus often solid, cylindrical, with an expanded termination; pedal muscles 4, posterior large in front of the adductor; adductor composed of 2 elements; retractors of the mantle forming a series of dots, and a large spot near the adductor; lips simple: palpi truncated; gills equal, crescentic, united behind the foot. (Brit. M.)

Distr. 25 sp. Mexico, S. Brit. Medit. India, Pacific:—20 fms.

Fossil, 300 sp. L. Silurian —. World-wide.

Sub-genera, Meleagrina, Lam. M. margaritifera, Pl. XVI. fig. 19. The "pearl-oysters" are less oblique than the other *aviculæ*, and their valves are flatter and nearly equal; the posterior pedal impression is blended with that of the great adductor. They are found at Madagascar, Ceylon, Swan

* The cellular structure may be seen with a hand-lens, in the thin margin of the shell, by holding it up to the light; or on the edges of broken fragments.

R. Panama, &c. Manilla is the chief port to which they are taken. There are three principal kinds, which are worth from £2 to £4 per cwt.: 1. the silver-lipped, from the Society Ids. of which about 20 tons are annually imported to Liverpool; 2. the black-lipped, from Manilla, of which 30 tons were imported in 1851; 3. a smaller sort from Panama, 200 tons of which are annually imported; in 1851 a single vessel brought 340 tons. (T. C. Archer.) These shells afford the "mother-o'-pearl" used for ornamental purposes; and the "oriental" pearls of commerce (p. 38). Mr. Hope's pearl, said to be the largest known, measures 2 inches long, 4 round, and weighs 1800 grains.* Pearl-oysters are found in about 12 fathom water; the fisheries of the Persian Gulf and Ceylon have been celebrated from the time of Pliny.

Malleus, Lam. M. vulgaris, Pl. XVI. fig. 20. The "hammer-oyster" is remarkable for its form, which becomes extremely elongated with age; both ears are long, and the umbones central. When young it is like an ordinary Avicula, with a deep byssal notch in the right valve. 6 sp. China, Australia.

Vulsella, Lam. V. lingulata, Pl. XVI. fig. 21. *Syn.* Reniella, Sw. Shell oblong, striated, sub-equivalve; umbones straight, earless. Often found imbedded in living sponges. *Distr.* 3 sp. Red Sea, India, Australia, Tasmania. *Fossil*, 4 sp. U. Chalk —. Brit. France.

Pteroperna, Lycett, 1852. P. costatula, Desl. *Shell* with a long posterior wing; hinge-line bordered by a groove; anterior teeth numerous, minute; posterior 1 or 2, long, nearly parallel with the hinge-margin. *Fossil*, 3 sp. Bath oolite; Brit. France.

? *Aucella* (Pallasii) Keyserling, 1846. (*Monotis*, Münster, not Bronn.) Very inequivalve; left umbo prominent, earless; right valve small and flat, with a deep sinus beneath the small anterior ear. *Fossil*, Permian — Gault. Europe. "In *A. cygnipes* we find no trace of prismatic cellular structure or nacre, but the coarsely corrugated and somewhat tubular structure of the Pectens." (*Carpenter.*)

Ambonychia (bellistriata) Hall, 1847. Nearly equivalve, gibbose, oblique, obtusely winged. *A. vetusta* (Inoceramus, Sby.) is concentrically furrowed; the right valve has a small anterior ear (usually concealed) separated by a deep and narrow sinus. *Fossil*, 12 sp. L. Silurian — Carb. U. S. Europe.

? *Cardiola* (interrupta) Broderip, 1844. Equivalve, gibbose, obliquely oval, radiately ribbed; beaks prominent; hinge-area short and flat. *Fossil*, 17 sp. U. Silurian — Dev. U. S. Europe.

? *Eurydesma* (cordata) Morris; Devonian? N. S. Wales. *Shell* equivalve,

* Sections of oriental pearls exhibit very fine concentric laminæ surrounding a grain of sand, or some such extraneous matter; the nacreous lustre has been attributed to the diffraction of light from the out-cropping edges of the laminæ, but Dr. Carpenter has shown that it may result from the minute plication of a *single* lamina. (See fig. 23, p. 38.)

sub-orbicular, ventricose, very thick near the beaks; ligamental area long, wide, sub-internal; byssal groove close to the umbo; right valve with a large, blunt hinge-tooth; adductor impression single, placed anteriorly; pallial line dotted.

Pterinea (lævis) Goldf. 1832. *Shell* thick, rather inequivalve, very oblique and broadly winged; beaks anterior; sinus shallow; hinge-area long, straight, narrow, striated lengthwise; anterior teeth few, radiating; posterior teeth laminar, elongated; anterior (pedal) scar deep, posterior (adductor) impression large, very eccentric. *Fossil,* 25 sp. L. Sil. — Carb. U. S. Europe, Australia. Pteronites (angustatus) M'Coy, 1844, is thinner and has the teeth, &c. less developed.

Monotis, Bronn, 1830. M. salinaria, Schl. *Trias,* Hallein. Obliquely oval, compressed, radiated; anterior side short, rounded; posterior slightly eared.

Syn. ? *Halobia* (salinarum) Br. 1830. *Trias,* Hallstadt. Semi-oval, radiated, compressed, with a shallow sinus in front; hinge-line long and straight.

Posidonomya, Bronn.

Syn. Posidonia, Br. 1828. (not König). *Poseidôn,* Neptune.

Type, P. Becheri, Pl. XVI. fig. 22.

Shell thin, equivalve, compressed, earless, concentrically furrowed; hinge-line short and straight, edentulous.

Fossil, 50 sp. L. Silurian — Trias. U. S. Europe.

? Aviculo-pecten, M'Coy, 1852

Type, Pecten granosus, Sby. Min. Con. t. 574.

Shell inequivalve, sub-orbicular, eared; hinge-areas flat, with several long, narrow cartilage furrows, slightly oblique on each side of the umbones; right valve with a deep and narrow byssal sinus beneath the anterior ear; adductor impression large, simple, sub-central; pedal scar small and deep, beneath the umbo.

Fossil (see Pecten). L. Silurian — Carb. Spitzbergen — Australia.

Gervillia, Defrance.

Etym. Dedicated to M. Gerville, a French naturalist.

Ex. G. anceps, Pl. XVII. fig. 1.

Shell like Avicula; elongated: anterior ear small, posterior wing-like: area long and flat, cartilage pits several, wide apart; hinge-teeth obscure, diverging posteriorly.

Fossil, 30 sp. Carb. — Chalk. Europe.

Sub-genus ? *Bakewellia,* King. B. ceratophaga, Schl. *Fossil,* 5 sp. Permian, Brit. Germany, Russia. *Shell* small, inequivalve, cartilage pits 2—5; hinge with anterior and posterior teeth; anterior muscular impression and pallial line distinct.

Perna, Bruguiere.

Etym. Perna, a shell-fish (resembling a *gammon*) Pliny.

Syn. Melina, Retz. Isognomon, Klein. Pedalion, Solander.

Type, P. ephippium, L. Pl. XVII. fig. 2.

Shell nearly equivalve, compressed, sub-quadrate; area wide, cartilage pits numerous, elongated, close-set; right valve with a byssal sinus; muscular impression double.

The Pernas vary in form like the *Aviculæ*; some are very oblique, some very inequivalve, and many fossil sp. have the posterior side produced and wing-like. In some Tertiary Pernas the pearly layer is an inch thick.

Distr. 16 sp. Tropical seas; W. Indies — India — W. America.

Fossil, 30 sp. Trias —. U. States, Chile, Europe.

Sub-genera, Crenatula, Lamk. C. viridis, Pl. XVI. fig. 24. *Shell* thin, oblong, compressed; byssal sinus obsolete; cartilage pits shallow, crescent-shaped. *Distr.* 5 sp. N. Africa, Red Sea — China; in sponges.

Hypotrema, D'Orb. 1853. H. rupellensis (= ? Pulvinites Adansonii, Defr. 1826); Coral-rag, Rochelle. *Shell* oblong, inequivalve; right valve flat or concave, with a round byssal foramen near the hinge; left valve convex, with a muscular impression near the umbo; hinge-margin broad, curved, with about 12 close-set transverse cartilage grooves.

Inoceramus, Sowerby (1814).

Etym. Is (inos) fibre, *Keramos* shell.

Ex. I. sulcatus, Pl. XVII. fig. 3. *Syn.* Catillus, Brongn.

Shell inequivalve, ventricose, radiately or concentrically furrowed, umbones prominent; hinge-line straight, elongated; cartilage pits transverse, numerous, close-set.

This genus differs from *Perna* chiefly in form. *I. involutus* has the left valve spiral, the right opercular. *I. Cuvieri* attains the length of a yard. Large flat fragments are common both in the chalk and flints, and are often perforated by the *Cliona*. Hemispherical pearls have been found developed from their inner surface, and spherical pearls of the same prismatic-cellular structure occur detached, in the chalk. (*Wetherell.*) The *Inocerami* of the gault are nacreous.

Fossil, 40 sp. Lias — Chalk. S. America, U.S. Europe, Algeria, Thibet.

Pinna, L.

Etym. Pinna, a fin or wing. *Type*, P. squamosa, Pl. XVI. fig. 23.

Shell equivalve, wedge-shaped; umbones quite anterior; posterior side truncated and gaping; ligamental groove linear, elongated; hinge edentulous; anterior adductor scar apical, posterior sub-central, large, ill-defined; pedal scar in front of posterior adductor.

Animal with the mantle margin doubly fringed; foot elongated, grooved, spinning a powerful byssus, attached by large triple muscles to the centre of each valve; adductors both large; palpi elongated; gills long.

N 3

Distr. 30 sp. U. States, S. Brit. Medit. Australia, Pacific, Panama.

Fossil, 50 sp. Devonian —. U. S. Europe, S. India.

The shell of the *Pinna* attains a length of two feet; when young it is thin, brittle, and translucent, consisting almost entirely of prismatic cell-layers; the pearly lining is thin, divided, and extends less than halfway from the beak. Some fossil Pinnas crumble under the touch into their component fibres. The living sp. range from extreme low-water to 60 fms; they are moored vertically, and often nearly buried in sand, with knife-like edges erect. The byssus has sometimes been mixed with silk, spun, and knitted into gloves, &c. (Brit. Mus.) A little crab which nestles in the mantle and gills of the Pinna, was anciently believed to have formed an alliance with the blind shellfish, and received the name of Pinna-guardian (*Pinnoteres*) from Aristotle; similar species infest the Mussels and *Anomiæ* of the British coast.

Sub-genus, Trichites, (Plott) Lycett. T. Plottii, Llhwyd. ("Pinnigene," Saussure.) *Shell* thick, inequivalve, somewhat irregular, margins undulated. *Fossil,* 5 sp. Oolitic strata of England and France. Fragments an inch or more in thickness are common in the Cotteswolde-hills; full-grown individuals are supposed to have measured a yard across.

FAMILY III. Mytilidæ. Mussels.

Shell equivalve, oval or elongated, closed, umbones anterior, epidermis thick and dark, often filamentose; ligament internal, sub-marginal, very long; hinge edentulous; outer shell layer obscurely prismatic-cellular;* inner more or less nacreous; pallial line simple; anterior muscular impression small and narrow, posterior large, obscure.

Animal marine or fluviatile, attached by a byssus; mantle-lobes united between the siphonal openings; gills two on each side, elongated, and united behind to each other and to the mantle, dorsal margins of the outer and innermost laminæ free; foot cylindrical, grooved.

The shells of this family exhibit a propensity for concealment, frequently spinning a nest of sand and shell-fragments, burrowing in soft substances, or secreting themselves in the burrows of other shells.

Mytilus, L. Sea-mussel.

Ex. M. smaragdinus, Pl. XVII. fig. 4.

Shell wedge-shaped, rounded behind; umbones terminal, pointed; hinge-teeth minute or obsolete; pedal muscular impressions two in each valve, small, simple, close to the adductors.

Animal with the mantle-margins plain in the anal region, and projecting slightly; branchial margins fringed; byssus strong and coarse; gills nearly equal; palpi long and pointed, free.

* A thin layer of minute cells may frequently be detected immediately under the epidermis. (*Carpenter.*)

The common edible mussel frequents mud-banks which are uncovered at low-water; the fry abound in water a few fathoms deep; they are full-grown in a single year. From some unknown cause they are, at times, extremely deleterious. The consumption of mussels in Edinburgh and Leith is estimated at 400 bushels (=400,000 mussels) annually; enormous quantities are also used for bait, especially in the deep sea fishery, for which purpose 30 or 40 millions are collected yearly in the Frith of Forth alone. (*Dr. Knapp.*) Mussels produce small and inferior pearls. At Port Stanley, Falkland Ids. Mr. Macgillivray noticed beds of mussels which were chiefly dead, being frozen at low-water. *M. bilocularis* (Septifer, Recluz) has an umbonal shelf for the support of the anterior adductor, like *Dreissena;* it is found at Mauritius and Australia. *M. exustus* (Brachydontes, Sw.) has the hinge-margin denticulated continuously.

Distr. 50 sp. World-wide. Ochotsk, Behring's Sea, Russian Ice-meer; Black Sea, C. Horn, Cape, New Zealand.

Fossil, 80 sp. Permian —. U. S. Europe, S. India.

? Myalina, Koninck, 1842.

Types, M. Goldfussiana, Kon. Carb. M. acuminata, Sby. Permian.

Shell equivalve, mytili-form; beaks nearly terminal, septiferous internally; hinge-margin thickened, flat, with several longitudinal cartilage-grooves; muscular impressions 2; pallial line simple.

Fossil 6 sp. Carb. — Permian. Europe. The ligamental area resembles that of the recent Arca obliquata, Chemn. India.

Modiola, Lam. Horse-mussel.

Etym. Modiolus, a small measure, or drinking-vessel.

Ex. M. tulipa, Pl. XVII. fig. 5. M. modiolus, p. 250, fig. 177.

Shell oblong, inflated in front: umbones anterior, obtuse: hinge toothless; pedal impressions 3 in each valve, the central elongated; epidermis often produced into long beard-like fringes.

Animal with the mantle-margin simple, protruding in the branchial region; byssus ample, fine; palpi triangular, pointed.

The *Modiolæ* are distinguished from the Mussels by their habit of burrowing, or spinning a nest. Low-water—100 fms.

Distr. 50 sp. chiefly tropical; *M. modiolus,* Arctic seas — Brit.

Fossil, 130 sp. Silurian ? Lias —. U. S. Europe, Thibet, S. India.

Sub-genera. Lithodomus, Cuv. M. lithophaga, Pl. XVII. fig. 7. *Shell* cylindrical, inflated in front, wedge-shaped behind; epidermis thick and dark; interior nacreous.* *Distr.* 12 sp. W. Indies — New Zealand. *Fossil,*

* The outer shell-layer has a tubular structure; the tubes are excessively minute, seldom branching, oblique and parallel. (*Carpenter.*)

16 sp. Bath oolite —. Europe, U. S. The "date-shell" bores into corals, shells, and the hardest limestone rocks (fig. 25, p. 42); its burrows are shaped like the shell, and do not admit of free rotatory motion. The animal, which is eaten in the Medit. is like a common mussel; in *L. patagonicus* the siphons are produced. Like other burrowing shellfish, they are luminous. Perforations of *Lithodomi* in limestone cliffs, and in the columns of the Temple of Serâpis at Puteoli, have afforded conclusive evidence of changes in the level of sea-coasts in modern times. (*Lyell's Principles of Geology.*)

Crenella, Brown. C. discors, Pl. XVII. fig. 8. (Lanistes, Sw. Modiolaria, Beck.) *Shell* short and tumid, partly smooth, and partly ornamented with radiating striæ; hinge-margin crenulated behind the ligament; interior brilliantly nacreous. *Animal* with the anal tube and branchial margins prominent. *Distr.* Temperate and arctic seas; Nova Zembla, Ochotsk, Brit. New Zealand. Low-water — 40 fms. Spinning a nest, or hiding amongst the roots of sea-weed and corallines. *M. marmorata,* Forbes, burrows in the test of *Ascidia. Fossil,* U. Green-sand —. Europe.

Modiolarca (trapezina) Gray; Falkland Ids. — Kerguelen, attached to floating sea-weed; mantle-lobes united, pedal opening small, foot with an expanded sole, front adductor round. *M.* ? *pelagica,* Pl. XVII. fig. 6. is found burrowing in floating blubber, off the Cape. (*Forbes.*)

? *Mytilimeria* (Nuttallii) Conrad. *Shell* irregularly oval, thin, edentulous, gaping posteriorly; umbones sub-spiral; ligament short, semi-internal. *Distr.* California; animal gregarious, forming a nest.

Modiolopsis (mytiloides) Hall, 1847 (= Cypricardites, part, Conrad. Lyonsia, part, D'Orb.) *Shell* like modiola, thin and smooth, front end somewhat lobed; anterior adductor scar large and oval. *Fossil,* Silurian, U. S. Europe.

? *Orthonotus* (pholadis) Conrad. L. Silurian, New York. *Shell* elongated, margins parallel, umbones anterior, back plaited.*

Dreissena, Van Beneden.

Etym. Dedicated to Dreyssen, a Belgian physician.

Syn. Mytilomya, Cantr. Congeria, Partsch. Tichogonia, Rossm.

Type, D. polymorpha, Pl. XVII. fig. 9. (Mytilus Volgæ, Chemn.)

Shell like *Mytilus,* without its pearly lining; inner layer composed of large prismatic cells; umbones terminal; valves obtusely keeled; right valve with a slight byssal sinus; anterior adductor supported on a shelf within the beak; pedal impression single, posterior.

* Hall and Salter employ the name *Orthonotus* for such shells as *Solen constrictus,* Sandb. Devonian, Germany; *Sanguinolites anguliferus,* M'Coy, U. Silurian, Kendal; and *Solenopsis minor,* M'Coy, Carb. limestone, Ireland. M. D'Orbigny has mistaken the plaits for teeth, and placed the genus with *Nucula.* The recent *M. plicata,* Lam. from Nicobar Ids. has the same long straight back and plaited dorsal region.

Animal with the mantle closed; byssal orifice small; anal siphon very small, conical, plain, branchial prominent, fringed inside; palpi small, triangular; foot-muscles short and thick, close in front of the posterior adductor.

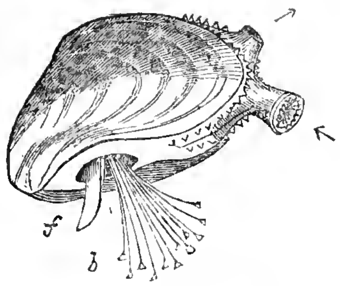


Fig. 181. Dreissena.

D. polymorpha is a native of the Aralo-Caspian rivers; in 1824 it was observed by Mr. J. Sowerby in the Surrey docks, to which it appears to have been brought with foreign timber, in the holds of vessels. It has since spread into the canals and docks of many parts of the country, and has been noticed in the iron water-pipes of London, incrusted with a ferruginous deposit. (*Cunnington.*)

Fossil. 10 sp. Eocene —. Brit. Germany.

FAMILY IV. Arcadæ.

Shell regular, equivalve, with strong epidermis; hinge with a long row of similar, comb-like teeth; pallial line distinct; muscular impressions sub-equal. Structure corrugated, with vertical tubuli in rays between the ribs or striæ. (*Carpenter.*)

Animal with the mantle open; foot large, bent, and deeply grooved; gills very oblique, united posteriorly to a membranous septum.

Arca, L.

Etym. Arca, a chest. *Type,* A. Noæ, Pl. XVII. fig. 12.

Ex. A. granosa, Pl. XVII. fig. 10. A. pexata, fig. 11. A. zebra, fig. 13.

Shell equivalve or nearly so, thick, sub-quadrate, ventricose, strongly ribbed or cancellated; margins smooth or dentated, close or sinuated ventrally; hinge straight, teeth very numerous, transverse; umbones anterior, separated by a flat, lozenge-shaped ligamental area, with numerous cartilage-grooves; pallial line simple; posterior adductor impression double; pedal scars 2, the posterior elongated.

Animal with a long pointed foot, heeled and deeply grooved; mantle furnished with ocelli; palpi 0; gills long, narrow, less striated externally, continuous with the lips: hearts two, each with an auricle.

The name *Bysso-arca* was chosen unfortunately, by Swainson, for the *typical* species of the genus, in which the byssal orifice is sometimes very large (Pl. XVII. fig. 13). The byssus is a horny cone, composed of numerous thin plates, occasionally becoming solid and calcarious; it can be cast off and re-formed with great rapidity. (*Forbes.*) The Arcas with close valves have the left valve a little larger than the right, and more ornate.

The Bysso-arks secrete themselves under stones at low-water, in crevices of rocks, and the empty burrows of boring mollusks; they are often much worn and distorted.

Distr. 130 sp. World-wide, most abundant in warm sea; low water —

230 fms. (*A. imbricata*, Poli). Prince-Regent Inlet (*A. glacialis*) *A. scaphula, Benson,* is found in the Ganges and its branches, from Calcutta to Humeerpoor on the Jumna, 1000 miles from the sea.

Fossil, 200 sp. L. Silurian —. U. S. Europe; S. India.

Cucullæa, Lamarck.

Etym. *Cucullus,* a cowl. *Type,* C. concamerata, Pl. XVII. fig. 14.

Shell sub-quadrate, ventricose; valves close, striated; hinge-teeth few and oblique, parallel with the hinge-line at each end; posterior muscular impression bounded by an elevated ridge.

Distr. 1 sp. Mauritius, Nicobar, China.

Fossil, 100 sp. L. Silurian —. N. America, Patagonia, Europe.

Sub-genus, Macrodon, Lycett. M. Hirsonensis, Pl. XVII. fig. 15. *Shell* with a few oblique anterior teeth and one or more long laminar posterior teeth. The Ark-shells of the Palæozoic and secondary strata have their anterior teeth more or less oblique, like *Arca,* the posterior teeth parallel with the hinge-line like *Cucullæa;* their valves are close or gaping below; their umbones frequently sub-spiral; and the hinge-area is often very narrow, and in some species only the posterior moiety is visible.

Pectunculus, Lam.

Type, P. pectiniformis, Pl. XVII. fig. 16. (Arca pectunculus, L.)

Shell orbicular, nearly equilateral, smooth or radiately striated; umbones central, divided by a striated ligamental area; hinge with a semicircular row of transverse teeth; adductors sub-equal; pallial line simple; margins crenated inside.

Animal with a large crescent-shaped foot, margins of the sole undulated; mantle open, margins simple, with minute ocelli; gills equal, lips continuous with the gills.

Distr. 50 sp. W. Indies, Brit. India, N. Zealand, W. America: ranging from 8 to 60, rarely 120 fathoms.

Fossil, 70 sp. Neocomian —. U. S. Europe: S. India.

The teeth of *Pectunculus* and *Arca* increase in number with age, by additions to each end of the hinge-line, but sometimes the central teeth are obliterated by encroachments of the ligament.

Limopsis, Sassi, 1827.

Type, L. aurita, Pl. XVII. fig. 17. *Syn.* Trigonocœlia, Nyst.

Shell orbicular, convex, slightly oblique; ligamental area with a triangular cartilage-pit in the centre; hinge with 2 equal, curved series of transverse teeth.

Distr. 1 sp. Red Sea (Nyst.)

Fossil, 17 sp. Bath-oolite —. U. States; Europe.

NUCULA, Lam.

Etym. Diminutive of *nux*, a nut. *Ex.* N. Cobboldiæ, Pl. XVII. fig. 18.

Shell trigonal, with the umbones turned towards the short *posterior* side; smooth or sculptured, epidermis olive, interior pearly, margins crenulated; hinge with prominent internal cartilage-pit, and a series of sharp teeth on each side; pallial line simple.

Animal with the mantle open, its margins plain; foot large, deeply fissured in front, forming when expanded a disk with serrated margins; mouth and lips minute, palpi very large, rounded, strongly plaited inside and furnished with a long convoluted appendage; gills small, plume-like, united behind the foot to the branchial septum.

The Nucula uses its foot for burrowing, and Prof. Forbes has seen it creep up the side of a glass of sea-water. The labial appendages protrude from the shell at the same time with the foot. *N. mirabilis*, Adams, from Japan, is sculptured like the extinct *N. Cobboldiæ.*

Distr. 70 sp. U. S. Norway, Cape, Japan, Sitka, Chile. On coarse bottoms, from 5—100 fms.

Fossil, 100 sp. L. Silurian ? —. Trias —. America, Europe, India.

Sub-genera. *Nuculina*, D'Orb.* 1847. N. miliaris, Pl. XVII. fig. 19. *Shell* minute; teeth few, in one series, with a posterior lateral tooth. *Eocene*, France. Nucinella (ovalis) Searles-Wood, 1850 (=Pleurodon, Wood, 1840) a minute shell from the Coralline crag of Suffolk, is described as having an external ligament.

? *Stalagmium* (margaritaceum) Conrad, 1833=Myoparo costatus, Lea. *Eocene*, Alabama. ? *S. Nystii*, Galeotti (Nucunella, D'Orb. *Eocene*, Belgium. *Shell* like *Limopsis;* ligamental area narrow, wholly posterior.

ISOARCA, Münster, 1842.

Type, I. subspirata, M. Oxford Clay; France, Germany.

Shell ventricose; beaks large, anterior, often sub-spiral; ligament entirely external; hinge-line curved, with two series of transverse teeth, smallest in the centre; pallial line simple.

I. Logani (Ctenodonta) Salter, L. Silurian, Canada. is 3 inches long and has the ligament preserved.

Fossil, 14 sp. L. Silurian — Chalk. N. America; Europe.

Sub-genus. Cucullella, M'Coy. C. antiqua, Sby. U. Silurian, Herefordshire. *Shell* elliptical, with a strong rib behind the anterior adductor impression.

LEDA, Schumacher.

Etym. *Leda*, in Greek myth. mother of Castor and Pollux.

Syn. Lembulus (Leach) Risso. *Ex.* L. caudata, Pl. XVII. fig. 20.

Shell resembling *Nucula;* oblong, rounded in front, produced and pointed

* *N. donaciformis*, Parreyss, from the White Nile, is a crustacean! (*Estheria*).

behind; margins even; pallial line with a small sinus; umbonal area with a linear impression joining the anterior adductor.

Animal furnished with two partially-united, slender, unequal, siphonal tubes (*Forbes*); gills narrow, plume-like, deeply laminated, attached throughout; mantle-margin with small ventral lobes forming by their apposition a third siphon.

Distr. 30 sp. Northern and Arctic Seas, 10—180 fms. Siberia, Melville Id. Mass. Brit. Medit. Cape, Japan, Australia.

Fossil, 110 sp. U. S. Europe; S. India.

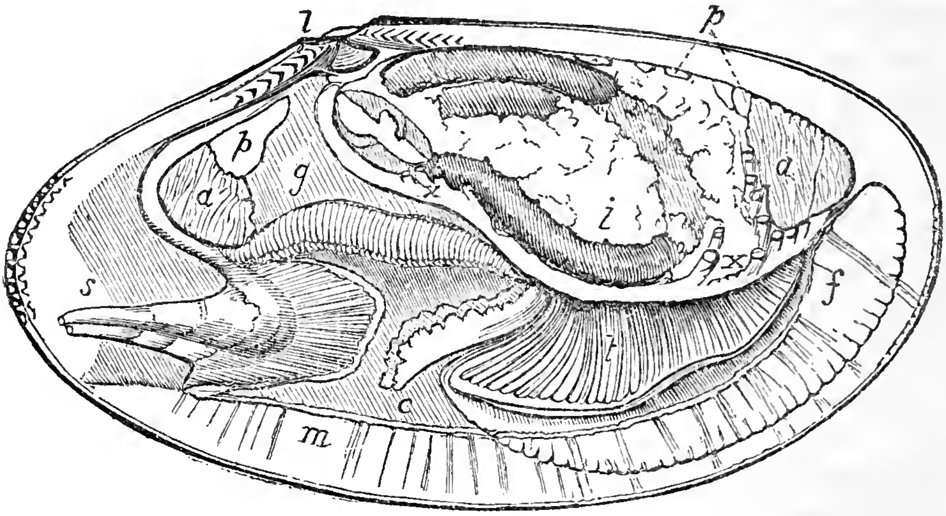


Fig. 182. Yoldia n. sp. $\frac{3}{1}$. Antarctic Expedition.

(From a drawing by Albany Hancock, Esq.) The internal organs are represented as seen, through the mantle, on the removal of the right valve.

a, a, adductors; *p, p,* pedal muscles; *l,* ligament; *g,* gills; *s,* siphons (much contracted); *t. c,* labial palpi and appendages; *i,* intestine; *f,* foot; *x, x,* lateral muscles of the foot; *m,* pallial line.

Sub-genus, Yoldia, Möller (dedicated to the Countess Yoldi). Y. myalis, Pl. XVII. fig. 21. *Shell* oblong, slightly attenuated behind, compressed, smooth or obliquely sculptured, with dark olive shining epidermis; external ligament slight; cartilage as in Leda; pallial sinus deep. *Animal* with the branchial and anal siphons united, retractile; palpi very large, appendiculate; gills narrow, posterior; foot slightly heeled, deeply grooved, its margins crenulated; intestine lying partly close to the right side of the body, and producing an impression in the shell; mantle-margin plain in front, fringed behind; destitute of ventral lobes. *Distr.* Arctic and Antarctic Seas; Greenland, Mass. Brazil; Norway, Kamtschatka. *Fossil, Miocene* —. (Crag and Glacial deposits.) England, Belgium.

SOLENELLA, Sowerby.

Type, S. Norrisii, Pl. XVII. fig. 22. S. ornata, fig. 23.

Syn. Malletia, Desm. Ctenoconcha, Gray. Neilo, Adams.

Shell oval or ark-shaped, compressed, smooth or concentrically furrowed, epidermis olive; ligament external, elongated, prominent: hinge with an anterior and posterior series of fine sharp teeth; interior sub-nacreous; pallial sinus large and deep; anterior adductor giving off a long oblique pedal line.

Animal like *Yoldia;* mantle-margins slightly fringed and furnished with ventral lobes; siphonal tubes united, long and slender, completely retractile; palpi appendiculate, convoluted, as long as the shell; gills narrow, posterior; foot deeply cleft, forming an oval disk, even-margined and striated across.

Distr. 2 sp. Valparaiso; New Zealand (shell like *S. ornata*).

Fossil, 1 sp. Miocene. Pt. Desire, Patagonia.

? SOLEMYA, Lamarck.

Type, S. togata, Pl. XXII. fig. 17. *Syn.* Solenomya, Menke.

Shell elongated, cylindrical, gaping at each end; epidermis dark, horny, extending beyond the margins; umbones posterior; hinge edentulous; ligament concealed; pallial line obscure. Outer layer of long prismatic cells, nearly parallel with the surface, and mingled with dark cells, as in *Pinna;* inner layer also cellular.

Animal with the mantle lobes united behind, with a single siphonal orifice, hour-glass shaped, and cirrated; foot proboscidiform, truncated and fringed at the end; gills forming a single plume on each side, with the laminæ free to the base; palpi long and narrow, nearly free.

The shell resembles *Glycimeris* in the shortness of its posterior side, and the extraordinary development of its epidermis; the animal most resembles *Leda* in the structure of its foot and gills.

Distr. 4 sp. U. States, Canaries, W. Africa (Gaboon R.), Medit. Australia, New Zealand. Burrowing in mud; 2 fms.

Fossil, 4 sp. Carb. —. Brit. Belgium.

FAMILY V. TRIGONIADÆ.

Shell equivalve, close, trigonal, with the umbones directed posteriorly; ligament external; interior nacreous; hinge-teeth few, diverging; pallial line simple.

Animal with the mantle open; foot long and bent; gills two on each side, recumbent; palpi simple.

TRIGONIA, Bruguiere (not Aublet.)

Etym. Trigonos, three-angled. *Syn.* Lyriodon, G. Sby.

Ex. T. costata, Pl. XVII. fig. 24. T. pectinata, fig. 183.

Shell thick, tuberculated, or ornamented with radiating or concentric ribs; posterior side angular; ligament small and prominent; hinge-teeth 2.3, diverging, transversely striated; centre tooth of left valve divided; pedal impressions in front of the posterior adductor, and one in the umbo of the left valve; anterior adductor impression close to the umbo.

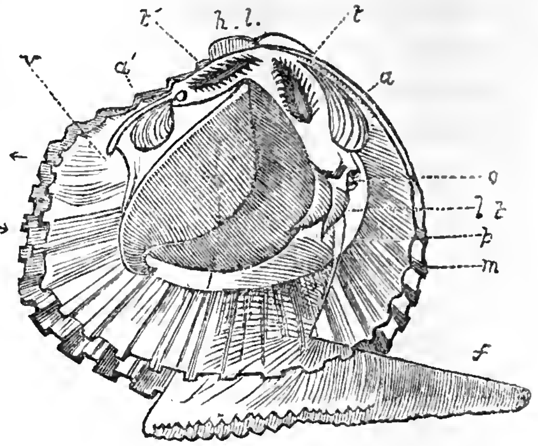


Fig. 183. *Trigonia pectinata.*‡

Animal with a long and pointed foot, bent sharply, heel prominent, sole bordered by two crenulated ridges; palpi small and pointed; gills ample, the outer smallest, united behind the body to each other and to the mantle.

The shell of Trigonia is almost entirely nacreous, and usually wanting or metamorphic in limestone strata; casts of the interior are called "horse-heads" by the Portland quarry-men;* they spoil the stone. Silicified casts have been found at Tisbury, in which the animal itself, with its gills, was preserved.† The species with the posterior angle of the shell elongated, have a siphonal ridge inside. The epidermal layer of the recent shell consists of nucleated cells, forming a beautiful microscopic object. A Trigonia placed by Mr. S. Stutchbury on the gunwale of his boat leapt overboard, clearing a ledge of four inches; they are supposed to be migratory, as dredging for them is very uncertain, though they abound in some parts of Sydney Harbour.

Distr. 3 sp. (or varieties ?) Australia.

Fossil, 100 sp. Trias — Chalk; (not known in Tertiaries). Europe, U. S. Chile, Algeria, Cape, S. India.

Myophoria, Bronn, 1830.

Type, M. vulgaris, Sehl. *Syn.* Cryptina (Kefersteinii) Boue.

Shell trigonal, umbones turned forwards; obliquely keeled; smooth or sculptured; teeth 2.3, striated obscurely, centre tooth of left valve simple, anterior of right valve prominent; mould like *Trigonia. M. decussata,* Pl. XVII. fig. 25, has a lateral tooth at the dorsal angle of the left valve.

Fossil, 13 sp. Trias: Germany, Tyrol.

Axinus, Sowerby, 1821.

Type, A. obscurus, Sby. *Syn.* Schizodus, King (not Waterhouse).

Shell trigonal, rounded in front, attenuated behind; rather thin, smooth, with an obscure oblique ridge; ligament external; hinge-teeth 2.3, smooth, rather small; anterior adductor slightly impressed, removed from the hinge, with a pedal scar close to it; pallial line simple.

Fossil, 20 sp. U. Silurian — Muschelkalk. U. States, Europe. *Mactra* tri-

* See Plott's Oxfordshire, T. vii. fig. 1.

† In the collection of the late Miss Benett of Warminster, now in Philadelphia.

‡ Fig. 183. From a specimen in alcohol; the gills slightly curled and contracted, they should terminate near the margin, between the arrows which indicate the inhalent and exhalent currents: *a,a'*, adductors; *hl*, ligament; *t. t'*, dental sockets; *o*, mouth; *lt*, labial tentacles or palpi; *p*, pallial line; *m*, margin; *f*, foot; *v*, cloaca.

gona, Goldf. *Isocardia* axiniformis. Ph. *Anodontopsis* securiformis, *Anatina* attenuata and *Dolabra* securiformis, M'Coy, probably belong to this genus. *Dolabra* equilateralis, *Amphidesma* subtruncatum, *Anodontopsis* angustifrons, M'Coy, with many others from the Palæozoic rocks, may constitute a distinct genus, but their generic character has yet to be discovered.

LYRODESMA, Conrad, 1841.

Type, L. plana, New York. *Syn.* Actinodonta, Phil.

Shell trigonia-shaped, rather elongated, with a striated posterior area; hinge with several (5—9) radiating teeth, striated across; ligament external.

Fossil, 3 sp. L. Silurian: Canada, U. States, Brit.

FAMILY VI. UNIONIDÆ. Naïdes.

Shell usually regular, equivalve, closed; structure nacreous, with a very thin prismatic-cellular layer beneath the epidermis; epidermis thick and dark; ligament external, large and prominent; margins even; anterior hinge-teeth thick and striated, posterior laminar, sometimes wanting; adductor scars deeply impressed; pedal scars 3, distinct, 2 behind the anterior adductor, one in front of the posterior.

Animal with the mantle-margins united between the siphonal orifices and, rarely, in front of the branchial opening; anal orifice plain, branchial fringed; foot very large, tongue-shaped, compressed, byssiferous in the fry; gills elongated, sub-equal, united posteriorly to each other and to the mantle, but not to the body; palpi moderate, laterally attached, striated inside: lips plain. Sexes distinct.

The river-mussels are found in the ponds and streams of all parts of the world. In Europe the species are few, though specimens are abundant; in N. America both species and individuals abound. All the remarkable generic forms are peculiar to S. America and Africa. Two of these are fixed, and irregular when adult, and have been placed with the chamas and oysters by the admirers of artificial systems; fortunately, however, M. D'Orbigny has ascertained that the *Mulleria*, which is fixed and *mono-myary* when adult, is locomotive and di-myary when young!*

Like other fresh-water shells, the naïds are often extensively eroded by the carbonic acid dissolved in the water they inhabit (p. 41).† This condition of the umbones is conspicuous in the great fossil *Uniones* of the Wealden,

* In the synopsis at p. 252 it will be seen that each of the principal groups of bivalves contains members which are fixed and irregular, and others which are byssiferous, or burrowing, or locomotive.

† Probably many of the organic acids, produced by the decay of vegetable matter, assist in the process. It has been suggested that sulphuric acid may sometimes be set free in river-water, by the decomposition of iron-pyrites in the banks: but Prof. Boye of Philadelphia states that it has not been detected in any river of the United States, where the phenomenon of erosion is most notorious.

but cannot be detected in the *Cardiniæ*, and some other fossils formerly referred to this family.

The outer gills of the female unionidæ are filled with spawn in the winter and early spring; the fry spins a delicate, ravelled byssus, and flaps its triangular valves with the posterior shell-muscle, which is largely developed, whilst the other is yet inconspicuous. The shells of the female river-mussels are rather shorter and more ventricose than the others. (See pp. 18, 34.)

UNIO, Retz. River-mussel.

Etym. Unio a pearl (Pliny). *Ex.* U. litoralis, Pl. XVIII. fig. 1.

Shell oval or elongated, smooth, corrugated, or spiny, becoming very solid with age; anterior teeth 1.2 or 2.2, short, irregular; posterior teeth 1.2, elongated, laminar.

Animal with the mantle-margins only united between the siphonal openings; palpi long, pointed, laterally attached. (Fig. 172, p. 246.)

U. plicatus (Symphynota, Sw. Dipsas, Leach) has the valves produced into a thin, elastic dorsal wing, as in *Hyria.** In the Pearl-mussel, *U. margaritiferus* (Margaritana, Schum. Alasmodon, Say) the posterior teeth become obsolete with age. This species, which afforded the once famous British pearls, is found in the mountain streams of Britain, Lapland, and Canada; it is used for bait in the Aberdeen Cod-fishery. The Scotch pearl-fishery continued till the end of the last century, especially in the R. Tay, where the mussels were collected by the peasantry before harvest-time. The pearls were usually found in old and deformed specimens; round pearls about the size of a pea, perfect in every respect, were worth £3 or £4. (Dr. Knapp.) An account of the Irish pearl-fishery was given by Sir R. Redding in the Phil. Trans. 1693. The mussels were found set up in the sand of the river-beds with their open side turned from the torrent; about one in 100 might contain a pearl, and one pearl in 100 might be tolerably clear. (See p. 38.)

Distr. 250 sp. N. America, S. America, Europe, Africa, Asia, Australia.

Fossil, 50 sp. Wealden —. Europe, India.

Sub-genera, Monocondylæa, D'Orb. M. Paraguayana, Pl. XVIII. fig. 2. *Shell* with a single large, round, obtuse cardinal tooth in each valve; no lateral teeth. *Distr.* 6 sp. S. America.

Hyria, Lam. H. syrmatophora, Pl. XVIII. fig. 3. *Syn.* Pachyodon and Prisodon, Schum. *Shell* Arca-shaped, hinge-line straight, with a dorsal wing on the posterior side; teeth elongated, transversely striated. *Distr.* 4 sp. S. America.

* This is the species in which the Chinese produce artificial pearls by the introduction of shot, &c., between the mantle of the animal and its shell (p. 38); Mr. Gaskoin has an example containing two strings of pearls, and another in the Brit. Mus. has a number of little josses made of bell-metal, now completely coated with pearl, in its interior.

CASTALIA, Lamarck.

Type, C. ambigua, Pl. XVIII. fig. 4. *Syn.* Tetraplodon, Spix.

Shell ventricose; trigonal; umbones prominent, furrowed; hinge-teeth striated; anterior 2.1, short; posterior 1.2, elongated.

Animal with mantle-lobes united behind, forming two distinct siphonal orifices, the branchial cirrated.

Distr. Rivers of S. America, Guiana, Brazil.

ANODON, Cuvier. Swan-mussel.

Type, A. cygneus, fig. 171. p. 245. *Etym. Anodontos*, edentulous.

Shell like *unio*, but edentulous; oval, smooth, rather thin, compressed when young, becoming ventricose with age.

Animal like unio: the outer gills of a female have been computed to contain 600,000 young shells (*Lea*). See p. 19.

Distr. 50 sp. N. America, Europe, Siberia. *Fossil*, 5 sp. Eocene —. Europe.

M. D'Orbigny relates that he found great quantities of small Anodons (*Bysso-anodonta Paraniensis*, D'Orb.) 4 lines in length, *attached by a byssus*, in the R. Parana, above Corrientes.

IRIDINA, Lamarck.

Syn. Mutela, Scop. Spatha, Lea (including *Mycetopus*).

Type. I. exotica, Pl. XVIII. fig. 5. *Etym. Iris*, the rainbow.

Shell oblong; umbones depressed; hinge-line long, straight, attenuated towards the umbones, crenated by numerous unequal teeth; ligament long and narrow.

Animal with mantle-lobes united posteriorly, forming two short siphons; mouth and lips small; palpi immense, oval; gills united to the body.

Iridina ovata (Pleiodon, Conrad), has a broader hinge-line.

Distr. 6 sp. Rivers of Africa, Nile, Senegal.

MYCETOPUS, D'Orbigny.

Etym. Mukes a mushroom, *pous* the foot.

Type, M. soleniformis, Pl. XVIII. fig. 6.

Shell elongated, sub-cylindrical, gaping in front; margins sub-parallel, hinge edentulous.

Animal with an elongated, cylindrical foot, expanded into a disk at the end; mantle open; gills equal; palpi short.

Distr. 3 sp. R. Parana, Corrientes; R. Amazon, Bolivia.

ÆTHERIA, Lamarck.

Type, Æ. semilunata, Pl. XVIII. fig. 7. (*aitherios*, aërial.)

Shell irregular, inequivalve; attached by the umbo, and tubular processes of one of the valves, usually the left; epidermis thick, olive; interior pearly, blistered (as if with air-bubbles); hinge edentulous; ligament external, with a conspicuous area and groove in the fixed valve; two adductor impressions, the anterior very long and irregular; pallial line simple.

Animal with the mantle-lobes open; body large, oblong, projecting backwards; no trace of a foot; palpi large, semi-oval; gills sub-equal, plaited, united posteriorly, and to the body and mantle.

Distr. R. Nile, from 1st Cataracts to Fazool;* R. Senegal.

MULLERIA, Férussac.

Dedicated to Otto Frid. Müller, author of the "Zoologia Danica."

Type, M. lobata, Fér. *Syn.* Acostæa (Guaduasana) D'Orb.

Shell when *young* free, equivalve, Anodon-shaped, with a long and prominent ligament, and two adductor impressions: *adult* irregular, inequivalve, attached by the right valve; umbones elongated, progressively filled up with shell, and forming an irregular "talon" in front of the fixed valve; epidermis thick; ligament in a marginal groove; interior pearly, muscular impression single, posterior.

Distr. R. Magdalena, near Bogota, New Granada.

Mr. Isaac Lea has determined the identity of *Mülleria* and *Acostæa* by examination of Férussac's type, and the suite of specimens, of different ages, in the collection of M. D'Orbigny.†

SECTION B. SIPHONIDA.

Animal with respiratory siphons; mantle-lobes more or less united.

a. Siphons short, pallial line simple; Integro-pallialia,

FAMILY VII. CHAMIDÆ.

Shell inequivalve, thick, attached; beaks sub-spiral; ligament external; hinge-teeth 2 in one valve, 1 in the other; adductor impressions large, reticulated; pallial line simple.

Animal with the mantle closed; pedal and siphonal orifices small, subequal; foot very small; gills two on each side, very unequal, united posteriorly.

CHAMA (Pliny) L.

Ex. C. macrophylla, Pl. XVIII. figs. 8, 9. *Syn.* Arcinella, Schum.

Shell attached usually by the *left* umbo; valves foliaceous, the upper smallest; hinge-tooth of free valve thick, curved, received between two teeth, in the other; adductor impressions large, oblong, the anterior encroaching on the hinge-tooth.

Animal with the mantle-margins united by a curtain, with two rows of tentacular filaments; siphonal orifices wide apart, branchial slightly prominent, fringed, anal with a simple valve; foot bent, or heeled; liver occupying the umbo of the attached valve only; ovary extending into both mantle-lobes, as far as the pallial line; lips simple, palpi small and curled; gills

* The "fresh-water oysters" discovered by BRUCE.

† The only specimen of Mülleria in England was purchased many years ago by Mr. Thos. Norris, of Bury, for £20.

deeply plaited, the outer pair much shorter and very narrow, furnished with a free dorsal border, and united behind to each other, and to the mantle; adductors each composed of two elements.

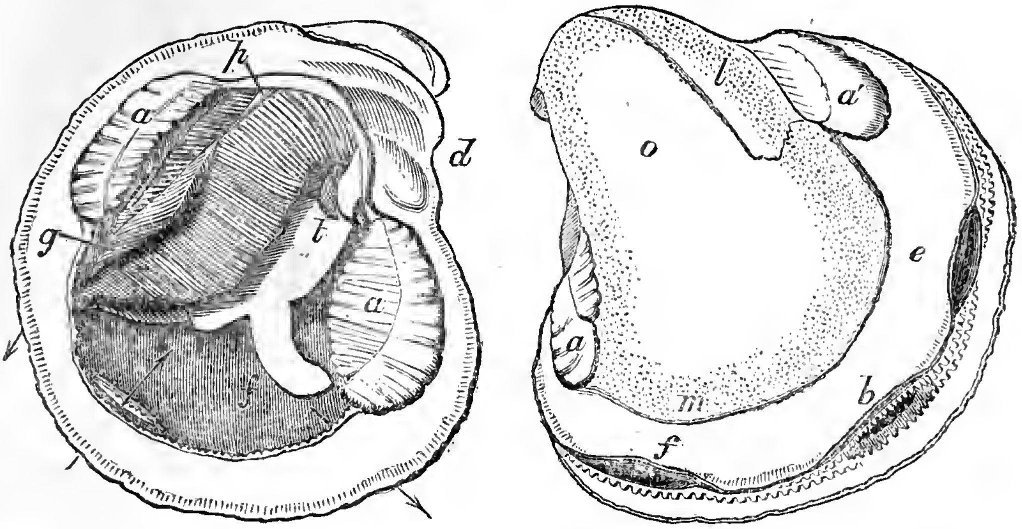


Fig. 184. *Right Side.* Fig. 185. *Left side.*
Animal of Chama (from Torres Str. Mr. Jukes.)
Fig. 184. Right side, with the umbonal portion of the mantle removed.
Fig. 185. Left side, showing the relative extent of the liver and ovarium.
a, *a*, adductors; *m*, pallial line; *e*, excurrent orifice; *b*, branchial; *f*, foot and pedal orifice; *p*, posterior pedal muscle; *t*, palpi; *g*, gills (contracted); *l*, liver; *o*, ovarium; *d*, dental lobes.

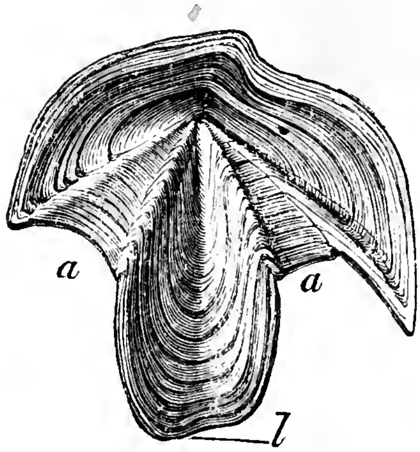
The shell of *Chama* consists of three layers; the external, coloured layer is laminated by oblique lines of growth, with corrugations at right angles to the laminæ; the foliaceous spines contain reticulated tubuli: the middle layer is opaque white and consists of ill-defined vertical prisms or corrugated structure; the inner layer, which is translucent and membranous, is penetrated by scattered vertical tubuli; the minute processes that occupy the tubuli give to the mantle (and to the casts of the shell) a granular appearance (fig. 185, *l*, *m*.)

Some Chamas are attached indifferently by either valve; when fixed by the right valve the dentition is reversed, the left valve having the single tooth. *Chama arcinella*, which is always attached by the right umbo, has the normal dentition 1 : 2; it is nearly regular and equivalve, and has a distinct lunule.

Distr. 50 sp. Tropical seas, especially amongst coral-reefs; — 50 fms. W. Indies, Canaries, Medit. India, China.

Fossil, 30 sp. Green-sand —. U. States, Europe.

Sub-genus ? Monopleura; Matheron (= Dipilidia, Math) *M. imbricata*, Math. Fig. 187. Neocomian, S. France. *Shell* attached by the *dextral* umbo; valves alike in structure and sculpturing; fixed valve straight, inversely conical, with a long, straight ligamental groove, and obscure hinge-area; opercular valve flat or convex, with an oblique, sub-marginal umbo.



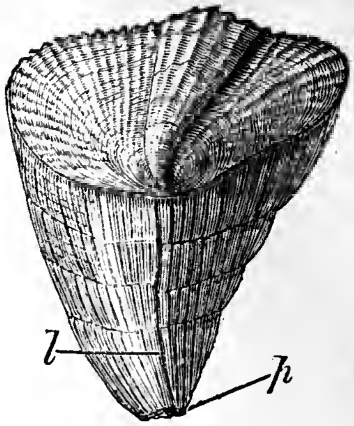
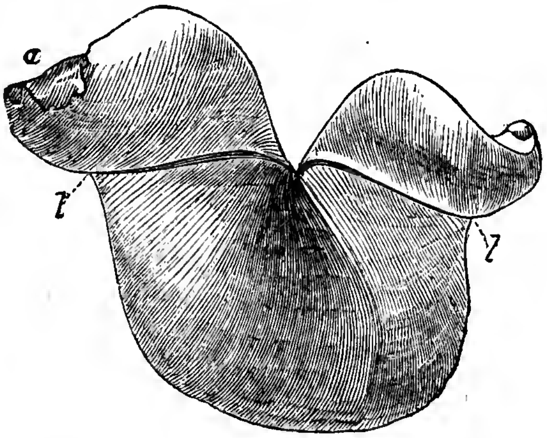


Fig. 186. *Bi-radiolites*, $\frac{3}{5}$. Fig. 187. *Monopleura*, $\frac{1}{2}$.
p, point of attachment; *l*, ligamental groove; *a, a*, corresponding areas.

Fossil, 9 sp. Neocomian — Chalk. France, Texas. They are commonly found in groups, adhering laterally, or rising one above the other; the casts of such as are known are quite simple and chama-like.



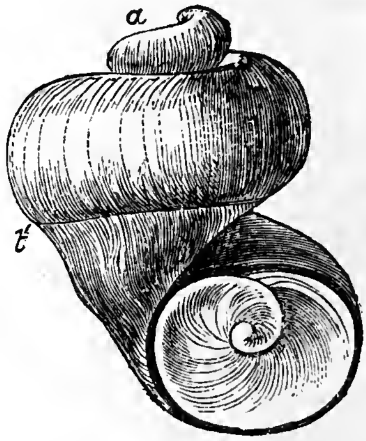


Fig. 188. *Diceras arietinum*, $\frac{1}{2}$. Fig. 189. *Requienia ammonia*, $\frac{1}{4}$.
a, point of attachment; *l, l*, ligamental grooves; *t*, posterior adductor inflection.

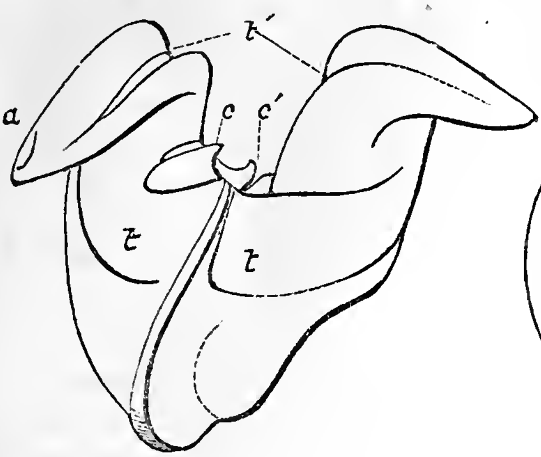
Diceras, Lamarck.

Type, D. arietinum, Pl. XVIII. figs. 10, 11, and fig. 188, 190.

Shell sub-equivalve, attached by either umbo; beaks very prominent, spiral, furrowed externally by ligamental grooves; hinge very thick, teeth 2.1, prominent; muscular impressions bounded by long spiral ridges, sometimes obsolete.

Distr. 5 sp. Middle oolite. Germany, Switz. France, Algeria.

Diceras differs from *Chama* in the great prominence of both its *umbones*, in having constantly two hinge-teeth in the right valve and one in the left, and in the prominent ridges bordering the muscular impressions. Similar ridges exist in *Cucullæa, Megalodon, Cardilia* and the Hippurite; they produce deep spiral furrows on the casts, which are of common occurrence in the Coral-oolite of the Alps. One or both the anterior furrows (fig. 190, *t, t*) are frequently obsolete. The dental pits are much deeper than the teeth which they receive, and are sub-spiral, giving rise to bifid projections (*c*, *c*) on the casts; the single tooth in the left valve consists of two elements, and the cavity (*fosset*) which receives it is divided at the bottom.



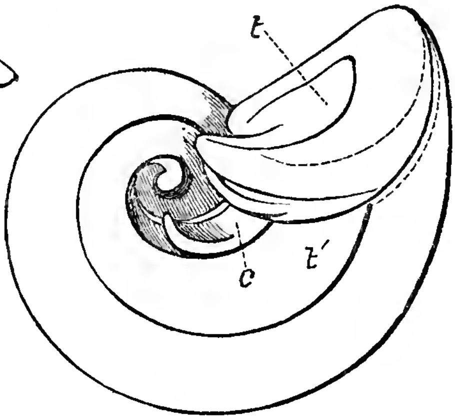


Fig. 190. *Diceras*, ¼. Fig. 191. *Requienia*, ½.
Internal casts: *a*, point of attachment; *c*, *c'*, casts of dental pits; *t*, *t'*, furrows produced by spiral ridges. (Mus. Brit.)

Requienia, Matheron.

Dedicated to M. Requien, author of a Catalogue of Corsican Mollusca.

Ex. R. Lonsdalii, Pl. XVIII. fig. 12 and fig. 191. R. Ammonia, fig. 189.

Shell thick, very inequivalve, attached by the *left* umbo; ligament external; teeth 2:1; left valve spiral, its cavity deep, not camerated; free valve smaller, sub-spiral; posterior adductor bordered by a prominent sub-spiral ridge in each valve.

The shell-structure of *Requienia* is like that of *Chama*. The relative size of the valves is subject to much variation; in *R. Favri* (Sharpe) they are nearly equal. The hinge-teeth are like those of *Diceras*; the cavity for the posterior tooth of the right valve is very deep and sub-spiral (fig. 191, *c'*). The internal muscular ridges are produced by duplicatures of the shell-wall, and are indicated outside by grooves (fig. 189, *t'*). In *R. sub-æqualis* and *Toucasiana* there is a second parallel ridge, as in Hippurites and *Caprotina*.

Fossil, 7 sp. Neocomian — L. Chalk. Brit. France, Spain, Algeria, Texas.

FAMILY VIII. Hippuritidæ.

(Order *Rudistes*, Lamarck.)

Shell inequivalve, unsymmetrical, thick, attached by the *right* umbo; umbones frequently camerated; structure and sculpturing of valves dissimilar; ligament internal; hinge-teeth 1 : 2; adductor impressions 2, large, those of the left valve on prominent apophyses; pallial line simple, submarginal.

The shells of this extinct family are characteristic of the cretaceous strata, and abound in many parts of the Peninsula, the Alps and E. Europe, where the equivalent of the Lower Chalk has received the name of "Hippurite limestone." They occur also in Turkey and in Egypt, and Dr. F. Rœmer has found them in Texas and Guadaloupe.

They are the most problematic of all fossils: there are no recent shells which can be supposed to belong to the same family; and the condition in which they usually occur has involved them in greater obscurity.* The characters which determine their position amongst the ordinary bivalves are the following:—

1. The shell is composed of two distinct layers.
2. They are essentially unsymmetrical, and right-and-left valved.
3. The sculpturing of the valves is dissimilar.
4. There is evidence of a large internal ligament.
5. The hinge-teeth are developed from the free valve.
6. The muscular impressions are 2 only.
7. There is a distinct pallial line.

The outer layer of shell in the Hippurite and Radiolite consists of prismatic cellular structure (fig. 123); the prisms are perpendicular to the shell-laminæ, and subdivided often minutely. The cells appear to have been empty, like those of *Ostrea* (p. 254).† The inner layer, which forms the hinge and lines the umbones is sub-nacreous, and very rarely preserved. It is usually replaced by calcareous spar (fig. 200), sometimes by mud or chalk, and very often it is only indicated by a vacuity between the outer shell and the internal mould (fig. 205). The inner shell-layer is seldom compact, its lamellæ are extremely thin, and separated by intervals like the water-chambers of *Spondylus;* similar spaces occur in the deposit, filling the umbonal cavity of the long-beaked oysters.‡

* 1. Buch regarded them as Corals. 1840, Leonh. and Bronn Jahrb. p. 573.
2. Desmoulins, as a combination of the Tunicary and Sessile Cirripede.
3. Dr. Carpenter, as a "group intermediate between the *Conchifera* and *Cirripeda*." An. Nat. Hist. XII. 390.
4. Prof. Steenstrup, of Copenhagen, as Anellides.
5. Mr. D. Sharpe refers *Hippurites* to the Balani; *Caprinella* to the Chamaceæ.
6. Lapeirouse considered the Hippurites *Orthocerata;* the Radiolites, *Ostracea.*
7. Goldfuss and D'Orbigny place them both with the *Brachiopoda.*
8. Lamarck and Rang, between the *Brachiopoda* and *Ostraceæ.*
9. Cuvier and Owen, with the Lamellibranchiate bivalves.
10. Deshayes, in the same group with *Ætheria.*
11. Quenstedt, between the *Chamaceæ* and *Cardiaceæ.*

† This is very conspicuous in *Radiolites* from the Chalk; a formation in which other prismatic-cellular fossils are solid.

‡ The water-chambers in some of the cylindrical Hippurites are large and regular, like those of the fossil corals *Amplexus* and *Cyathophyllum.* A section of *Hippurites bi-oculatus* passing through only one of the dental sockets, resembles an *Orthoceras* with a lateral siphuncle; whilst a *Caprinella* (fig. 207), which has lost its outer layer, might be mistaken for a sort of *Ammonite.*

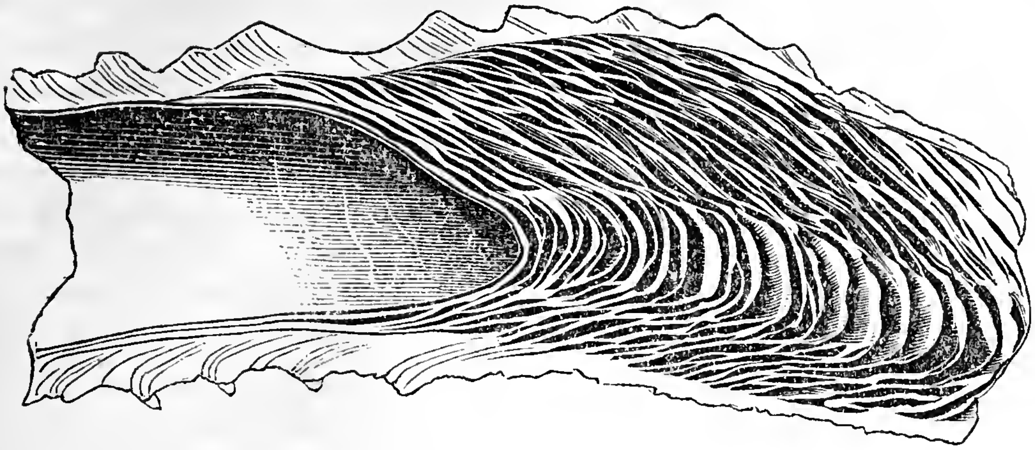


Fig. 192. Section of a fragment of *Ostrea cornucopiæ.*

The inner layer ceases at the pallial line, beyond which, on the rim of the shell, the cellular structure is often apparent; obscure bifurcating impressions radiate from the pallial line to the outer margin, (fig. 193, *v*, *v*.)

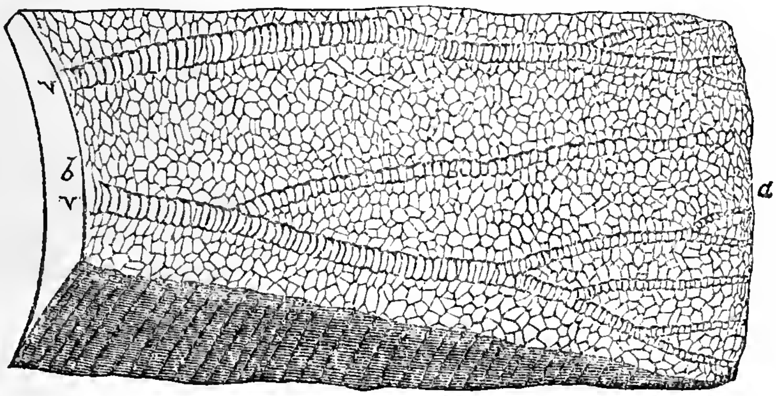


Fig. 123, Part of the rim of *Radiolites Mortoni*, Mantell, *

These have been compared to the vascular impressions of *Crania.* (figs. 157, 8) and constitute the only argument for supposing the *Rudistes* to have been *palliobranchiate;* but they occur on the *rim* of the shell, and not on the disk, as in *Crania.*† The chief peculiarity of the *Hippuritidæ* is the dissimilarity in the structure of the valves, but even this is deprived of much significance by its inconstancy.‡ The free valve of *Hippurites* is perforated by radiating canals which open round its inner margin, and communicate with

* Traced from the original specimen in the Museum of the School of Mines. *b*, is the inner edge: *a*, the outer edge; *v*, *v*, the dichotomous impressions; the horizontal laminæ are seen on the shaded side. Lower Chalk; Sussex.

† M. D'Orbigny considers they were produced by peculiar appendages to the mantle-margin, which, in *Hippurites,* were prolonged into the canals of the upper valve.

‡ The lower valves of some *Spondyli* are squamous or spiny, the upper plain; those of many oysters Pectens and some Tellens are diversely sculptured; but in no instance is the internal structure of the two valves different? The inconstancy of the shell-structure in the *Rudista* has a parallel in *Rhynchonella* and *Terebratula* (p. 213), and in the condition of the hepatic organ in *Tritonia* and *Dendronotus.*

the upper surface by numerous pores, as if to supply the interior with filtered water; possibly, they were closed by the epidermis.*

In the closely allied genus *Radiolites* there is no trace of such canals, nor in *Caprotina*. Those which exist in the upper valve of *Caprina*, and in both valves of *Caprinella*, have no communication with the outer surface of the shell; they appear to be only of the same character with the tubular ribs of *Cardium costatum* (Pl. XIX. fig. 1), and it is highly improbable that they were permanently occupied by processes from the margin of the mantle.

The teeth of the left, or upper valve, are so prominent and straight, that its movement must have been nearly vertical, for which purpose the internal ligament appears to have been exactly suited by its position and magnitude; but it is probable that, like other bi-valves, they opened to a very small extent.

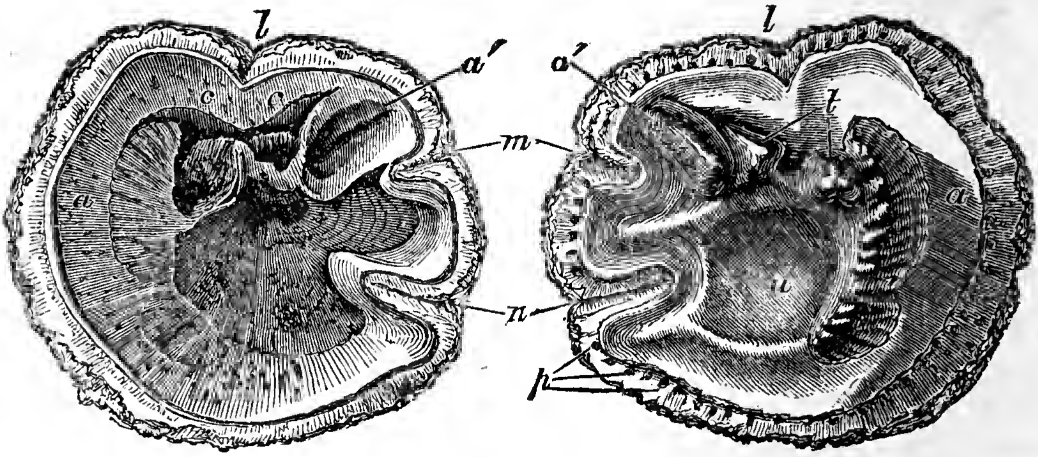


Fig. 194. *Interior of lower valve*, ½. Fig. 195. *Upper valve* (restored).
Hippurites radiosus, *Desm.* *Lower Chalk*, *St. Mamest*, *Dordogne*.†
a, *a*, adductor impressions and processes; *c*, *c*, cartilage pits; *t*, *t'*, teeth and dental sockets; *u*, umbonal cavity; *p*, orifices of canals; *l*, ligamental inflection; *m*, muscular; *n*, siphonal inflection.

Hippurites, Lamarck.

Name, adopted from old writers, "fossil *Hippuris*" or Horse-tail.

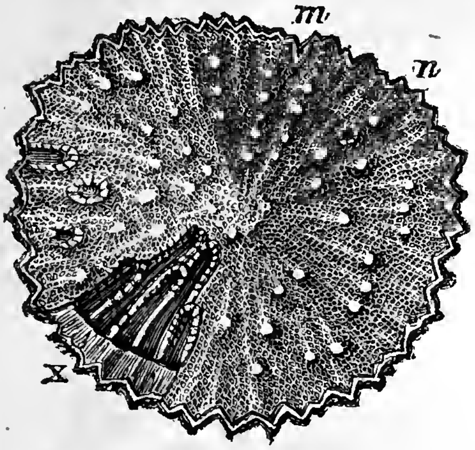
Types, *H. bi-oculatus*, Lam. and *H. cornu-vaccinum*, fig. 198.

Shell very inequivalve, inversely conical, or elongated and cylindrical; *fixed valve* striated or smooth, with three parallel furrows (*l*, *m*, *n*,) on the cardinal side, indicating duplicatures of the outer shell layer: internal margin slightly plaited; pallial line continuous; umbonal cavity moderately deep, ligamental inflection (*l*) with a small cartilage-pit on each side (*c*, *c*); dental sockets sub-central, divided by an obsolete tooth; anterior muscular impression (*a*) elongated, double; posterior (*a'*) small, very deep, bounded by the second duplicature (*m*); third duplicature (*n*) projecting into the um-

* The valves of *Crania* are perforated by branching tubuli, but in that case they pass *vertically* through every part of the shell, and all its layers (p. 214.)

† From the original in the Brit. M. The inner layer of shell in this species has an irregularly cellular structure, to which its preservation is due.

bonal cavity: *free valve* depressed, with a central umbo, and two grooves or pits corresponding to the posterior ridges in the lower valve; surface porous, the pores leading to canals in the outer shell-layer, which open round the pallial line upon the inner margin; anterior cartilage-pit deep and conical,



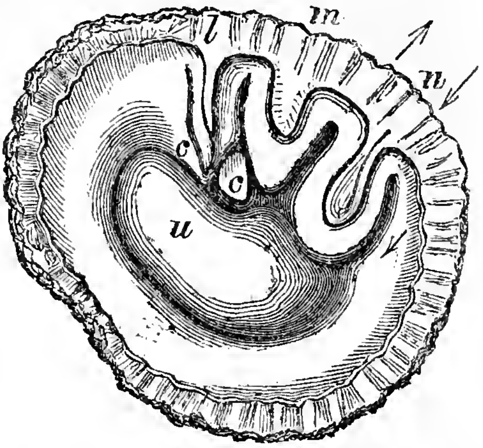


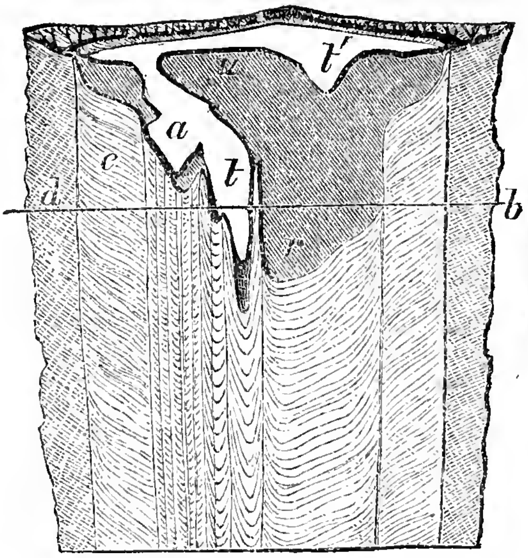
Fig. 196. *H. Toucasianus, upper valve*, ½.* Fig. 197. *Lower valve, with mould*, ⅔. *l*, ligamental; *m*, muscular; *n*, siphonal inflections; *x*, fracture, showing canals; c, cartilage: *u*, left umbo; the arrows indicate the probable direction of thebranchial currents.

posterior shallow; umbonal cavity turned to the front (*u*); teeth 2, straight, sub-central, the anterior largest, each supporting a crooked muscular apophysis, the first broad, the hinder prominent, tooth-like; inflections (*m*, *n*) surrounded by deep channels.

H. cornu-vaccinum attains a length of more than a foot, and is curved like a cow's-horn; the outer layer separates readily from the core, which is furrowed longitudinally, The ligamental inflection (*l*) is very deep and narrow, and the anterior tooth further removed from the side than in *H. bi-oculatus* and *radiosus* (figs. 194, 5); the posterior apophysis (*a'*) does not nearly fill the corresponding cavity in the lower valve. In *H. bi-oculatus* and some other species there is no ligamental ridge inside; these, when they have lost their inner layer, present a cylindrical cavity with two parallel ridges, extending down one side. The third inflection (*n*) is possibly a siphonal fold, such as exists in the tube of *Teredo*, and sometimes in the valves of *Pholas, Clavagella*, and the caudate species of *Trigonia*.

The development of processes from the upper valve, for the attachment of the adductor muscles harmonizes with the other peculiarities of the Hippurite. The equal growth of the margins of the valves produces central umbones, and necessitates an internal cartilage; this again causes the removal

* This internal mould, representing the form of the animal, was obtained by removing the upper valve piecemeal with the chisel; a plaster-cast taken from it represents the interior of the upper valve, with the bases of the teeth and apophyses. See originals in Brit. Mus.



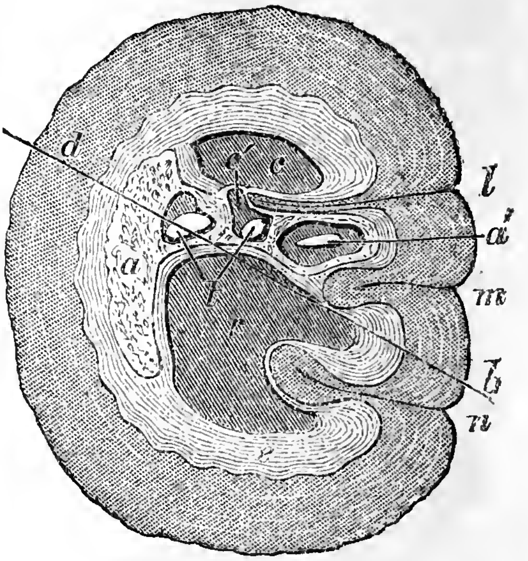
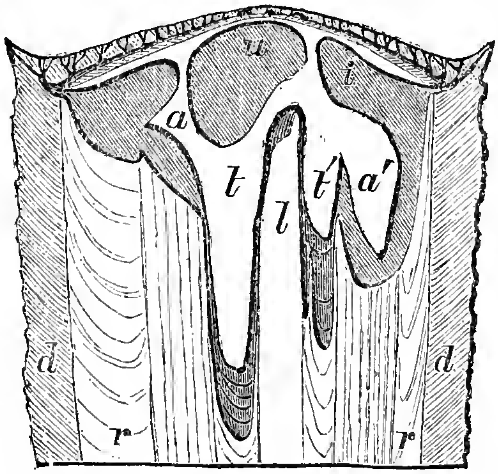


Fig. 198. Longitudinal section; upper half, ½. Fig. 199. Transverse section, ⅓.
Hippurites cornu-vaccinum, Bronn. Salzburg.

l, m, n, duplicatures; *u,* umbonal cavity of left valve; *r,* of right valve; *c, c',* cartilage-pits; *t, t',* teeth; *a, a',* muscular apophyses; *d,* outer shell-layer, Fig. 198 is taken in the line *d, b,* of fig. 199, cutting only the base of the posterior tooth (*t'*). Fig. 199, is from a larger specimen, at about the level *d, b* of fig. 198, cutting the point of the posterior apophysis (*a'*), and shewing the peculiar shell-texture deposited by the anterior adductor (*a*).

of the teeth and adductors further from the hinge-margin, to a position in which the muscles must have been unusually long, unless supported in the manner described. Supposing the animal to have had a small foot,* like



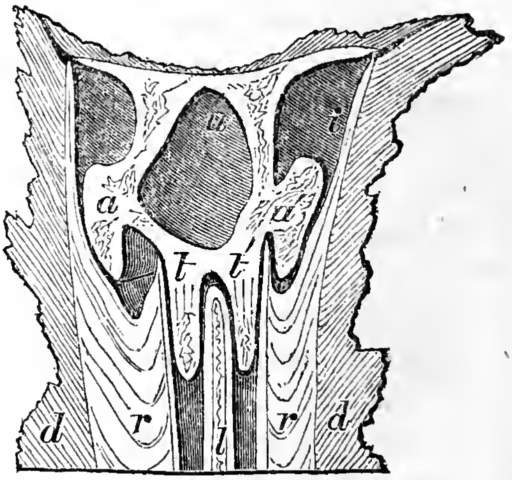
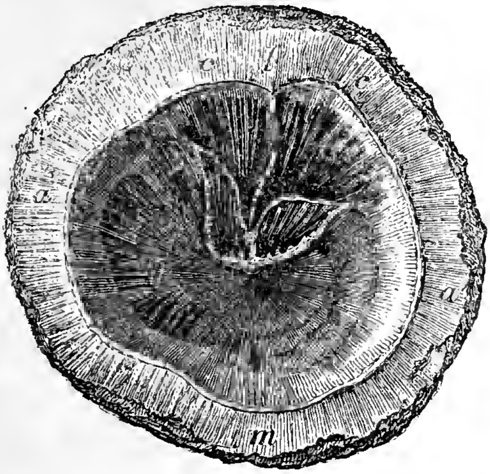


Fig. 200. *Hippurites cornu-vaccinum.* Fig. 201. *Radiolites cylindraceus,* ½.
Longitudinal sections taken through the teeth (*t, t'*) and apophyses (*a, a'*).
d, outer, *r,* inner shell-layer; *l,* dental plate of lower valve; *u,* umbonal cavity of upper valves; *i,* intestinal channel. Originals in Brit. M.

* This is extremely doubtful; since p. 253 was printed, we have examined an authentic specimen of *Aetheria,* and find that Rang and Cailliaud's account is incorrect: *it has no foot.*

Chama, the mantle-opening for that organ would have been completely obstructed by the adductor, but that the muscular support was hook-shaped (fig. 200, *a*). The posterior adductor-process is similarly under-cut for the passage of the rectum, which in all bivalves emerges between the hinge and posterior adductor, winds round outside that muscle and terminates in the line of the exhalent current. There is a groove (sometimes an inch deep) round the second and third duplicatures in the upper valve, which seems intended to facilitate the passage of the alimentary canal, and the flow of water from the gills into the exhalent channel. The smallness of the space for the branchiæ may have been compensated by deep plication of those organs, as in *Chama* and *Tridacna*.

Fossil, 16 sp. Chalk. Bohemia, Tyrol, France, Spain, Turkey, Syria Algeria, Egypt.



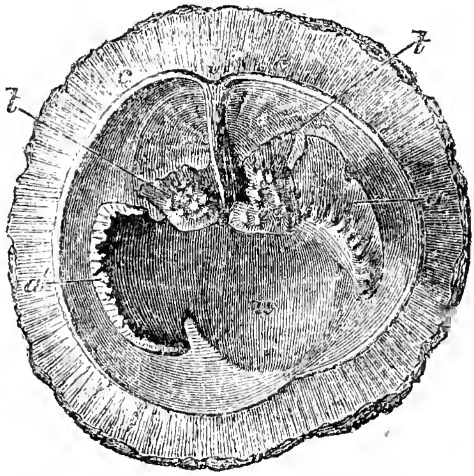


Fig. 202. Interior of lower valve. Fig. 203. Interior of upper valve.
Radiolites mammillaris, Math. ½ L. Chalk. S. Mamest, Dordogne.
l, ligamental inflection; *m*, pallial line; *c, c*, cartilage pits; *a, a*, adductor impressions and processes; *t*, teeth and dental sockets.

RADIOLITES, Lamarck, 1801.

Etym. Radius, a ray. *Syn.* Sphærulites, De la Metherie, 1805.

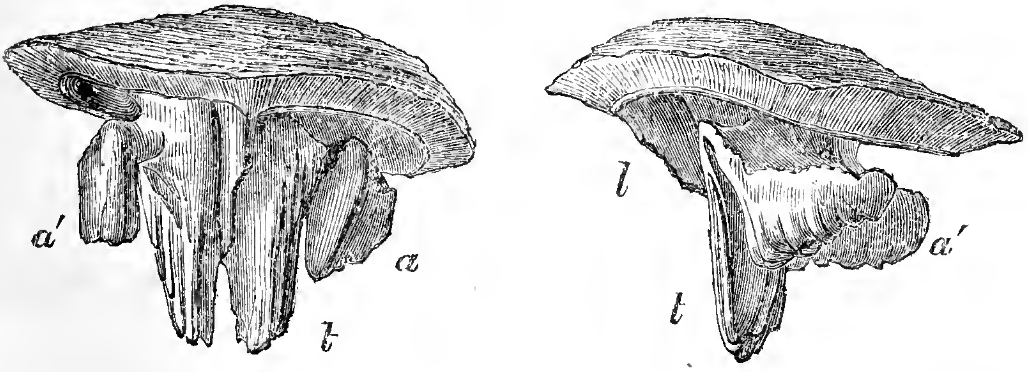
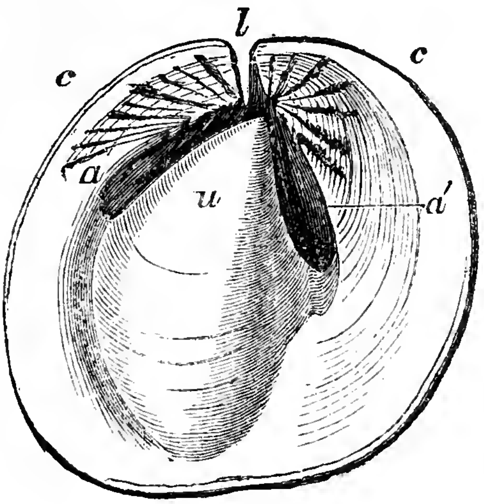


Fig. 204. Side views of the upper valve of *R. mammillaris*;' *l*, ligamental inflection *t*, teeth; *a, a'*, muscular processes.

Shell inversely conical, bi-conic, or cylindrical; valves dissimilar in structure; internal margins smooth or finely striated, simple, continuous; ligamental inflection very narrow, dividing the deep and rugose cartilage pits: *lower valve* with a thick outer layer, often foliaceous; its cavity deep and straight, with two dental sockets and lateral muscular impressions; *upper valve* flat or conical, with a central umbo; outer layer thin, radiated; umbonal cavity inclined towards the ligament; teeth angular, striated, supporting curved and sub-equal muscular processes.

The upper valve of *R. fleuriausus* has an oblique umbo, with a distinct ligamental groove. The foliations of the lower valve are frequently undulated; they are sometimes as thin as paper and several inches wide.

The umbonal cavity of the lower valve is partitioned off by very delicate funnel-shaped laminæ. Specimens frequently occur in which the outer shell layer is preserved, whilst the inner is wanting, and the mould ("birostrites") remains loose in the centre. The interior of the outer shell layer is deeply grooved with lines of growth, and exhibits a distinct ligamental ridge in each valve.



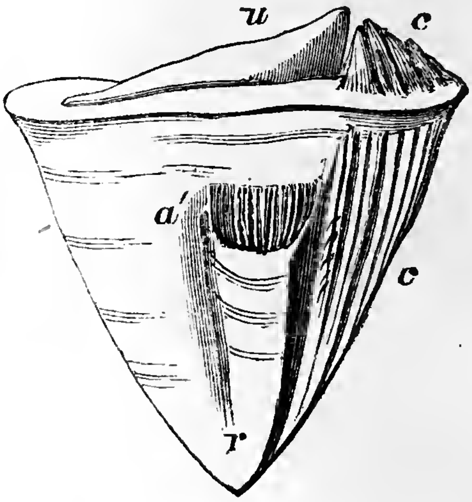


Fig. 205. Upper view. Fig. 206. Side view.

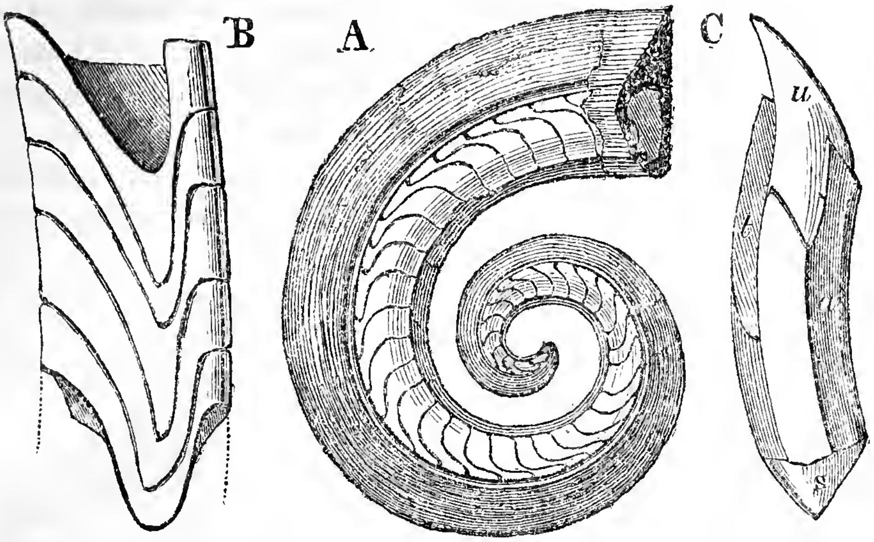
Internal mould of *R. Hœninghausii*, Desm. ½. Chalk.

u, umbo of left valve; *r*, right umbo; *l*, ligamental groove; *c, c*, cartilage; *a*, anterior adductor muscle; *a'*, posterior.

In aged examples of *R. calceoloides* the ligamental inflection is concealed, the cartilage pits partially filled up and smoothed, and the teeth and apophyses so firmly wedged into their respective cavities, as to suggest the notion that the valves had become fixed about ¼ inch apart, and ceased to open and close at the will of the animal.

Fossil, 42 sp. Neocomian — Chalk. Texas; Brit. France, Bohemia, Saxony, Portugal, Algeria, Egypt.

Sub-genus? Bi-radiolites, D'Orb. R. canaliculatus, (Fig. 186, upper valve). Ligamental groove visible in one or both valves, sometimes occupying the crest of a ridge, and bordered by two similar areas, (*a, a.*) *Fossil*, 5 sp. Chalk, France.



Fig, 207. *Caprinella triangularis,* Desm. U. Green-sand, Rochelle. $\frac{2}{5}$
A, portion of the left valve, after D'Orbigny,* the shell-wall is removed byweathering, exposing the camerated interior. B, mould of five of the water-chambers. C, mould of the body-chamber; *u*, umbo of right valve; *s*, of left valve; *t*, dental groove: *a*, surface from which the posterior lobe has been detached. From the originals in the Brit. M. presented by S. P. Pratt, Esq.

CAPRINELLA, D'Orbigny.

Type, C. triangularis, Desm. (Fig 207). *Syn.* Caprinula (Boissii) D'Orb.

Shell fixed by the apex of the right valve, or free; composed of a thick layer of open tubes, with a thin compact superficial lamina; cartilage internal, contained in several deep pits; umbones more or less camerated; right

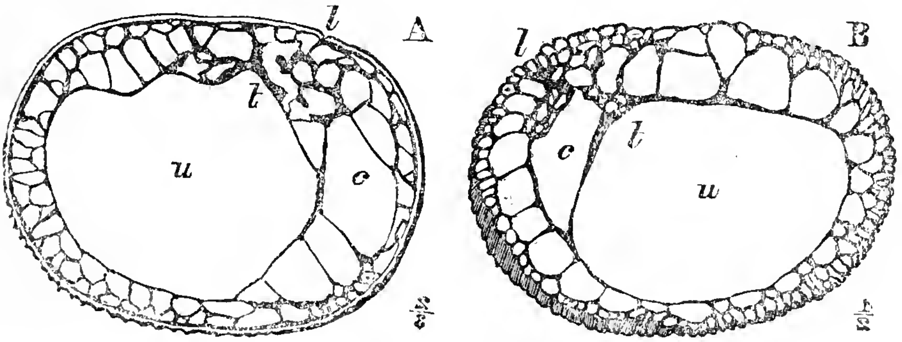


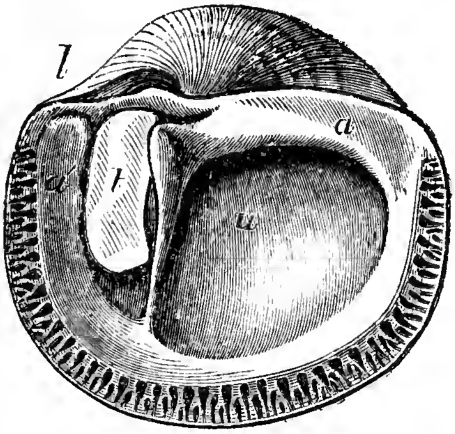
Fig. 208. Straight valve. Fig. 209. Spiral valve.
Transverse sections of *C. Boissii*, L. Chalk, Lisbon (Mr. Sharpe).
l, position of ligamental inflection; *t*, teeth; *c*, cartilage pits; *u*, umbonal cavity.
Fig. 209 is from a weathered specimen, which has lost the outer layer. The tubes of the shell-wall are filled with limestone containing small shells.

* In M. D'Orbigny's figure the smaller valve has been added from another specimen, and is turned *towards* the spire of the large valve, (Pal. Franc. pl. 542, fig. 1.) In Mr. Pratt's specimens, and those collected by M. Sharpe in Portugal, the umbo of the smaller valve is turned *away* with a sigmoid flexure. (Geol. Journ. VI. pl. 18.)

valve conical or elongated, with a ligamental furrow on its convex side, and furnished with one strong hinge-tooth supported by an oblique plate: left valve oblique or spiral, with 2 hinge-teeth, the anterior supported by a plate which divides the umbonal cavity lengthwise.

In *C. triangularis* the umbonal cavity of the spiral valve is partitioned off at regular intervals (Fig. 207, A); the length of the water chambers is sometimes 3½ inches, and of the body-chamber from 2 to 7 diameters; specimens measuring a yard across may be seen on the cavernous shores of the islets near Rochelle.* (*Pratt.*)

Fossil, 6 sp. Neocomian — L. Chalk. France, Portugal, Texas.



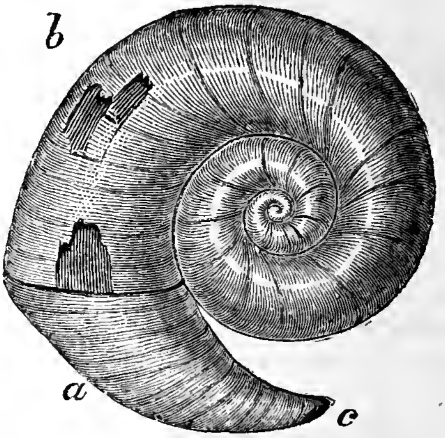


Fig. 210. *C. Aguilloni*, left valve. Fig 211. *C. adversa* (after D'Orb.)
a. a, position of adductors; *l*, ligament; *u*, umbonal cavity; *t*, tooth of fixed valve, broken off and remaining in its socket; *c*, original point of attachment.

Caprina, C. D'Orb.

Etym. Caprina, pertaining to a goat. *Syn.* Plagioptychus, Matheron.

Type, C. Aguilloni, C. D'Orb. L. Chalk, Tyrol, (= C. Partschii, Hauer.)

Shell with dissimilar valves, cartilage internal; fixed valve conical, marked only by lines of growth and a ligamental groove; hinge-margin with several deep cartilage-pits; and one large and prominent tooth on the posterior side; free valve oblique or spiral, thick, perforated by one or more rows of flattened canals, radiating from the umbo and opening around the inner margin; anterior tooth supported by a plate which divides the umbonal cavity lengthwise, posterior tooth obscure; hinge-margin much thickened, grooved for the cartilage.

In *C. adversa* (fig. 211) the free valve is (*b*) sinistrally spiral; its cavity is partitioned off by numerous septa, and divided longitudinally by the dental plate. When young it is attached by the apex of the straight valve (*c*), but afterwards becomes detached, as the large specimens are found imbedded with

* These singular fossils were called *ichthyosarcolites* by Desmarest, from their resemblance to the flaky muscles of fishes.

the spire downwards. (Saemann). The lower valve of *C. Coquandiana* is sub-spiral.

Fossil, 5 sp. U. Green-sand and L. Chalk. Bohemia, France, Texas.

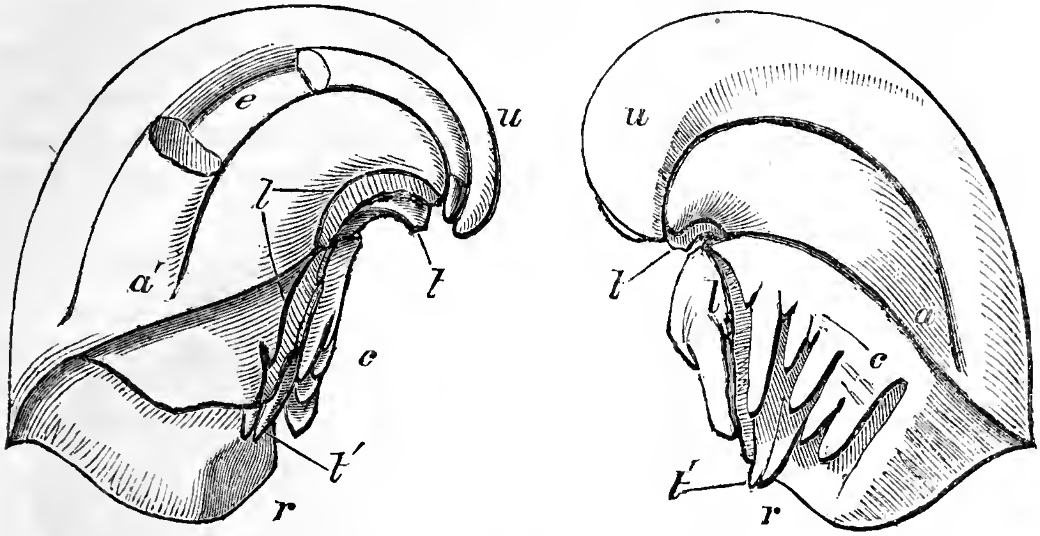


Fig. 212. Internal mould of *Caprotina quadripartita,* D'Orb. ½. *u,* left umbo; *r,* right umbo; *l,* ligamental inflection; *c,* cartilage; *t, t',* dental sockets; *a, a',* position of adductors; at *e,* a portion of the third lobe is broken away.* From a specimen collected by Mr. Pratt.

CAPROTINA, D'Orbigny.

Type, C. semistriata, Pl. XIX. fig. 13, 14. Le Mans, Sarthe.

Shell composed of two distinct layers; valves alike in structure, dissimilar in sculpturing; ligamental groove slight; cartilage internal; *right valve* fixed, striated, or ribbed, with one narrow tooth between two deep pits, cartilage pits several on each side of the ligamental inflection, posterior adductor supported by a plate: *free valve* flat or convex, with a marginal umbo; teeth 2, very prominent, supported by ridges (*apophyses*) of the adductor muscles (*a, a'*), the anterior tooth connected with a third plate (*n*), which divides the umbonal cavity.

The smaller *Caprotinæ* occur in groups, attached to oyster-shells; their muscular ridges are much less developed than in the large species (fig. 212). *C. costata* is like a little Radiolite.

Fossil, 4 sp. U. Green-sand, France. (The rest are Chamas, &c.)

FAMILY IX. TRIDACNIDÆ.

Shell regular, equivalve, truncated in front; ligament external; valves strongly ribbed, margins toothed; muscular impressions blended, sub-central, obscure.

Animal attached by a byssus, or free; mantle-lobe extensively united;

* The first and fourth lobes, those on each side of the ligamental inflection, appear to be the two divisions of a great internal cartilage, like that of the Radiolite. (Fig. 205, 206, *c, c.*)

pedal opening, large, anterior; siphonal orifices surrounded by a thickened pallial border; branchial plain; anal remote, with a tubular valve: shell-muscle single, large and round, with a smaller pedal muscle close to it behind; foot finger-like, with a byssal groove; gills 2 on each side, narrow, strongly plaited, the outer pair composed of a single lamina, the inner thick, with margins conspicuously grooved; palpi very slender, pointed.

The shell of *Tridacna* is extremely hard, being calcified until almost every trace of organic structure is obliterated. (*Carpenter.*)

Tridacna, Bruguière. Clam-shell.

Etym. *Tri-* three, *dakno*, to bite; a kind of oyster. (*Pliny.*)

Ex. T. squamosa, Pl. XVIII. fig. 15.

Shell massive, trigonal, ornamented with radiating ribs and imbricating foliations; margins deeply indented; byssal sinus in each valve large, close to the umbo in front; hinge teeth 1.1, posterior laterals 2.1.

A pair of valves of *T. gigas*, weighing upwards of 500 lbs. and measuring above 2 feet across, are used as *benitiers* in the Church of St. Sulpice, Paris. (Dillwyn.) Capt. Cook states that the animal of this species sometimes weighs 20 lbs. and is good eating.*

Distr. 6 sp. Indian Ocean, China Seas, Pacific.

Fossil, T. media. *Miocene,* Poland (Pusch). *Tridacna* and *Hippopus* are found in the raised coral-reefs of Torres Straits. (Macgillivray.)

Sub-genus. *Hippopus,* Lamarck. H. maculatus, Pl. XVIII. fig. 16. The "bear's-paw clam" has close valves with 2 hinge-teeth in each. It is found on the reefs in the Coral Sea. The animal spins a small *byssus.*

FAMILY X. Cardiadæ.

Shell regular, equivalve, free, cordate, ornamented with radiating ribs; posterior slope sculptured differently from the front and sides; cardinal teeth 2, laterals 1.1 in each valve; ligament external, short and prominent; pallial line simple or slightly sinuated behind; muscular impressions sub-quadrate.

Animal with mantle open in front; siphons usually very short, cirrated externally; gills 2 on each side, thick, united posteriorly; palpi narrow and pointed; foot large, sickle-shaped.

Cardium, L. Cockle.

Etym. *Kardia,* the heart. *Syn.* Papyridea, Sw.

Types, C. costatum, Pl. XIX. fig. 1. C. lyratum, fig. 2.

Shell ventricose, close or gaping posteriorly; umbones prominent, sub-central; margins crenulated; pallial line more or less sinuated.

* "We staid a long time in the lagoon (of Keeling Id.), examining the fields of coral and the gigantic clam-shells, into which if a man were to put his hand, he would not, as long as the animal lived, be able to withdraw it."—Darwin's Journal, p. 460.

Animal with the mantle-margins plaited; siphons clothed with tentacular filaments, anal orifice with a tubular valve: branchial fringed; foot long, cylin rical, sickle-shaped, heeled.

The cockle (*C. edule*) frequents sandy bays, near low-water; a small variety lives in the brackish waters of the R. Thames, as high as Gravesend; it ranges to the Baltic, and is found in the Black Sea and Caspian. *C. rusticum* extends from the Icy Sea to the Medit. Black Sea, Caspian, and Aral. On the coast of Devon the large prickly cockle (*C. aculeatum*) is eaten.

Sub-genera. Hemicardium (Cardissa) Cuvier. C. hemicardium, Pl. XIX. fig. 3. *Shell* depressed, posterior slope flat, valves prominently keeled.

Lithocardium aviculare, Pl. XVIII. fig. 17. *Shell* triangular, keeled; anterior side very short; hinge-teeth 1.2, directed backwards; posterior laterals 2.1; anterior muscular pit minute, posterior impression large, remote from the hinge. *L. cymbulare, Lam.* exhibits slight indications of a byssal sinus in the front margins of the valves. *Fossil, Eocene,* France. These shells present considerable resemblance to *Tridacna.*

Serripes (grœnlandicus) Beck. Hinge edentulous. Arctic Seas, from C. Parry to Sea of Kara; fossil in the Norwich Crag.

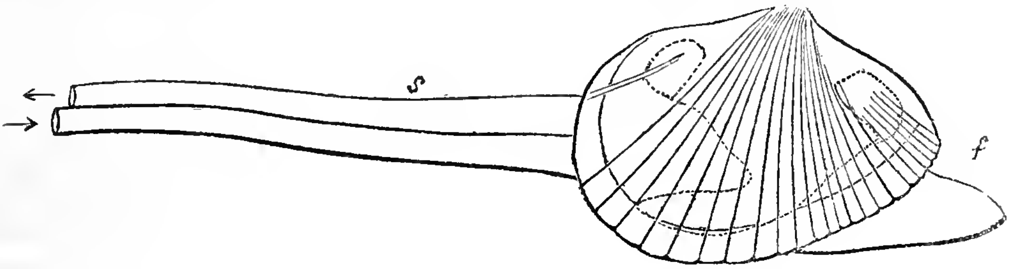


Fig. 213. C. læviusculum, Eichw. (after Middendorff.)

Adacna, Eichwald. C. edentulum, Pl. XIX. fig. 4. (Acardo, Sw. not Brug. Pholadomya, Ag. and Mid. not Sby.) *Shell* compressed, gaping behind, thin, nearly edentulous; pallial line sinuated. *Animal* with the foot (*f*) compressed; siphons (*s*) elongated, united nearly to the end, plain. *Distr.* 8 sp. Aral, Caspian, Azof, Black Sea, and the embouchures of the Wolga, Dnjestr, Dnjepr, and Don; burrowing in mud. *C. Caspicum* (Monodacna, Eichw.) has a single hinge-tooth, and *C. trigonoides* (Didacna, E.) rudiments of two teeth. The siphonal inflection varies in amount.

Distr. 200 sp. World-wide; from the sea-shore to 140 fathoms. Gregarious on sands and sandy mud.

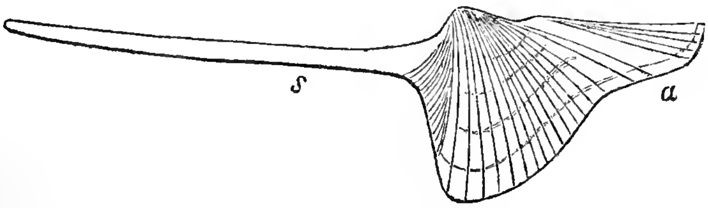


Fig. 214. Conocardium aliforme, Sby. Carb: Ireland. (Mus. Tennant.)

Fossil, 270 sp. U. Silurian —. Patagonia — S. India.

C. Hillanum, Sby. (Protocardium, Beyr.) is the type of a small group in which the sides are concentrically furrowed, the posterior slope radiately striated; the pallial line is slightly sinuated. Jura — Chalk; Europe; India.

Conocardium, Bronn.

Syn. Lychas, Stein. Pleurorhynchus, Ph. Lunulo-cardium, Münster.

Type, C. Hibernicum, Pl. XIX. fig. 5. C. aliforme, fig. 214.

Shell, equivalve trigonal, conical and gaping in front, truncated behind, with a long siphonal tube near the umbones; anterior slope radiately, posterior obliquely striated; margins strongly crenulated within; hinge with anterior and posterior laminar teeth: ligament external.

The truncated end has usually been considered *anterior,* a conclusion which seems incompatible with the vertical position and burrowing habits of most free and equivalve shells: if compared with *Adacna* (fig. 213) the large gape (*a*) will be for the foot, and the long tube (*s*) siphonal. *C. Hibernicum* has an expanded keel, like *Hemicardium inversum.* The shell-structure is prismatic-cellular, as first pointed out by Sowerby; but the cells are cubical, and much larger than in any of the *Aviculadæ.* In *Cardium* the outer layer is only corrugated or obscurely prismatic-cellular.

Fossil, 30 sp. U. Silurian — Carb. N. America, Europe.

FAMILY X. Lucinidæ.

Shell orbicular, free, closed; hinge-teeth 1 or 2, laterals 1—1 or obsolete; interior dull, obliquely furrowed; pallial line simple; muscular impressions 2, elongated, rugose; ligament inconspicuous or sub-internal.

Animal with mantle-lobes open below, and having one or two siphonal orifices behind; foot elongated, cylindrical, or strap-shaped (*ligulate*), protruded at the base of the shell; gills one (or two) on each side, large and thick, oval; mouth and palpi usually minute.

The *Lucinidæ* are distributed chiefly in the tropical and temperate seas, upon sandy and muddy bottoms, from the sea-shore to the greatest habitable depths. The shell consists of two distinct layers.

Lucina, Bruguière.

Etym. Lucina, a name of Juno.

Type, L. Pennsylvanica, Pl. XIX. fig. 6.

Shell orbicular, white; umbones depressed; lunule distinct; margins smooth or minutely crenulated; ligament oblique, semi-internal; hinge-teeth 2.2, laterals 1—1 and 2—2, or obsolete; muscular impressions rugose, anterior elongated within the pallial line, posterior oblong; umbonal area with an oblique furrow.

Animal with the mantle freely open below; siphonal orifices simple;

mouth minute, lips thin; gills single on each side, very large and thick; foot cylindrical, pointed, slightly heeled at the base.

The foot of *Lucina* is often twice as long as the animal, but is usually folded back on itself and concealed between the gills; it is hollow throughout. *L. lactea* (Loripes, Poli.) has a long, contractile anal tube. *L. tigrina* (Codakia, Scop.) has the ligament concealed between the valves, its lateral teeth are obsolete.

Distr. 70 sp. W. Indies, Norway, Black Sea, N. Zealand;—120 fms.

Fossil, 200 sp. U. Silurian —. U. States — T. del. Fuego; Europe — S. India.

Sub-genus, Cryptodon, Turton. L. flexuosa, Pl. XIX. fig. 7. *Syn.* Ptychina, Phil. Thyatira, Leach. Clausina (ferruginosa) Jeffr. *Shell* thin, edentulous; ligament quite internal, oblique, *Animal* with a long anal tube. *Distr.* Norway — N. Zealand. *Fossil,* Eocene —. U. S. Europe.

Corbis, Cuvier.

Etym. Corbis, a basket. *Type,* C. elegans. Pl. XIX. fig. 8.

Syn. Fimbria, Muhl. not Bohadsch. "Idotæa," Schum.

Shell oval, ventricose, sub-equilateral, concentrically sculptured; margins denticulated within; hinge-teeth 2, laterals 2, in each valve; pallial line simple; umbonal area with an oblique furrow, muscular impressions round and polished; pedal scars close to adductors.

Animal with the mantle open below, doubly fringed; foot long pointed; siphonal opening single, with a long retractile tubular valve; lips narrow; palpi rudimentary; gills single on each side, thick, quadrangular, plaited, united behind.

Distr. 2 sp. India, China, N. Australia, Pacific.

Fossil, 80 sp. (including sub-genera). Lias —. U. States, Europe.

In *C. dubia* (Semi-corbis) Desh. *Eocene,* Paris, the lateral teeth are obsolete.

Sub-genera. Sphæra (corrugata) Sby. *Shell* globular, concentrically furrowed and obscurely radiated; ligament prominent; margins crenulated; hinge-teeth 2.2, obscure; laterals obsolete. *Fossil,* Trias — Chalk. Europe.

? *Unicardium,* D'Orb. (Mactromya, Ag. part) = Corbula cardioïdes, Sby. *Shell* thin, oval, ventricose, concentrically striated; ligamental plates elongated; pallial line simple; hinge with an obscure tooth, or edentulous *Fossil,* 40 sp. ? Lias — Portlandian. Europe.

? Tancredia, Lycett, 1850.

Dedicated to Sir Thos. Tancred, Bt. founder of the Cotteswolde Naturalists Club.

Ex. T. extensa, L. Pl. XXI. fig. 22. *Syn.* Hettangia, Turquem.

Shell trigonal, smooth; anterior side usually longest; cardinal teeth

2.2, one of them small; a posterior lateral tooth in each valve; ligament external; muscular impressions oval; pallial line simple.

Fossil, 11 sp. Lias — Bath Oolite. Brit. France.

DIPLODONTA. Bronn.

Etym. Diplos, twin, *odonta,* teeth. *Syn.* Sphærella, Conrad.

Type, D. lupinus (Venus) Brocchi. Pl. XIX. fig. 9.

Shell sub-orbicular, smooth; ligament double, rather long, sub-marginal; hinge-teeth 2.2, of which the anterior in the left valve, and posterior in the right, are bifid; muscular impressions polished, anterior elongated.

Animal with the mantle-margins nearly plain, united; pedal opening large, ventral; foot pointed, hollow; palpi large, free; gills 2 on each side, distinct, the outer oval, inner broadest in front, united behind; branchial orifice small, simple; anal larger, with a plain valve.

Distr. 12 sp. W. Indies, Rio, Brit. Medit. Red Sea, W. Africa, India, Corea, Australia, California. D. diaphana (Felania Recluz) burrows in sand.

Fossil, Eocene —. U. States, Europe.

? *Scacchia,* Philippi, 1844; Tellina elliptica, Sc. *Shell* minute, ovate, posterior side shortest; hinge-teeth 1 or 2, laterals obsolete; ligament minute; cartilage internal, in an oblong pit. *Animal* with mantle widely open; siphonal orifice single; foot compressed, linguiform; palpi moderate, oblong. *Distr.* 2 sp. Medit. *Fossil,* 1 sp. Pliocene, Sicily.

? *Cyamium,* Philippi, 1845, C. antarcticum, Pl. XIX. fig. 16. *Shell* oblong, hinge-teeth 2.2; ligament double; cartilage in a triangular groove behind the teeth in each valve. *Distr.* Patagonia.

UNGULINA, Daudin.

Etym. Ungulina, like a hoof. *Type,* U. oblonga. Pl. XIX. fig. 10.

Shell sub-orbicular; ligament very short; epidermis thick, wrinkled, sometimes black; hinge-teeth 2.2; muscular impressions long, rugose.

Animal with the mantle open below, fringed; siphonal orifice single; foot vermi-form, thickened at the end and perforated, projecting from the base of the shell or folded up between the gills; palpi pointed; gills 2 on each side, unequal, the external narrower, with a free dorsal border, inner widest in front.

Distr. 4 sp. Senegal, Philippines, excavating winding galleries in coral.

KELLIA, Turton, 1822.

Etym. Named after Mr. O'Kelly of Dublin.

Syn. Lasea (Leach) Br. 1827. Cycladina (Adansonii) Cantr. Bornia (sub-orbicularis) *Phil.* Poronia (rubra) Recluz (not Willd.) Erycina (cycladiformis) Desh. (not Lam.)

Types, K. sub-orbicularis. Mont. K. rubra. Pl. XIX. fig. 12.

Shell small, thin, sub-orbicular, closed; beaks small; margins smooth; ligament internal, interrupting the margin (in *K. suborbicularis*), or on the thickened margins (in *K. rubra*); cardinal teeth 1 or 2, laterals 1—1 in each valve.

Animal with the mantle prolonged in front into a respiratory canal, either complete (in *K. suborbicularis*) or opening into the pedal slit (in *K. rubra*); foot strap-shaped, grooved; gills large, two on each side, united posteriorly, the external pair narrower and prolonged dorsally; palpi triangular; posterior siphonal orifice single, exhalent.

The hinges of these little shells are subject to variations, which are not constantly associated with the modifications of the mantle-openings. They creep about freely, and fix themselves by a *byssus* at pleasure. *K. rubra* is found in crevices of rocks at high-water mark, and often in situations only reached by the spray, except at spring-tides; other species range as deep as 200 fms. *K. Laperousii* (Chironia) Desh. Pl. XIX. fig. 11, was obtained, burrowing in sandstone, from deep-water, at Monterey, California.

Distr. 20 sp. Norway — New Zealaud — California.

Fossil, 20 sp. Eocene —. U. States, Europe.

Sub-genera. Turtonia (minuta) Hanley. *Shell* oblong, inequilateral, anterior side very short; ligament concealed between the valves; hinge-teeth 2.2. *Animal* with the mantle open in front; foot large, heeled; siphon single, slender, elongated, protruded from the long end of the shell. *Distr.* Greenland, Norway, Brit. In pools and crevices of rocks between tide-marks, and in the roots of sea-weeds and corallines. Mr. Thompson obtained them from the stomachs of mullets taken on the N.E. coast of Ireland.

Pythina (Deshayesiana) Hinds. (Myllita, D'Orb. and Recl.) *Shell* trigonal, divaricately sculptured; ligament internal; right valve with 2 lateral teeth, left with 1 cardinal and 2 laterals. *Distr.* 2 sp. New Ireland, Australia, Philippines. *Fossil,* Eocene —. France.

Montacuta, Turton.

Dedicated to Col. George Montagu, the most distinguished of the earlier English malacologists.

Type, M. substriata. Pl. XIX. fig. 13.

Shell minute, thin, oblong, anterior side longest; hinge-line notched; ligament internal, between 2 laminar, diverging teeth (with a minute ossicle. *Lovén*).

Animal with the mantle open in front; margins simple; siphonal orifice single; foot large and broad, grooved.

The *Montacutæ* moor themselves by a byssus, or walk freely; *M. substriata* has only been found attached to the spines of the purple heart-urchin (*Spatangus purpureus*) in 5—90 fms. *M. bidentata* burrows in the valves of dead oyster-shells.

Distr. 3 sp. U. S. Norway, Brit Ægean. *Fossil,* 2 sp. Miocene —. Brit.

Lepton, Turton.

Etym. *Lepton,* a minute piece of money (from *leptos,* thin).

Syn. ? Solecardia (eburnea) Conrad, L. California.

Type, L. squamosum. Pl. XIX. fig. 14. Fig. 215.

Shell sub-orbicular, compressed, smooth, or shagreened, a little opened at the ends and longest behind; hinge-teeth 0.1 or 1.1. in front of an angular cartilage notch; lateral teeth 2.2 and 1.1.

Animal with the mantle (*m*) open in front, extending beyond the shell, and bearing a fringe of filaments, of which one in front (*t*) is very large; siphon (*s*) single; gills 2 on each side, separate; foot (*f*) thick, tapering, heeled and grooved, forming a sole or creeping disk. (*Alder.*)

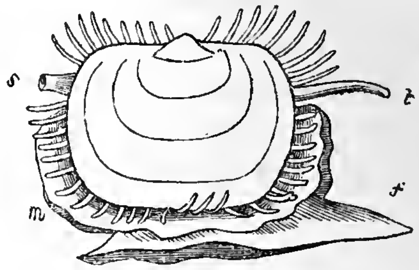


Fig. 215. *Lepton.*

Distr. 3 sp. U. S. Brit. Spain. Laminarian and Coralline Zones.

Fossil, Miocene —. U. S. Brit.

Galeomma, Turton.

Syn. Hiatella, Costa (not Daud.); Parthenopea, Scacchi (not Fabr.)

Type, G. Turtoni, Pl. XIX. fig. 15. (*Galee,* weasel, *omma,* eye.)

Shell thin, oval, equilateral, gaping widely below; invested with a thick, fibrous epidermis; beaks minute; ligament internal; teeth 0.1.

Animal with the mantle-lobes united behind and pierced with 1 siphonal orifice, margins double, the inner with a row of eye-like tubercles; gills large, sub-equal, united behind; lips large, palpi lanceolate, plaited; foot long compressed, with a narrow flat sole.

The *Galeomma* spins a byssus, but breaks from its mooring at will and creeps about like a snail, spreading out its valves nearly flat. (*Clarke.*)

Distr. 3 sp. Brit. Medit. Mauritius, Pacific.

Fossil, Pliocene —. Sicily.

FAMILY XI. Cycladidæ.

Shell sub-orbicular, closed; ligament external; epidermis thick, horny; umbones of aged shells eroded; hinge with cardinal and lateral teeth; pallial line simple, or with a very small inflection.

Animal with mantle open in front, margins plain; siphons (1 or 2) more or less united, orifices usually plain; gills 2 on each side, large unequal, united posteriorly; palpi lanceolate: foot large, tongue-shaped.

All the shells of this family were formerly included in the genus *Cyclas,* a name now retained for the small species inhabiting the rivers of the north temperate zone; the *Cyrenæ* are found in warmer regions, on the shores of creeks and in brackish water, where they are gregarious, burying vertically in the mud, and often associated with members of marine genera.

CYCLAS, Bruguière.

Etym. Kuklas, orbicular. *Type,* C. Cornea. Pl. XIX. fig. 17.

Syn. Sphærium, Scop. Pisum, Muhlf. (not L.) Musculium, Link.

Shell thin, ventricose, nearly equilateral; cardinal teeth 2.1, minute, laterals 1—1:2—2, elongated, compressed.

Animal ovo-viviparous; siphons partly united, anal shortest, orifices plain; gills very large, the outer smallest, with a dorsal flap; palpi small and pointed.

The fry of *Cyclas* are hatched in the *internal* branchiæ, they are few in number and very unequal in size; a full-grown *C. cornea* has about 6 in each gill; the largest being $\frac{1}{6}$ to $\frac{1}{4}$ the length of the parent. The young *Cyclades* and *Pisidia* are very active, climbing about submerged plants and often suspending themselves by byssal threads; the striated gills and pulsating heart are easily seen through the shell.

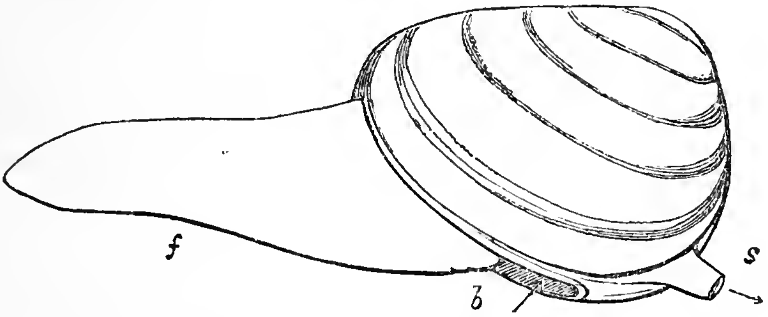


Fig 216. *Pisidium amnicum,* $\frac{3}{1}$. with its foot protruded.

Sub-genus, Pisidium, Pfr. P. amnicum, Pl. XIX. fig. 18. *Shell* inequilateral, anterior side longest; teeth stronger than in *Cyclas*. *Animal* with a single, small, excurrent siphon; branchial and pedal orifices confluent.

Distr. 30 sp. U. States, S. America, Greenland, Norway, Sicily, Algeria, Cape, India, Caspian.

Fossil, 35 sp. Wealden —. Europe.

CYRENA, Lamarck.

Etym. Cyrene, a nymph. *Type,* C. cyprinoides, Pl. XIX. fig. 20.

Shell oval, strong, covered with thick, rough epidermis; ligament thick and prominent; hinge-teeth 3.3, laterals 1—1 in each valve; pallial line slightly sinuated.

Animal (of type) with the mantle open in front and below, margins plain; siphons short, orifices fringed; gills unequal, square in front, plaited, inner lamina free at base; palpi lanceolate; foot strong, tongue-shaped.

Section, Corbicula, Muhlf. *C. consobrina,* Pl. XIX. fig. 21. *Shell* orbicular, concentrically furrowed, epidermis polished; lateral teeth elongated, striated across.

Distr. 25 sp. Tropical America (eastern); Egypt, India, China, Australia, Pacific Ids. In the mud of rivers, and in mangrove swamps, usually near the coast. *C. consobrina* ranges from Egypt to Cashmere and China, and is found fossil in the Pliocene formations of England,* Belgium and Sicily.

Fossil, 70 sp. Wealden —. Europe, U. States.

? Cyrenoides, Joannis.

Syn. Cyrenella, Desh. *Type*, C. Dupontii, Pl. XIX. fig. 19.

Shell orbicular, ventricose, thin, eroded at the beaks; epidermis dark olive; ligament external, prominent, elongated; cardinal teeth 3:2, the central tooth of the right valve bifid; muscular impressions long, narrow; pallial line simple.

Animal with the mantle open in front and below, margin simple, siphons short, united; palpi moderate, narrow; gills very unequal, narrow, united behind; foot cylindrical elongated.

Distr. 1 sp. R. Senegal. The marine sp. are *Diplodontæ*.

FAMILY XII. Cyprinidæ.

Shell regular, equivalve, oval or elongated; valves close, solid; epidermis thick and dark; ligament external, conspicuous; cardinal teeth 1—3 in each valve, and usually a posterior lateral tooth; pedal scars close to, or confluent with the adductors; pallial line simple.

Animal with the mantle-lobes united posteriorly by a curtain, pierced with two siphonal orifices; foot thick, tongue-shaped; gills 2 on each side, large, unequal, united behind, forming a complete partition; palpi moderate, lanceolate.

One half the genera of this family are extinct, and the rest (excepting *Circe*) were more abundant in former periods than at the present time. *Cyprina* and *Astarte* are boreal forms; *Circe and Cardita* abound in the Southern seas.

Cyprina, Lamarck.

Etym. Kuprinos (from *Kupris*) related to Venus.

Type, C. Islandica, Pl. XIX. fig. 22. *Syn.* Arctica, Schum.

Shell oval, large and strong, with usually an oblique line or angle on the posterior side of each valve; epidermis thick and dark; ligament prominent; umbones oblique; no lunule; cardinal teeth 2:2, laterals 0—1, 1—0; muscular impressions oval, polished; pallial sinus obsolete.

Animal with the mantle open in front and below, margins plain; siphonal orifices close together, fringed, slightly projecting; outer gills semilunar, inner truncated in front.

The principal hinge-tooth in the right valve of *Cyprina* represents the

* Associated with the bones of *Elephas meridionalis, Rhinoceros leptorhinus, Mastodon Arvernensis, Hippopotamus major*, &c.

second and third in *Venus* and Cytherea; the second tooth of the left valve is consequently obsolete.

Distr. C. Islandica ranges from Greenland and the U. S. to the Icy Sea, Norway, and England; in 5—80 fm. water. It occurs fossil in Sicily and Piedmont, but not alive in the Medit.

Fossil, 90 sp. (D'Orb.) Muschelkalk —. Europe.

CIRCE, Schumacher.

Etym. In Greek myth. a celebrated enchantress.

Ex. C. corrugata, Pl. XX. fig. 2. *Syn.* Paphia (undulata) Lam.*

Shell sub-orbicular, compressed, thick, often sculptured with diverging striæ; umbones flat; lunule distinct; ligament nearly concealed; margins smooth; hinge-teeth 3:3; laterals obscure; pallial line entire.

Animal (of *C. minima*) with the mantle open, margins denticulate, siphonal orifices close together, scarcely projecting, fringed; foot large, heeled; palpi long and narrow. Ranges from 8—50 fms. (Forbes.)

Distr. 37 sp. Australia, India, Red Sea, Canaries, Brit.

ASTARTE, Sowerby, 1816.

Syn. Crassina, Lam. Tridonta, Schum. Goodallia, Turton.

Ex. A. sulcata, Pl. XX. fig. 1. (*Astarte,* the Syrian Venus.)

Shell sub-orbicular, compressed, thick, smooth or concentrically furrowed; lunule impressed; ligament external; epidermis dark: hinge-teeth 2:2, the anterior tooth of the right valve large and thick; anterior pedal scar distinct; pallial line simple.

Animal with mantle open; margins plain or slightly fringed; siphonal orifices simple; foot moderate, tongue-shaped; lips large, palpi lanceolate; gills nearly equal, united behind, and attached to the siphonal band.

Distr. 14 sp. Behrings Sea, Wellington Channel, Kara Sea, Ochotsk, U. S. Norway, Brit. Canaries, Ægean (30—112 fms.)

Fossil, 200 sp. (D'Orb.) Lias —. N. and S. America, Europe, Thibet.

? *Digitaria,* Wood; Tellina digitaria, L. Medit. *Fossil,* Crag, Brit.

CRASSATELLA, Lamarck.

Syn. Ptychomya, Ag. Paphia (Lam. part) Roissy.

Type, C. ponderosa, Pl. XXI. fig. 4. *Etym. Crassus* thick.

Shell solid, ventricose, attenuated behind, smooth or concentrically furrowed; lunule distinct; ligament internal; margin smooth or denticulated;

* This name was employed by Bolten, in 1798, for sp. of *Veneridæ,* and by Lamarck, in 1801, for *Venus divaricata,* Chemn. (= Circe divaricata *and* Crassatella contraria) and *Mesodesma glabratum.* In 1808, Fabricius adopted the name for a group of butterflies, in which sense it is now widely employed, having been abandoned by Lamarck in his later works, and by all succeeding malacologists.

pallial line simple; hinge-teeth 1:2, striated, in front of cartilage pit; lateral teeth 0—1, 1—0; adductor impressions deep, rounded; pedal small, distinct.

Animal with mantle-lobes united only by the branchial septum; inhalent margins cirrated; foot moderate, compressed, triangular grooved; gills smooth, unequal, outer semi-lunar, inner widest in front; palpi triangular.

Distr. 30 sp. Australia, N. Zealand, Philippines, India, W. Africa, Canaries, Brazil.

Fossil, 50 sp. Neocomian —. Patagonia, U. S. Europe.

Isocardia, Lam. Heart-cockle.

Etym. Isos, like, *cardia,* the heart. *Type,* I. cor. Pl. XX. fig. 3.

Syn. Glossus, Poli; Bucardium, Muhlfeldt; Pecchiolia, Meneghini.

Shell cordate, ventricose; umbones distant, sub-spiral; ligament external; hinge-teeth 2:2; laterals 1—1 in each valve, the anterior sometimes obsolete.

Animal with the mantle open in front; foot triangular, pointed, compressed; siphonal orifices close together, fringed; palpi long and narrow; gills very large, nearly equal.

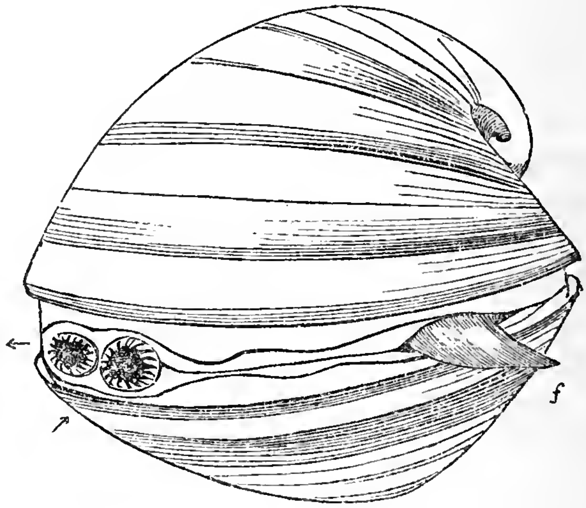


Fig. 217. Isocardia cor.

The heart-cockle burrows in sand, by means of its foot (*f*), leaving only the siphonal openings exposed. (*Bulwer.*)

Distr. 5 sp. Brit. Medit. China, Japan.

Fossil, 70 sp. Trias —. U. S. Europe, S. India.

The Isocardia-shaped fossils of the old rocks belong to the genera *Cardiomorpha* and *Iso-arca;* many of those in the Oolites to *Ceromya.* Casts of true *Isocardiæ* have only two transverse dental folds between the beaks, and no longitudinal furrows.

Cypricardia, Lam.

Ex. C. obesa, Pl. XX. fig. 4. *Syn.* Trapezium, Humph. Libitina, Sch.

Shell oblong, with an oblique posterior ridge; umbones anterior depressed; ligament external, in deep and narrow grooves; cardinal teeth 2:2, laterals 1—1 in each valve, sometimes obscure; muscular impressions oval, (of two elements); pallial line simple.

Animal (of *C. solenoides*) with mantle-lobes united, cirrated behind; pedal opening moderate; foot small, compressed, with a large byssal pore near the heel; siphons short, conical, unequal, cirrated externally; orifices fringed; palpi small; gills unequal, the outer narrower and shorter, deeply lamellated, united posteriorly, the inner prolonged between the palpi.

Distr. 13 sp. Red Sea, India, Australia. In crevices of rock and coral.

Fossil, 60 sp. L. Silurian —. N. America, Europe.

? *Sub-genera. Coralliophaga,* Bl. C. coralliophaga, Lam. *Shell* long, cylindrical, thin, slightly gaping behind; hinge-teeth 2:2, and a laminar posterior tooth; pallial line with a wide and shallow sinus. *Distr.* 2 sp. Medit. in the burrows of the *Lithodomus;* sometimes two or three dead shells are found one within the other, besides the original owner of the cell.

? *Cypricardites,* Conrad (part). An. Geol. Rep. 1841. (Sanguinolites, M'Coy). Employed for Cypricardia-shaped shells of the palæozoic rocks; some of them are more nearly related to *Modiola* (v. Modiolopsis, p. 266) but they bear no resemblance to *Sanguinolaria.*

Pleurophorus, King, 1848.

Type, P. costatus, Brown. Permian, England, (Pal. Trans. 1850. Pl. XV. fig. 13—20.)

Syn. ? Cleidophorus, Hall (cast only). Unionites, Wissm. ? Mæonia, Dana.

Shell oblong; dorsal area defined by a line, or keel; umbones anterior, depressed; hinge-teeth 2.2; laterals 1.1; elongated posterior; anterior adductor impression deep, with a small pedal scar close to it, and bounded posteriorly by a strong rib from the hinge; pallial line simple.

Fossil, L. Silurian — Trias. U. States; Europe, N. S. Wales, Tasmania.

? Cardilia, Deshayes.

Type, C. semisulcata, Pl. XVIII. fig. 18. *Syn.* Hemicyclonosta, Desh.

Shell oblong, ventricose, cordate; beaks prominent, sub-spiral; hinge with a small tooth and dental pit in each valve; ligament partly internal contained in a spoon-shaped inflection; anterior muscular scar long, with a pedal scar above; posterior adductor impression on a prominent sub-spiral plate; pallial line simple.

Distr. 2 sp. Chinese Sea; Moluccas.

Fossil, 2 sp. Eocene —. France, Piedmont.

Megalodon, J. Sowerby.

Type, M. cucullatus, Pl. XIX. fig. 19. (*Megas,* large, *odous,* tooth.)

Shell oblong, smooth or keeled; ligament external; hinge-teeth 1:2, thick;

laterals 1.1, posterior; anterior adductor impression deep, with a raised margin; and a small pedal scar behind it.

In the typical species the beaks are sub-spiral, the lateral teeth obscure, and the posterior adductors bounded by prominent ridges.

Fossil, 14 sp. U. Silurian — Devonian; U. States, Europe.

Sub-genera. ? *Goldfussia* (nautiloides) Castlenau. Umbones spiral; anterior side concentrically furrowed; posterior side with two oblique ridges. *Fossil,* Silurian, U. States.

Megaloma (Canadensis) Hall, 1852. U. Silurian, Canada. Umbones very thick, hinge-teeth rugged, almost obliterated with age; posterior lateral teeth 1.1; no muscular ridges.

PACHYDOMUS (Morris) J. Sowerby.

Etym. Pachus, thick, *domos,* house. *Syn.* Astartila, Dana.

? Cleobis (grandis) Dana. ? Pyramus (ellipticus) D. = Notomya, M'Coy.

Type, P. globosus (Megadesmus) J. Sby. in Mitchell's Australia.

Shell oval, ventricose, very thick; ligament large, external; lunette more or less distinct; hinge-line sunk; teeth 1 or 2 (?) in each valve; adductor impressions deep; anterior pedal scar distinct; pallial line broad and simple, or with a very shallow sinus.

Fossil, 5 sp. Devonian ? N. S. Wales, Tasmania.

PACHYRISMA, Morris and Lycett.

Etym. Pachus, thick, *ereisma,* support.

Type, P. grande, M. and L. Great Oolite (Bathonian) Minchinhampton.

Shell cordate, with large sub-spiral beaks; valves very thick near the umbones, obliquely keeled; hinge with one thick conical tooth (behind the dental pit, in the right valve), a small lateral tooth close to the deep and oval anterior adductor, and a posterior lateral-tooth (or muscular lamina ?); ligamental plates short and deep.

OPIS, Defrance.

Ex. O. lunulata, Pl. XIX. fig. 24. (*Opis,* a name of Artemis.)

Shell strong, ventricose, cordiform, obliquely keeled; beaks prominent, incurved or sub-spiral; cardinal teeth 1.1; lunule distinct.

Fossil, 42 sp. Trias — Chalk. Europe.

CARDINIA, Agassiz.

Etym. Cardo-inis, a hinge. *Type,* C. Listeri, Pl. XIX. fig. 23.

Syn. Thalassides, Berger 1833 (no descr.) Sinemuria, Christol. Pachyodon, Stutch. (not Meyer nor Schum.) Pronoe, Ag.

Shell oval or oblong, attenuated posteriorly, compressed, strong, not pearly, marked by lines of growth; ligament external; cardinal teeth obscure, laterals 1—0, 0—1, remote, prominent; adductor impressions deep pallial line simple.

Fossil, 20 sp. Lias —. Inf. Oolite, Europe; along with *marine* shells.

Sub-genus ? *Anthracosia,* King, 1844; Unio sub-constrictus. Sby. U. Sil. — Carb. 40 sp. They occur in the valuable layers of clay-ironstone called "mussel-bands," associated with *Nautili, Discinæ,* &c. In Derbyshire the mussel-band is wrought, like marble, into vases.

? Myoconcha, J. Sowerby.

Type, M. crassa, Pl. XIX. fig. 25. (*Mya,* mussel, *concha,* shell.)

Shell oblong, thick, with nearly terminal depressed umbones; ligament external, supported by long narrow appressed plates; hinge thick, with an oblique tooth in the right valve; anterior muscular impression round and deep, with a small pedal scar behind it; posterior impression large, single; pallial line simple.

This shell, which is not nacreous inside, is distinguished from any of the *Mytilidæ* by the form of its ligamental plates and muscular impressions; the hinge-tooth is usually overgrown and nearly obliterated by the hinge-margin as in aged examples of *Cardita orbicularis* and *Cypricardia vellicata.*

Fossil, 26 sp. Permian — Miocene. (D'Orb.) Europe.

Sub-genus. ? *Hippopodium* (ponderosum, Sby.) Coneybeare. Lias, Europe. *Shell* oblong, thick, ventricose; umbones large; ligament external; ventral margin sinuated; hinge with one thick, oblique tooth in each valve, sometimes nearly obsolete; pallial line simple; anterior muscular scar deep. This shell appears to be a ponderous form of *Cypricardia* or *Cardita;* it is a characteristic fossil of the English Lias, but only very aged examples have been found.

Cardita, Bruguière.

Syn. Mytilicardia and Cardiocardita, (ajar) Bl. Arcinella, Oken.

Type, C. calyculata, Pl. XX. fig. 5. *Etym. Cardia,* the heart.

Shell oblong, radiately ribbed; ligament external; margins toothed; hinge-teeth 1:2, and an elongated posterior tooth; pallial line simple; anterior pedal scar close to adductor.

Animal with the mantle lobes free, except between the siphonal orifices; branchial margin with conspicuous cirri; foot rounded and grooved, spinning a byssus; labial palpi short, triangular, plaited; gills rounded in front, tapering behind and united together, the outer pair narrowest.

C. pectunculus, Brug. (*Mytilicardia,* Bl.) has an anterior tooth. *C. concamerata,* Brug. found at the Cape, has a remarkable cup-like inflection of the ventral margin of each valve.

Sub-genus. Vencricardia, Lam. V. ajar, Pl. XX. fig. 6. *Shell* cordate, ventricose; hinge without lateral teeth. *Animal* locomotive, with a sickle-shaped foot like the cockles.

Distr. 50 sp. Chiefly in tropical seas, on rocky bottoms and in shallow water; the *Venericardiæ* on coarse sand and sandy mud. W. Indies, U. S. W. Africa, Medit. Red Sea, India, China, Australia, New Zealand, Pacific, W. America. *C. borealis*, Conrad, inhabits the sea of Ochotsk; *C. abyssicola*, Hinds, ranges to 100 fms.; *C. squamosa*, to 150 fms.

Fossil, 100 sp. Trias —. U. S. Patagonia, Europe, S. India.

? Verticordia, Searles Wood, 1844.

Syn. Hippagus, Philippi, not Lea. (*Verticordia*, a name of Venus.)

Type, V. cardiiformis (Wood, in Sby. Min. Con.) Pl. XVII. fig. 26.

Shell sub-orbicular, with radiating ribs; beaks sub-spiral; margins denticulated; interior brilliantly pearly; right valve with 1 prominent cardinal tooth; adductor scars 2, faint; pallial line simple; ligament internal, oblique; epidermis dark brown.

Distr. 2 sp. China Sea (Adams). Medit. ? (Forbes.)

Fossil, 2 sp. Miocene —. Brit. Sicily.

Hippagus isocardioides, Lea, 1833, Eocene, Alabama: is edentulous.

SECTION *b*. Sinu-pallialia.

Respiratory siphons long; pallial line sinuated.

FAMILY XIV. Veneridæ.

Shell regular, closed, sub-orbicular or oblong; ligament external; hinge with usually 3 diverging teeth in each valve; muscular impressions oval, polished; pallial line sinuated.

Animal free, locomotive, rarely byssiferous or burrowing; mantle with a rather large anterior opening; siphons unequal, united more or less; foot linguiform, compressed, sometimes grooved; palpi moderate, triangular, pointed; branchiæ large, sub-quadrate, united posteriorly.

The shells of this tribe are remarkable for the elegance of their forms and colours; they are frequently ornamented with chevron-shaped lines. Their texture is very hard, all traces of structure being usually obliterated. The *Veneridæ* appeared first in the Oolitic period, and have attained their greatest development at the present time; they are found in all seas, but most abundantly in the tropics.

Venus, L.

Syn. Merceneria, Antigone and Anomalocardia (flexuosa) Schum. Chione, Megerle (not Scop,) Erycina (cardioides) Lam. 1818.

Type, V. paphia, L. Pl. XX. fig. 7.

Shell thick, ovate, smooth, sulcated or cancellated; margins minutely crenulated; cardinal teeth 3—3; pallial sinus small, angular; ligament prominent; lunule distinct.

Animal with mantle-margins fringed; siphons unequal, more or less separate; branchial orifice sometimes doubly fringed, the outer pinnate; anal orifice with a simple fringe and tubular valve; foot tongue-shaped; palpi small, lanceolate.

V. textilis, and other elongated species, have a deep pallial sinus; *V. gemma* (Totten) has a very deep angular sinus, like *Artemis; V. reticulata* has bifid teeth, like *Tapes; V. tridacnoides,* a fossil of the U. States, has massive valves, ribbed like the clam-shell. The N. American Indians used to make coinage (*wampum*) of the sea-worn fragments of *Venus mercenaria,* by perforating and stringing them on leather thongs.

Distr. 176 sp. World-wide. Low-water — 140 fathoms. *V. astartoides,* Behrings' Sea. *V. verrucosa,* Brit. Medit. Senegal, Cape, Red Sea: Australia ?

Fossil, 160 sp. Oolites —. Patagonia, U. S. Europe, India.

? *Volupia rugosa,* (Defrance, 1829.) Shell minute, Isocardia-shaped, concentrically ribbed, with a large lunule. *Eocene,* Hauteville.

Saxidomus (Nuttalli) Conrad. Oval, solid, with tumid umbones; lunule, 0; teeth 3—4, unequal, the central bifid; pallial sinus large. *Distr.* 8 sp. India, Australia, W. America.

CYTHEREA, Lam.

Etym. Cytherea, from Cythera, an Aegean Island.

Syn. Meretrix, Gray.. Dione, Megerle.

Examples, C. dione, Pl. XX. fig. 8. C. chione, fig. 14, p. 26.

Shell like *Venus*; margins simple; hinge with 3 cardinal teeth and an anterior tooth beneath the lunule; pallial sinus moderate, angular.

Animal with plain mantle-margins; siphons united half-way.

Distr. Same as *Venus.* Recent 113 sp. *Fossil,* 80 sp.

MEROE, Schum.

Etym. Meroë, an island of the Nile.

Syn. Cuneus (part) Megerle (not Da Costa). Sunetta, Link.

Type, M. picta (= Venus Meroë, L. Donax, Desh.) Pl. XX. fig. 9.

Shell oval, compressed; anterior side rather longest; hinge with 3 cardinal teeth, and a long narrow anterior tooth; lunule lanceolate; ligament in a deep escutcheon.

Distr. 10 sp. Senegal, India, Japan, Australia.

TRIGONA, Mühlfeldt.

Etym. Trigonos, theee-cornered. *Type,* T. tripla, Pl. XX. fig. 10.

Shell trigonal, wedge-shaped, sub-equilateral; ligament short, prominent; cardinal teeth 3—4, anterior $\frac{2}{1}$ remote; pallial sinus rounded, horizontal.

Distr. 28 sp. W. Indies, Medit, Senegal, Cape, India, W. America.

Fossil, Miocene —. Bordeaux.

T. crassatelloides attains a diameter of 5 inches and is very ponderous.

Sub-genus, Grateloupia, Desm. G. irregularis, Pl. XX. fig. 11.

Shell sub-equilateral, rounded in front, attenuated behind; hinge with 1 anterior tooth, 3 cardinal teeth and several small posterior teeth; pallial sinus deep, oblique. *Fossil,* 4 sp. Eocene — Miocene. U. States, France.

ARTEMIS, Poli.

Etym. Artemis, in Greek myth. Diana.

Type, A. exoleta, Pl. XX. fig. 12. (*Syn.* Dosinia, Scopoli.)

Shell orbicular, compressed, concentrically striated, pale; ligament sunk; lunule deep; hinge like *Cytherea;* margins even; pallial sinus deep, angular, ascending.

Animal with a large hatchet-shaped foot, projecting from the ventral margin of the shell; mantle-margins slightly plaited; siphons united to their ends; orifices simple; palpi narrow.

Distr. 85 sp. Boreal — Tropical seas; low-water—80 fms.

Fossil, 8 sp. Miocene —. U. States, Europe, S. India.

Sub-genera. Cyclina, Desh. V. Sinensis, Chemn. Orbicular, ventricose, margins crenulated, no lunule, sinus deep and angular. *Distr.* 10 sp. Senegal, India, China, Japan. W. America. *Fossil,* 1 sp. *Miocene,* Bordeaux.

Clementia (papyracea) Gray. Thin, oval, white; ligament semi-internal; posterior teeth bifid, sinus deep and angular. *Animal* with long, united siphons, and a large crescentic foot, similar to *Artemis. Distr.* 3 sp. Australia, Philippines.

LUCINOPSIS, Forbes.

Syn. Dosinia, Gray, 1847 (not Scop.) Mysia, Gray, 1851 (not Leach). Cyclina, Gray, 1853 (not Desh.)

Type, Venus undata, Pennant, Pl. XX. fig. 13. (*Lucina,* and *opsis,* like.)

Shell lenticular, rather thin; right valve with 2 laminar, diverging teeth, left with 3 teeth, the central bifid: muscular impressions oval, polished; pallial sinus very deep, ascending.

Animal with mantle-margins plain; pedal opening contracted; foot pointed, basal; siphons longer than the shell, separate, divergent, with fringed orifices. (Clark.)

Distr. 1 sp. Norway, Brit. *Fossil,* 3 sp. Miocene. Brit. Belgium.

TAPES, Mühlfeldt.

Syn. Paphia, Bolten, 1798. Pullastra, G. Sby.

Example, T. pullastra, Pl. XX. fig. 14. (*Tapes,* tapestry.)

Shell oblong, umbones anterior, margins smooth; teeth 3 in each valve, more or less bifid; pallial sinus deep, rounded.

Animal spinning a byssus; foot thick, lanceolate, grooved; mantle plain or finely fringed; freely open in front; siphons moderate, separate half-way or throughout, orifices fringed, anal cirri simple, branchial ramose; palpi long, triangular.

Distr. 78 sp. Norway, Brit. Black Sea, Senegal, Brazil, India, China, New Zealand. Low-water—100 fms. (Beechey).

Fossil, Miocene —. Brit. France, Belgium, Italy.

The animal is eaten on the continental coasts; it buries in the sand at low-water or hides in the crevices of rocks, and roots of sea-weed.

Venerupis, Lamarck.

Etym. Venus, and *rupes*, a rock. *Syn. Gastrana*, Schum.

Example, V. exotica, Pl. XX. fig. 15.

Shell oblong, a little gaping posteriorly, radiately striated and ornamented with concentric lamellæ; three small teeth in each valve, one of them bifid; pallial sinus moderately deep, angular.

Animal with the mantle closed in front, pedal opening moderate; siphons united half-way, anal with a simple fringe and tubular valve, branchial siphon doubly fringed, inner cirri branching; palpi small and pointed.

Distr. 19 sp. Brit. — Crimea; Canaries; India, Tasmania; Kamtschatka. Behring's Sea — Peru. In crevices of rocks.

Fossil, Miocene —. U. States, Europe.

Petricola, Lamarck.

Etym. Petra, stone, *colo*, to inhabit.

Syn. Rupellaria, Bellevue; Choristodon, Jonas; Naranio, Gray.

Type, P. lithophaga, Pl. XX. fig. 16. P. pholadiformis, Pl. XX. fig. 17.

Shell oval or elongated, thin, tumid, anterior side short; hinge with 3 teeth in each valve, the external often obsolete; pallial sinus deep.

Animal with the mantle closed in front, much thickened and recurved over the edges of the shell; pedal opening small; foot small, pointed, lanceolate; siphons partially separate, orifices fringed, anal with a valve and simple cirri, branchial cirri pinnate; palpi small, triangular.

Distr. 30 sp. U. S. France, Red Sea, India, New Zealand, Pacific, W. America (Sitka—Peru). Burrows in limestone and mud.

Fossil, 12 sp. Eocene —. U. S. Europe.

Glaucomya, (Bronn) Gray.

Syn. Glauconome, Gray 1829 (not Goldfuss 1826).

Type, G. Sinensis, Pl. XX. fig. 18. (*Glaucos* sea-green, *mya* mussel.)

Shell oblong, thin; epidermis dark, greenish; ligament external; hinge with 3 teeth in each valve, one of them bifid; pallial sinus very deep and angular.

Animal with a rather small, linguiform foot; pedal opening moderate;

siphons very long, united, projecting far into the branchial cavity when retracted, their ends separate and diverging; palpi large, sickle-shaped; gills long, rounded in front, the outer shortest.

Distr. 11 sp. Embouchures of rivers; China, Philippines, Borneo, India.

FAMILY XV. MACTRIDÆ.

Shell equivalve, trigonal, close, or slightly gaping; ligament (cartilage) internal, contained in a deep triangular pit; epidermis thick; hinge with 2 diverging cardinal teeth, and usually with anterior and posterior laterals; pallial sinus short, rounded.

Animal with the mantle more or less open in front; siphonal tubes united, orifices fringed; foot compressed; gills not prolonged into the branchial siphon.

Sections of the shell exhibit an indistinct cellular layer on the external surface and a distinct inner layer of elongated cells. (*Carpenter.*)

MACTRA, L.

Etym. *Mactra,* a kneading trough. *Syn.* Trigonella, Da Costa (not L.) Schizodesma (Spengleri), Spisula (solida), Mulinia (lateralis) Gray.

Type, M. stultorum, Pl. XXI. fig. 1.

Shell nearly equilateral; anterior hinge tooth Λ-shaped, with sometimes a small laminar tooth close to it; lateral teeth doubled in the right valve.

Animal with the mantle open as far as the siphons, its margins fringed; siphons united, fringed with simple cirri, anal orifice with a tubular valve; foot large, linguiform, heeled; palpi triangular, long and pointed; outer gills shortest.

The Mactras inhabit sandy coasts, where they bury just beneath the surface; the foot can be stretched out considerably, and moved about like a finger, it is also used for leaping. They are eaten by the star-fishes and whelks. and in the I. of Arran *M. subtruncata* is collected at low-water to feed pigs. (*Alder.*)

Distr. 60 sp. All seas, especially within the tropics; — 35 fms.

Fossil, 30 sp. Lias —. U. States, Europe, India.

? *Sub-genus.* *Sowerbya,* D'Orb. S. crassa, Oxfordian, France. Cartilage-pit simply grooved; lateral teeth very large.

GNATHODON, Gray.

Etym. *Gnathos* a jaw-bone, *odous* a tooth. *Syn.* Rangia, Desm.

Type, G. cuneatus, Pl. XXI. fig. 2.

Shell oval, ventricose; valves thick, smooth, eroded; epidermis olive; cartilage-pit central; hinge teeth $\frac{2}{1}$; laterals doubled in the right valve, elongated, striated transversely; pallial sinus moderate.

Animal with the mantle freely open in front; margins plain; siphons short, partly united; foot very thick, tongue-shaped, pointed; gills unequal, the outer short and narrow; palpi large, triangular, pointed.

Distr. 1 sp. N. Orleans (3 other sp.? Mazatlan, California; Moreton B. Australia. *Petit.*)

Fossil, 1 sp. Miocene —. Petersburg, Virginia.

G. cuneatus was formerly eaten by the Indians. At Mobile, on the Gulf of Mexico, it is found in colonies along with *Cyrena Carolinensis,* burying 2 inches deep in banks of mud; the water is only brackish, though there is a tide of 3 feet. Banks of dead shells, 3 or 4 feet thick, are found 20 miles inland: Mobile is built on one of these shell-banks. The road from New Orleans to Lake Pont-chartrain (6 miles) is made of Gnathodon shells procured from the east end of the lake, where there is a mound of them a mile long, 15 feet high, and 20—60 yards wide; in some places it is 20 feet above the level of the lake. (*Lyell.*)

LUTRARIA, Lamarck. Otter's-shell.

Type, L. oblonga, Gmel. Pl. XXI. fig. 3. (= L. solenoides, Lam.)

Shell oblong, gaping at both ends; cartilage-plate prominent, with 1 or 2 small teeth in front of it, in each valve; pallial sinus deep, horizontal.

Animal with closed mantle-lobes; pedal opening moderate; foot rather large, compressed; siphons united, elongated, invested with epidermis; palpi rather narrow, their margins plain; gills tapering to the mouth.

Distr. 18 sp. U. States, Brazil, Brit. Medit. Senegal, Cape, India, N. Zealand, Sitka.

Fossil, 10 sp. Miocene — U. States, Europe.

Resembles *Mya;* burying vertically in sand or mud, especially of estuaries; low-water, 12 fms. *L. rugosa* is found living on the coasts of Portugal and Mogador, fossil on the coast of Sussex. (Dixon.)

ANATINELLA, G. Sowerby.

Type, A. candida, (Mya) Chemn. Pl. XXIII. fig. 6.

Shell ovate, rounded in front, attenuated and truncated behind; cartilage in a prominent spoon-shaped process, with 2 small teeth in front; muscular impressions irregular, the anterior elongated; pallial line slightly truncated behind.

Distr. 3 sp. Ceylon, Philippines; sands at low-water.

FAMILY XVI. TELLINIDÆ.

Shell free, compressed, usually closed and equivalve; cardinal teeth 2 at most, laterals 1—1, sometimes obsolete; muscular impressions rounded, polished; pallial sinus very large; ligament on shortest side of the shell, sometimes internal. Structure obscurely prismatic-cellular; prisms fusiform, nearly parallel with surface, radiating from the hinge in the outer layer, transverse in the inner.

Animal with the mantle widely open in front, its margins fringed; foot tongue-shaped, compressed; siphons separate, very long and slender; palpi large, triangular; gills united posteriorly, unequal, the outer pair sometimes directed dorsally.

The Tellens are found in all seas, chiefly in the littoral and laminarian zones; they frequent sandy bottoms, or sandy mud, burying beneath the surface; a few species inhabit estuaries and rivers. Their valves are often richly coloured and ornamented with finely sculptured lines.

TELLINA, L. Tellen.

Etym. Telline, the Greek name for a kind of mussel.

Syn. Peronæa (*part*) Poli. Phylloda (foliacea), Omala (planata) Schum. Psammotea (solidula) Turt. Arcopagia (crassa) Leach.

Examples, T. lingua-felis, Pl. XXI. fig. 5. T. carnaria, fig. 6.

Shell slightly inequivalve, compressed, rounded in front, angular and slightly folded posteriorly, umbones sub-central; teeth 2.2, laterals 1—1, most distinct in the right valve; pallial sinus very wide and deep; ligament external, prominent.

Animal with slender, diverging siphons, twice as long as the shell, their orifices plain; foot broad, pointed, compressed; palpi very large, triangular; gills small, soft and very minutely striated, the outer rudimental and directed dorsally.

Tellinides, Lam. T. planissima, Pl. XXI. fig. 7. Valves with no posterior fold; lateral teeth wanting.

T. carnaria (*Strigilla,* Turt.) has the valves obliquely sculptured; *T. fabula,* Gron. has the right valve striated, the other plain. *T. Burneti,* California, hás the right valve flat; *T. lunulata, Pliocene,* S. Carolina, much resembling it in shape, has the left valve flat.

Distr. above 200 sp. In all seas, especially the Indian Ocean; most abundant and highly coloured in the tropics. Low-water — Coral zone, 50 fms. Wellington Channel; Kara Sea; Behrings' Sea; Baltic; Black Sea.

Fossil, 130 sp. Oolites —. U. States, S. America (Chiloe) Europe.

DIODONTA, Schumacher.

Etym. Di- two, *odonta* teeth. *Syn.* Fragilia, Desh.

Type, Tellina fragilis, L. Pl. XXI. fig. 8.

Shell equivalve, convex, with squamose lines of growth; cardinal teeth 2 in right valve, 1 bifid tooth in left; pallial sinus deep and rounded; umbonal area punctate; ligament external.

Animal with the mantle open in front, its margins fringed; siphons elongated, slender, separate, unequal, orifices with cirri; foot small, compressed, linguiform; palpi large, triangular; gills unequal, soft, finely striated.

Diodonta inhabits shallow water, boring in mud and clay, and not travelling about like the *Tellens.*

Distr. 3 sp. Greenland, Brit. Medit. Black Sea, Senegal, Cape.
Fossil, Miocene —. Brit. France, Belgium.

CAPSULA, Schumacher.

Etym. Dimin. of *capsa,* a box.
Syn. Capsa (part) Brug. 1791. Sanguinolaria Lam. 1818, not 1801.
Type. C. rugosa, Pl. XX. fig. 19. (= Venus deflorata, Gmel.)
Shell oblong, ventricose, slightly gaping at each end; radiately striated; cardinal teeth 2 in each valve, one of them bifid; ligament external, large, prominent; siphonal inflection short.
Animal like *Psammobia;* foot moderate; gills deeply plaited, attenuated in front, outer small, dorsal border wide, fixed; siphons moderate.
Distr. W. Indies, Red Sea, India, China, Australia.
Fossil 4 sp. U. Green-sand —. U. States, Europe. (D'Orb.)

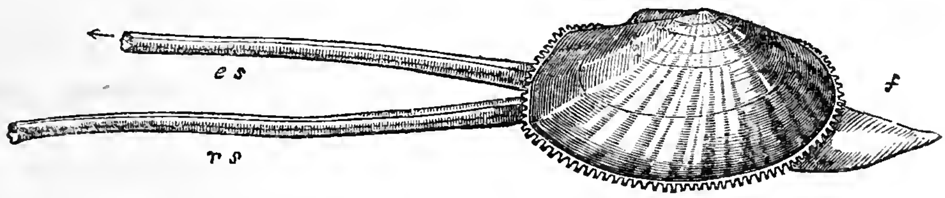


Fig. 218. *Psammobia vespertina,* Chemn, $\frac{1}{2}$, Brit.

PSAMMOBIA, Lamarck. Sunset-shell.

Etym. *Psammos* sand, *bio* to live.
Syn. Psammotea (zonalis) Lam. Psammocola, Bl. Gari, Schum.
Ex. P. Ferroënsis, Pl. XXI. fig. 9. P. squamosa, Pl. XXI. fig. 10.
Shell oblong, compressed, slightly gaping at both ends; hinge-teeth $\frac{2}{1}$; ligament external, prominent; siphonal inflection deep, in contact with the pallial line; epidermis often dark.
Animal: mantle open, fringed; siphons very long, slender, nearly equal, longitudinally ciliated, orifices with 6—8 cirri; foot large, tongue-shaped; palpi long, tapering; gills unequal, recumbent, few plaited.
Distr. 40 sp. Norway, Brit. India, New Zealand, Pacific. Littoral — coralline zone, 100 fms. *P. gari* is eaten in India.
Fossil, 24 sp. Oolite? Eocene —. U. States, Europe.

SANGUINOLARIA, Lamarck.

Name, from the type, *Solen sanguinolentus,* Chemn.
Syn. Soletellina (*diphos*) Bl. Lobaria, Schum. Aulus, Oken.
Ex. S. livida, Pl. XXII. fig. 1. S. diphos, fig. 2, S. orbiculata, fig. 3.
Shell oval, compressed, rounded in front, attenuated and slightly gaping behind; hinge-teeth $\frac{2}{2}$, small; siphonal inflection very deep, connected with the pallial line; ligament external, on very prominent fulcra.
Animal: mantle open, fringed; siphons very long, branchial largest

orifices fringed; foot large, broadly tongue-shaped, compressed; palpi long pointed; gills recumbent, inner laminæ free, dorsal border wide.

Distr. 20 sp. W. Indies, Red Sea, India, Madagascar, Japan; Australia, Tasmania, Peru.

Fossil, 30 sp. Eocene —. U. States, Europe.

SÉMELE, Schumacher, 1817.

Etym. *Semele,* in Greek myth. the mother of Bacchus.

Syn. Amphidesma, Lam. 1818.* *Type,* S. reticulata, Pl. XXI. fig. 11.

Shell rounded, sub-equilateral, beaks turned forwards; posterior side slightly folded; hinge-teeth 2.2, laterals elongated, distinct in the right valve; external ligament short, cartilage internal, long, oblique; pallial sinus deep, rounded.

Distr. 40 sp. W. Indies, Brazil, India, China, Australia, Peru.

Fossil, 10 sp. Eocene —. U. States, Europe.

Sub-genera. *Cumingia,* G. Sowerby. C. lamellosa, Pl. XXI. fig. 12. Shell slightly attenuated and gaping behind, lamellated concentrically; cartilage-process prominent; pallial sinus very wide. *Distr.* 10 sp. In sponges, sand, and the fissures of rocks, — 7 fathoms. W. Indies, India, Australia, W. America. *Fossil,* Miocene —. Wilmington, N. Carolina.

Syndosmya, Recluz. *Syn.* Abra, Leach MS. Erycina (part) Lam. 1805.† *Type,* S. alba, Pl. XXI. fig. 13. *Shell* small, oval, white and shining; posterior side shortest; umbones directed backwards; cartilage-process oblique; hinge-teeth minute or obsolete, laterals distinct; pallial sinus wide and shallow. *Animal* with the mantle open, fringed; siphons long, slender, diverging, anal shortest, orifices plain; foot large, tongue-shaped, pointed; palpi triangular, nearly as large as the gills; branchiæ unequal, triangular. *Distr.* Norway, Brit. Medit. Black Sea, India. The sp. are few, and mostly boreal, ranging from the laminarian zone to 180 fms. (*Forbes.*) They live buried in sand and mud, but when confined are able to creep up the sides of the vessel with their foot. (*Bouchard.*) *Fossil,* 6 sp. Eocene —. Brit. France.

Scrobicularia, Schumacher. *Syn.* Trigonella (part) Da Costa (not L.) Ligula (part)). Mont. "Le Lavignon" (Reaumur) Cuv. Listera, Turt. (not R. Brown.) Lutricola, Bl. Mactromya, D'Orb. (not Ag.) *Type,* S. piperata (Belon) Gmelin, Pl. XXI. fig. 14. (See p. 60.) *Shell* oval, compressed, thin; sub-equi-lateral; ligament external, slight; cartilage-pit shal-

* The name *Amphi-desma,* as employed by Lamarck, included species of *Semele, Loripes, Syndosmya, Mesodesma, Thracia, Lyonsia,* and *Kellia;* in addition to which it has since been applied to some Oolitic *Myacites.*

† The name *Erycina* was originally appplied by Lamarck to a number of minute fossil shells, including sp. of *Syndosmya, Venus, Lucina, Tellina, Astarte,* and *Kellia.* In 1808 Fabricius employed it for a well-known group of insects.

low, triangular; hinge-teeth small, 1 or 2 in each valve, laterals obsolete; pallial sinus wide and deep.

Animal with the mantle open, margins denticulated; siphons very long, slender, separate, orifices plain; foot large, tongue-shaped, compressed; palpi very large, triangular, gills minutely striated, the outer pair directed dorsally. Lives buried, vertically, in the mud of tidal estuaries, 5 or 6 inches deep. (*Montagu.*) The siphons can be extended to 5 or 6 times the length of the shell. (*Deshayes*). The animal has a peppery taste, but is sometimes eaten on the coasts of the Mediterranean. *Distr.* Norway, Brit. Medit. Senegal. *Fossil,* Pliocene, Brit.

Mesodesma, Deshayes.

Etym. Meso- middle, *desma* ligament. *Syn.* Eryx, Sw. (not Daud.) Paphia (part) Lam. 1799 (see p. 299, note). Erycina (part) Lam. 1818 (not Lam. 1805, nor Fabr. 1808). "Donacille," Lam. 1812 (not characterized).

Examples, M. glabratum, Pl. XXI. fig. 15. M. donacium. fig. 16.

Shell trigonal, thick, compressed, closed; ligament internal, in a deep central pit; a minute anterior hinge-tooth, and 1—1 lateral teeth in each valve; muscular scars deep, pallial sinus small.

Animal with mantle-margins plain; siphons short, thick, and separate, orifices cirrated, branchial cirri dendritic; foot compressed, broadly lanceolate: gills large, unequal; palpi small.

Sub-genus. Anapa, Gray. A. Smithii, Pl. XXI. fig. 17. Umbones anterior, siphonal inflection obsolete.

Distr. 20 sp. W. Indies, Medit. Crimea, India, New Zealand, Chili; sands at low-water.

Fossil, 7 sp. Neocomian —. U. S. Europe (*Donacilla,* D'Orb.)

Ervilia, Turton. Lentil-shell.

Etym. Ervilia, diminutive of *ervum,* the bitter-vetch.

Type, E. nitens, P. XXI. fig. 18.

Shell minute, oval, close; cartilage in a central pit; right valve with a single prominent tooth in front and an obscure tooth behind; left valve with 2 obscure teeth; no lateral teeth; pallial sinus deep.

Distr. W. Indies, Brit. Canaries, Medit. Red Sea. — 50 fms.

Donax, L. Wedge-shell.

Ex. D. denticulatus, Pl. XXI. fig. 19. *Etym. Donax,* a sea-fish, Pliny.

Syn. Chione, Scop. Cuneus, Da Costa. Capisterium, Meusch.* Latona and Hecuba, Schum. Egeria, Lea (not Roissy).

Shell trigonal, wedge-like, closed; front produced, rounded; posterior side short, straight; margins usually crenulated; hinge-teeth 2.2; laterals

* Meuschen was a Dutch auctioneer; the names occur in his "sale catalogues." *Idiotæ imposuere nomina absurda.* Linnæus.

1—1 in each valve; ligament external, prominent; pallial sinus deep, horizontal.

Animal with the mantle fringed; siphons short and thick, diverging, anal orifice denticulated, branchial with pinnate cirri; foot very large, pointed, sharp-edged, projected quite in front; gills ample, recumbent, outer shortest; palpi small, pointed.

Distr. 45 sp. Norway, Baltic, — Black Sea, all tropical seas. In sands near low-water mark (— 8 fms.) buried an inch or two beneath the surface.

Fossil, 30 sp. Eocene —. U. States, Europe.

Sub-genera. ? *Amphichæna,* Phil. A. Kindermanni, California. *Shell* oblong, nearly equilateral, gaping at each end; teeth $\frac{2}{3}$; ligament external, pallial line sinuated.

Iphigenia, Schum. (Capsa, Lam. 1818, not 1801. Donacina, Fér.) I. Brasiliensis, Pl. XXI. fig. 20. *Shell* nearly equilateral, smooth; hinge-teeth 2.2, one bifid, the other minute; laterals remote, obsolete in the left valve; margins smooth. *Distr.* 4 sp. W. Indies, Brazil, W. Africa, Pacific, Central America. Inhabits estuaries; *I. ventricosa,* Desh. is rayed like *Galatea,* and has its beaks eroded.

? *Isodonta* (Deshayesii) Buv. Bull. Soc. Geol. *Oxf.* France.

Galatea, Bruguière.

Syn. Egeria, Roissy. Potamophila, Sby. Megadesma, Bowdich.

Type, G. reclusa, Pl. XXI. fig. 21.

Shell very thick, trigonal, wedge-shaped; epidermis smooth, olive; umbones eroded; hinge thick, teeth 1.2, laterals indistinct; ligament external, prominent; pallial sinus distinct.

Animal with the mantle open in front; siphons moderate, with 6—8 lines of cilia, orifices fringed; foot large, compressed; palpi long, triangular; gills unequal, united to the base of the siphons, the external pair divided into 2 nearly equal areas by a longitudinal furrow, indicating their line of attachment.

Distr. 2 or 7 sp.? Nile, and rivers of W. Africa.

FAMILY XVII. Solenidæ.

Shell elongated, gaping at the ends; ligament external; hinge-teeth usually 2.3, compressed, the posterior bifid. External shell layer with definite cell-structure, consisting of long prisms, very oblique to the surface, and exhibiting nuclei; inner layer nearly homogeneous.

Animal with a very large and powerful foot, more or less cylindrical: siphons short and united (in the typical Solens, with long shells) or longer and partly separate (in the shorter and more compressed genera); gills narrow, prolonged into the branchial siphon.

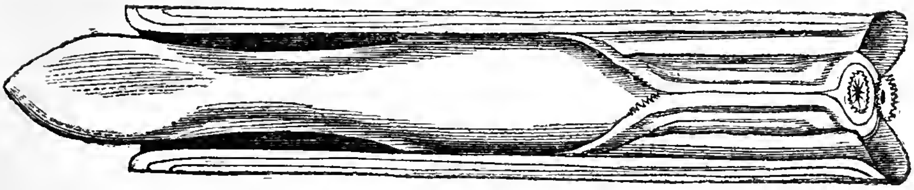


Fig. 219. Solen siliqua, L. $\frac{1}{3}$; the valves forcibly opened, and mantle divided as far as the ventral foramen, to show the foot.

Solen (Aristotle) L. Razor-fish.

Type, S. siliqua, Pl. XXII. fig. 4.

Syn. Hypogæa, Poli. Vagina, Megerle. Ensis, Schum. Ensatella, Sw.

Shell very long, sub-cylindrical, straight, or slightly recurved, margins parallel, ends gaping: beaks terminal, or sub-central; hinge-teeth $\frac{2}{2}$; ligament long, external; anterior muscular impression elongated; posterior oblong; pallial line extending beyond the adductors; sinus short and square.

Animal with the mantle closed except at the front end, and a minute ventral opening; siphons short, united, fringed; palpi broadly triangular; foot cylindrical, obtuse.

Distr. 25 sp. World-wide, except Arctic seas:—100 fms.

Fossil, 10 sp. Eocene —. U. States, Europe.

The Razor-fishes live buried vertically in the sand, at extreme low-water, their position being only indicated by an orifice like a key-hole; when the tide goes out they sink deeper, often penetrating to a depth of 1 or 2 feet. They never voluntarily leave their burrows, but if taken out soon bury themselves again. They may be caught with a bent wire, and are excellent articles of food, when cooked. (*Forbes.*)

Cultellus, Schumacher.

Type, C. lacteus, Pl. XXII. fig. 5. *Etym. Cultellus* a knife.

Shell elongated, compressed, rounded and gaping at the ends; hinge-teeth 2.3; beaks in front of the centre, supported internally by an oblique rib; pedal impression behind the umbonal rib; posterior adductor trigonal; pallial line not prolonged behind the posterior adductor; sinus short and square.

Animal (of C. Javanicus) with short, fringed siphons; gills narrow, half as long as the shell, transversely plaited; palpi large, angular, broadly attached; foot large, abruptly truncated.

Distr. 4 sp. Africa, India, Nicobar.

Sub-genera. Ceratisolen, Forbes. (Polia, D'Orb. Pharus, Leach, MS. Solecurtoides, Desm.) C. legumen, Pl. XXII. fig. 6. *Shell* narrow, sub-equilateral, anterior adductor impressions elongated, a second pedal scar near the pallial sinus. *Animal* with a long, truncated foot; siphons separate, diverging, fringed. *Distr.* 1 sp. Brit. Medit. Senegal, Red Sea. *Fossil,* 1 sp. Pliocene —. Italy.

Machæra, Gould. (Siliqua, Megerle. Leguminaria, Schum.) M. polita, Pl. XXII. fig. 7. *Shell* smooth, oblong; epidermis polished; umbonal rib extending across the interior of the valve; pallial sinus short. The animal, figured hy Middendorff, is similar to *Solecurtus. Distr.* India, China, Ochotsk, Oregon, Sitka, Behring's Sea, Newfoundland. *M. costata,* Say, is often obtained from the maw of the cod-fish. *Fossil,* 4 sp. U. Greensand —. Brit. France.

SOLECURTUS, Blainville.

Etym. Solen and *curtus,* short.

Syn. Psammosolen Risso. Macha, Oken. Siliquaria, Schum.

Ex. S. strigilatus, Pl. XXII. fig. 8. S. Caribæus, Pl. XXII. fig. 9.

Shell elongated, rather ventricose, with sub-central beaks; margins subparallel; ends truncated, gaping; ligament prominent; hinge-teeth $\frac{2}{2}$; pallial sinus very deep, rounded; posterior adductor rounded.

Animal very large and thick, not entirely retractile within the shell; mantle closed below; pedal orifice and foot large; palpi triangular, narrow, lamellated inside; gills long and narrow, outer much shortest; siphons separate at the ends, united and forming a thick mass at their bases; anal orifices plain, branchial fringed.

The *Solecurti* bury deeply in sand or mud, usually beyond low-water, and are difficult to obtain alive. *P. Caribæus* occurs in countless myriads in the bars of American rivers, and on the coast of New Jersey in sand exposed at low-water; by removing 3 or 4 inches of sand its burrows may be discovered; they are vertical cylindrical cavities, 1½ inches in diameter and 12 or more deep, the animal holds fast by the expanded end of its foot.

Distr. 25 sp. U. States, Brit. Medit. W. Africa, Madeira.

Fossil, 30 sp. Neocomian —. U. S. Europe.

Sub-genus, Novaculina, Benson. N. gangetica, Pl. XXII. fig. 10. *Shell,* oblong, plain; epidermis thick and dull; pallial sinus rather small; anterior pedal scar linear. *Distr.* India, China. In the mud of river-estuaries.

FAMILY XVIII. MYACIDÆ.

Shell thick, strong and opaque; gaping posteriorly; pallial line sinuated; epidermis wrinkled. Structure more or less distinctly cellular, with dark nuclei near outer surface; cartilage process composed of radiated cells.

Animal with the mantle almost entirely closed; pedal aperture and foot small; siphons united, partly or wholly retractile; branchiæ 2 on each side, elongated.

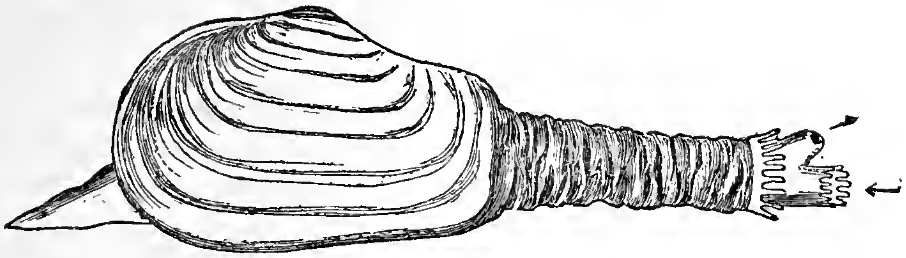


Fig. 220. *Mya truncata*, L. ½. Brit. (after Forbes.)

Mya, L. Gaper.

Etym. Myax (-acis) a mussel, Pliny. *Syn.* Platyodon, Conrad.

Types, M. truncata, Pl. XXIII. fig. 1. M. Arenaria, fig. 170, p. 244.

Shell oblong, inequivalve, gaping at the ends; left valve smallest, with a large flattened cartilage process; pallial sinus large.

Animal with a small straight linguiform foot; siphons combined, covered with epidermis, partially retractile; orifices fringed, the branchial opening with an inner series of large tentacular filaments; gills not prolonged into the siphon; palpi elongated, free.

M. anatina, Chemn. (Tugonia, Gray) W. coast of Africa; posterior side extremely truncated; similar cartilage-processes in each valve. *Fossil, Miocene,* Dax, and the Morca.

Distr. 10 sp. Northern Seas, W. Africa, Philippines, Australia, California. The Myas frequent soft bottoms, especially the sandy and gravelly mud of river-mouths; they range from low-water to 25 fathoms, rarely to 100 or 145 fms. *M. arenaria* burrows a foot deep; this species and *M. truncata* are found throughout the northern and Arctic seas, from Ochotsk and Sitka to the Russian Ice-meer, the Baltic, and British coast; in the Mediterranean they are only found fossil. They are eaten in Zetland and N. America, and are excellent articles of food. In Greenland they are sought after by the walrus, the Arctic fox, and birds. (*O. Fabricius.*)

Fossil, Miocene —. U. States, Brit. Sicily. Most of the fossil "Myas" have an external ligament, and are related either to *Panopæa* or *Pholadomya.*

Corbula, Bruguière.

Etym. Corbula, a little basket. *Type,* C. sulcata, Pl. XXIII. fig. 2.

Syn. Erodona, Daud. (= Pacyodon, Beck.) Agina, Turt.

Shell thick, inequivalve, gibbose, closed, produced posteriorly; right valve with a prominent tooth in front of the cartilage pit; left valve smaller, with a projecting cartilage process; pallial sinus slight: pedal scars distinct from the adductor impressions.

Animal with very short, united siphons; orifices fringed; anal valve tubular; foot thick and pointed; palpi moderate; gills 2 on each side, obscurely striated.

Distr. 50 sp. U. S. Norway, Brit. Medit. W. Africa, China. Inhabits sandy bottoms; Lower laminarian zone—80 fms.

Fossil. 90 sp. Inf. Oolite —. U. States, Europe, India. The external shell-layer consists of fusiform cells; the inner is homogeneous and adheres so slightly to the outer layer, that it is very frequently detached in fossil specimens. Corbulomya, Nyst (*C. complanata*, Sby.) Crag. Brit.

Sub-genera. Potamomya, J. Sby. P. gregaria, Eocene, I. Wight. Cartilage process broad and spatulate, received between two obscure teeth in the right valve. The estuary *Corbulæ* differ very little from the marine species. *P. labiata* (Azara, D'Orb.) Pl. XXIII. fig. 3, lives buried in the mud of the R. Plata, but not above Buenos Ayres, and consequently in water which is little influenced by the superficial ebb of the river. The same species is found in banks widely dispersed over the Pampas near S. Pedro, and many places in the Argentine Republic, 5 yards above the R. Parana. (*Darwin.*)

Sphenia, Turt. S. Binghami, Pl. XXIII. fig. 4. *Shell* oblong; right valve with a curved, conic tooth in front of the oblique, sub-trigonal cartilage-pit. *Animal* with thick united siphons, fringed at the end, anal valve conspicuous; foot finger-like, with a byssal groove. *Distr.* Brit. France. Burrowing in oyster-shells and limestone, in 10—25 fms. *Fossil,* Miocene —. Brit.

Neæra, Gray.

Etym. Neæra, a Roman lady's name.

Type, N. cuspidata, Pl. XXIII. fig. 5. *Syn.* Cuspidaria, Nardo.

Shell globular, attenuated and gaping behind; right valve a little the smallest; umbones strengthened internally by a rib on the posterior side; cartilage process spatulate, in each valve, (furnished with a moveable ossicle, *Deshayes*) with an obsolete tooth in front, and a posterior lateral tooth; pallial sinus very shallow.

Animal with the mantle closed; foot lanceolate; siphons short, united, branchial largest, anal with a membranous valve, both with a few long, lateral cirri.

Distr. 20 sp. Norway, Brit. Medit, Canaries, Madeira, China, Moluccas, New Guinea, Chile. From 12—200 fms.

Fossil, 6 sp. Oolite —. Brit. Belgium, Italy.

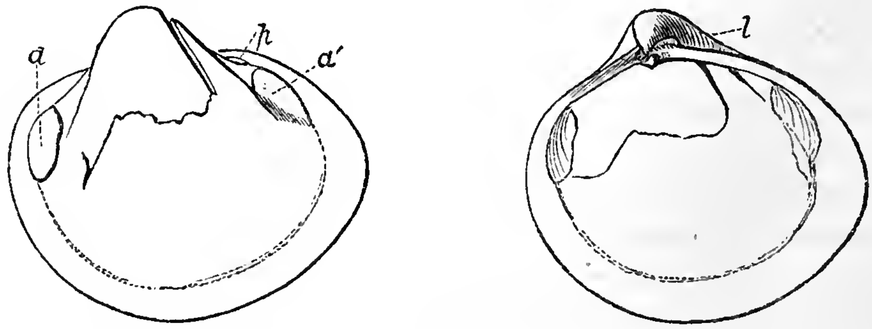


Fig. 221. *Thetis, minor,* Sby. *Neocomian,* I. Wight.

Thetis, Sowerby.

Etym. Thetis, in Greek myth. a sea-nymph.

Syn. Poromya (anatinoides) Forbes. Embla (Korenii) Lovén ?. Inoceramus (impressus) D'Orb. ? Corbula (gigantea) Sby.

Type, T. minor, fig. 221. T. hyalina, Pl. XXII. fig. 11.

Shell sub-orbicular, ventricose, thin, translucent, surface regularly granulated, interior slightly nacreous; ligament (*l*) external; hinge-teeth 1 or 2; umbones strengthened inside by a posterior lamina; adductor (*a, a'*) and pedal impressions (*p*) separate, slightly impressed, posterior adductor bordered by a ridge; pallial line nearly simple, sub-marginal.

Animal with short siphons, the branchial largest, surrounded at their base by 18—20 tentacles, generally reflected on the shell; mantle open in front; foot long, narrow and slender. (*M'Andrew.*)

Distr. 5 sp. Norway, Brit. Medit. Madeira, Borneo, China. 40—150 fms.

Fossil, 7 sp. Neocomian —. Brit. Belgium, France, S. India.

Sub-genus ? *Eucharis,* Recluz; Corbula quadrata, Hinds, Guadaloupe. *Shell* equivalve, obliquely keeled, gaping; beaks anterior; hinge-teeth 1—1; ligament external; pallial line simple; surface granulated.

Panopæa, Menard de la Groye.

Etym. Panopè, a Nereid. *Ex.* P. Americana, Pl. XXII. fig. 12.

Syn. ? Pachymya (gigas) Sby. U. Greensand. Brit. France.

Shell equivalve, thick, oblong, gaping at each end; ligament external, on prominent ridges; 1 prominent tooth in each valve; pallial sinus deep.

Animal with very long, united siphons, invested with thick, wrinkled epidermis; pedal orifice small, foot short, thick and grooved below; gills long and narrow, extending far into the branchial siphon, the outer pair much narrower, faintly pectinated; palpi long, pointed and striated.

In *P. Norvegica* the pallial line is broken up into a few scattered spots, as in *Saxicava*; the animal itself is like a gigantic Saxicava. (*Hancock.*) This species ranges from Ochotsk to the White Sea, Norway and N. Britain; it was formerly an inhabitant of the Medit. where it now occurs fossil. (= P. *Bivonæ,* Phil.) The British specimens have been caught, accidentally, by the deep-water fishing-hooks. *P. australis* is found at Port Natal, buried in the sand at low-water; the projecting siphons first attracted attention (doubtless by the strong jets of water they sent up when molested) but the shells were only obtained by digging to the depth of several feet. The Medit. sp. *P. glycimeris* attains a length of 6 or 8 inches.

Distr. 6 sp. Northern Seas, Medit. Cape, Australia, New Zealand, Patagonia. Low-water—90 fms.

Fossil, 140 sp. Inf. Oolite —. U. States, Europe, India.

SAXICAVA, Bellevue.

Etym. Saxum, stone, *cavo*, to excavate. S. rugosa, Pl. XXII. fig. 13.

Syn. Byssomya, Cuv. Rhomboides, Bl. Hiatella (minuta) Daud. Biapholius, Leach. Arcinella (carinata) Phil.

Shell when young symmetrical, with 2 minute teeth in each valve; adult rugose, toothless; oblong, equivalve, gaping, ligament external; pallial line sinuated, not continuous.

Animal with mantle-lobes united and thickened in front; siphons large, united nearly to their ends, orifices fringed; pedal opening small, foot finger-like, with a byssal groove; palpi small, free; gills narrow, unequal, united behind and prolonged into the branchial siphon.

Five genera and 15 species have been manufactured out of varieties and conditions of this Protean shell. It is found in crevices of rocks and corals, and amongst the roots of sea-weed, or burrowing in limestone and shells; at Harwich it bores in the cement stone (clay iron-stone), at Folkestone in the Kentish-rag, and the Portland stone employed in the Plymouth Breakwater has been much wasted by it. Its crypts are sometimes 6 inches deep (*Couch*); they are not quite symmetrical, and like those of the *Lithodomus* are inclined at various angles, so as to invade one another, the last comers cutting quite through their neighbours; they are usually fixed by the byssus to a small projection from the side of the cell. The Saxicava ranges from low-water to 140 fathoms; it is found in the Arctic Seas, where it attains its largest size; in the Medit, at the Canaries, and the Cape. It occurs fossil in the Miocene tertiary of Europe and in the U. States, and in all the Glacial deposits.

GLYCIMERIS, Lamarck.

Etym. Glukus, sweet, *meris*, bit.

Type, G. siliqua, Pl. XXII. fig. 14. *Syn.* Cyrtodaria, Daud.

Shell oblong, gaping at each end; posterior side shortest; ligament large and prominent; epidermis black, extending beyond the margins; anterior muscular scar long, pallial impression irregular, slightly sinuated.

Animal larger than its shell, sub-cylindrical; mantle closed, siphons united, protected by a thick envelope; orifices small; pedal opening small anterior; foot conical; palpi large, striated inside, the posterior border plain; gills large, extending into branchial siphon.

Distr. Arctic Seas, Cape Parry, N. W. America, Newfoundland.

Fossil, Miocene —. Brit. Belgium.

FAMILY XIX. ANATINIDÆ.

Shell often inequivalve, thin; interior nacreous; surface granular; ligament external, thin; cartilage internal, placed in corresponding pits and furnished with a free ossicle; muscular impressions faint, the anterior elongated; pallial line usually sinuated.

Animal with mantle margins united; siphons long, more or less united, fringed; gills single on each side, the outer lamina prolonged dorsally beyond the line of attachment.

Pholadomya and its fossil allies have an external ligament only; *Cochlodesma* and *Pandora* have no ossicle. The external surface of these shells is often rough with large calcarious cells, sometimes ranged in lines, and covered by the epidermis; the outer layer consists of polygonal cells, more or less sharply defined; the inner layer is nacreous.

ANATINA, Lamarck. Lantern-shell.

Type, A. rostrata, Pl. XXIII. fig. 7. (*Anatinus,* pertaining to a duck.)

Syn. Laternula, Bolten M. S. Auriscalpium, Muhlf. Osteodesma, Bl. Cyathodonta (undulata) Conrad ? W. America.

Shell oblong, ventricose, sub-equivalve, thin and translucent, posterior side attenuated and gaping; umbones fissured, directed backwards, supported internally by an oblique plate; hinge with a spoon-shaped cartilage-process in each valve, furnished in front with a transverse ossicle; pallial sinus wide and shallow.

Animal with a closed mantle and long united siphons, clothed with wrinkled epidermis; gills one on each side, thick, deeply plaited; palpi very long and narrow; pedal opening minute, foot very small, compressed.

Distr. 20 sp. India, Philippines, New Zealand, W. America.

Fossil, 50 sp. Devonian ? — Oolite —. U. States, Europe.

Sub-genera. Periploma (inequivalvis) Schum. "Spoon-hinge" of Petiver; oval, inequivalve, left valve deepest; posterior side very short and contracted. *Distr.* W. Indies, S. America.

Cochlodesma, Couthouy, C. prætenue, Pl. XXIII. fig. 8. (Bontia, Leach MS. Ligula, Mont. part.) Oblong, compressed, thin, slightly inequivalve; umbones fissured; cartilage processes prominent, without an ossicle; pallial sinus deep. *Animal* with a broad, compressed foot; siphons long, slender, divided throughout; gills one on each side, deeply plaited, divided by an oblique furrow into two parts, the dorsal portion being narrower, composed of a single lamina only, and attached by its whole inner surface. (*Hancock.*) *Distr.* 2 sp. U. States, Brit. Medit. *Fossil,* Pliocene, Sicily.

Cercomya, Agassiz. C. undulata, Sby. (= Rhynchomya, Ag.) *Shell* very thin, elongated, compressed, attenuated posteriorly; sides concentrically furrowed, umbones fissured, posterior (cardinal) area more or less defined. *Fossil,* 12 sp. Oolite — Neocomian; Europe.

THRACIA (Leach) Bl.

Syn. Odoncinetus, Costa. Corimya, Ag. Rupicola (concentrica) Bellevue.

Type, T. pubescens, Pl. XXIII. fig. 9.

Shell oblong, nearly equivalve, slightly compressed, attenuated and gaping posteriorly, smooth or minutely scabrous; cartilage processes thick, not prominent, with a crescentic ossicle; pallial sinus shallow. Outer shell layer composed of distinct, nucleated cells.

Animal with the mantle closed; foot linguiform; siphons rather long, separate, with fringed orifices; gills single, thick, plaited; palpi narrow, pointed.

T. concentrica and *T. distorta,* Mont. are found in the crevices of rocks, and burrows of *Saxicava;* they have been mistaken for boring-shells.

Distr. 10 sp. Greenland, U. States, Norway, Brit. Medit. Canaries, China, Sooloo: 4—110 fms.

Fossil, 30 sp. (Trias ?) L. Oolite —. U. States, Europe.

Pholadomya, G. Sowerby.

Recent Type, P. candida. Pl. XXII. fig. 15. I. Tortola.

Shell oblong, equivalve, ventricose, gaping behind; thin and translucent, ornamented with radiating ribs on the sides; ligament external; hinge with one obscure tooth in each valve; pallial sinus large.

Animal with a single gill on each side, thick, finely plaited, grooved along its free border, the outer lamina prolonged dorsally; mantle with a fourth (ventral) orifice. (*Owen.*)

Fossil, 150 sp. Lias —. U. S. Europe, Algeria, Thibet.

Homomya (hortulana) Ag. *Shell* thick, concentrically furrowed, without radiating ribs; 6 sp. Oolites, Europe.

Myacites (Schlotheim) Bronn.

Syn. Myopsis (Jurassi) Ag. Pleuromya, Ag. Arcomya (Helvetica) Ag. Mactromya (mactroides) Ag. Anoplomya (lutraria) Krauss.

Ex. M. sulcatus, Flem. (Allorisma, King, Pal. Tr. 1850, Pl. XX. fig. 5.)

Shell oblong, ventricose, gaping, thin, often concentrically furrowed; umbones anterior; surface granulated; ligament external; hinge with an obscure tooth or edentulous; muscular impressions faint; pallial line deeply sinuated.

Fossil, 50 sp. L. Silurian — L. Chalk. U. S. Europe, S. Africa.

*Sub-genera ? Goniomya,*Ag. Mya literata, Pl. XXII. fig. 16. (Lysianassa, Münster, not M. Edw.) *Shell* equivalve, thin, granulated; ligament external, short, prominent. *Fossil,* 30 sp. U. Lias — Chalk. Europe.

Tellinomya (nasuta) Hall; *Silurian,* U. S. Europe. Not characterised.

? *Grammysia,* Verneuil. Nucula cingulata, His. *U. Silurian,* Europe. Valves with a strong transverse fold extending from the umbones to the middle of the ventral margin.

? *Sedgwickia* (corrugata) M'Coy. = ? Leptodomus (senilis) M'Coy.

Shell thin, ventricose, concentrically furrowed in front; escutcheon long and flat. Silurian — Carb. Europe.

Ceromya, Agassiz.

Etym. Keraos horned, *mya*, mussel.

Type, C. concentrica (Isocardia) Sowerby, Min. Con. 491, fig. 1.

Shell Isocardia-shaped, slightly inequivalve ? very thin, granulated, often eccentrically furrowed; ligament external; hinge edentulous; right valve with an internal lamina behind the umbo; pallial line scarcely sinuated?

Fossil, 14 sp. Inf. Oolite —. Green-sand ? Europe.

Sub-genus ? *Gresslya* (sulcosa) Ag. (Amphidesma and Unio. sp. Phil.) *Shell* oval, rather compressed; umbones anterior, incurved, not prominent; valves thin, close, smooth or concentrically furrowed; pallial sinus deep. *Fossil*, 17 sp. Lias — Portlandian. Europe. The lamina within the posterior hinge-margin of the right valve produces a furrow in the casts, which are more common than specimens retaining the shell.

? Cardiomorpha, Koninck.

Type, C. oblonga (Isocardia) Sby. (not Kon.) Carb. lime.

Shell Isocardia-shaped, smooth or concentrically furrowed, umbones prominent, hinge edentulous; hinge-margin with a narrow ligamental furrow, and an obscure internal cartilage-groove.

Fossil, 38 sp. L. Silurian — Carb. N. America, Europe.

Edmondia, Koninck.

Ex. E. sulcata, Ph. (T. Pal. Soc. 1850, Pl. XX. fig. 5.) Carb. Brit.

Syn. Allorisma, King (part). Sanguinolites, M'Coy (part).

Shell oblong, equivalve, thin, concentrically striated, close; umbones anterior; ligamental grooves narrow, external; hinge-line thin, edentulous, furnished with large oblique cartilage-plates, placed beneath the umbones, and leaving space for an ossicle ? pallial line simple ?

Fossil, 4 sp. Carb. — Permian. Europe.

Lyonsia, Turton, 1822 (not R. Brown).

Syn. Magdala, Leach, 1827. Myatella, Brown. Pandorina, Scacchi.

Type, L. Norvegica, Pl. XXIII. fig. 10.

Shell nearly equivalve, left valve largest, thin, sub-nacreous, close, truncated posteriorly; cartilage plates oblique, covered by an oblong ossicle; pallial sinus obscure, angular. Structure intermediate between *Pandora* and *Anatina*; outer layer composed of definite polygonal cells.

Animal with the mantle closed; foot tongue-shaped, grooved, byssiferous; siphons very short, united nearly throughout, fringed; lips large, palpi narrow, triangular.

Distr. 9 sp. Greenland, N. Sea, Norway, W. Indies, Madeira, India, Borneo, Philippines, Peru.

L. Norvegica ranges from Norway to the sea of Ochotsk; in 15—80 fms.

Fossil ? Miocene —. Europe. (100 sp. L. Sil. —. D'Orb.)

? *Entodesma* (Chilensis) Phil. *Shell* thin, saxicava-shaped, slightly inequivalve and gaping, covered with thick epidermis; hinge edentulous; each valve with a semi-circular process containing the cartilage.

PANDORA (Solander) Brug.

Type, P. rostrata, Pl. XXIII. fig. 11. (*Pandora*, the Grecian Eve.)

Shell inequivalve, thin, pearly inside; valves close, attenuated behind; right valve flat, with a diverging ridge and cartilage furrows; left valve convex, with two diverging grooves at the hinge; pallial line slightly sinuated. Outer layer of regular, vertical, prismatic cells, 250 times smaller than those of *Pinna* (fig. 260). (*Carpenter.*)

Animal with mantle closed, except a small opening for the narrow, tongue-shaped foot; siphons very short, united nearly throughout, ends diverging, fringed; palpi triangular, narrow; gills plaited, one on each side, with a narrow dorsal border.

Distr. 13 sp. U. States, Spitzbergen, Jersey, Canaries, India, N. Zealand, Panama: 4—110 fms. burrowing in sand and mud.

Fossil, 4 sp. Eocene —. U. States, Brit.

MYADORA, Gray.

Type, M. brevis, Pl. XXIII, fig. 12.

Shell trigonal, rounded in front, attenuated and truncated behind; right valve convex, left flat; interior pearly; cartilage narrow, triangular, between 2 tooth-like ridges in the left valve, with a free sickle-shaped ossicle; pallial line sinuated: structure like *Anatina*; outer cells large, rather prismatic.

Distr. 10 sp. N. Zealand, N. S. Wales, Philippines.

MYOCHAMA, Stutchbury.

Type, M. anomioides, Pl. XXIII. fig. 13.

Shell inequivalve, attached by the dextral valve and modified by form of surface of attachment; posterior side attenuated; left valve gibbose; cartilage internal, between 2 tooth-like projections in each valve, and furnished with a moveable ossicle; anterior muscular impression curved, posterior rounded, pallial sinus small.

Animal with mantle-lobes united; pedal opening and siphons surrounded by separate areas; siphons distinct, unequal, small, slightly fringed; a minute fourth orifice close to the base of the branchial siphon; visceral mass large, foot small and conical; mouth rather large, upper lip hood-like; palpi tapering, few-plaited; gills one on each side, triangular, plaited, divided by an oblique line into two portions; excurrent channels 4, 2 at the base of the gills and two below the dorsal laminæ. (Hancock, An. Nat. Hist. 1853.)

Distr. 3 sp. New South Wales; attached to Crassatella and Trigonia, in 8 fm. water; the fry (as indicated by the umbones) is free, regular, and Myadora-shaped.

CHAMOSTREA, Roissy.

Type, C. albida, Pl. XXIII. fig. 14. *Syn.* Cleidothærus, Stutch.

Shell inequivalve, chama-shaped, solid, attached by the anterior side of the deep and strongly-keeled dextral valve; umbones anterior, sub-spiral; left valve flat, with a conical tooth in front of the cartilage; cartilage internal, with an oblong, curved ossicle; muscular impressions large and rugose, the anterior very long and narrow; pallial line simple.

Animal with mantle-lobes united by their extreme edge between the pedal orifice and siphons; pedal opening small, with a minute ventral orifice behind it; siphons a little apart, very short, denticulated; body oval, terminating in a small, compressed foot; lips bilobed, palpi disunited, rather long and obtusely pointed; gills one on each side, large, oval, deeply plaited, prolonged in front between the palpi, united posteriorly; each gill traversed by an oblique furrow, the dorsal portion consisting of a single lamina with a free margin. (Hancock, An. Nat. Hist. Feb. 1853.)

Distr. 1 sp. New South Wales.

FAMILY XX. GASTROCHÆNIDÆ.

Shell equivalve, gaping; valves thin, edentulous, united by a ligament, sometimes cemented to a shelly tube when adult; adductor impressions 2, pallial line sinuated.

Animal elongated, truncated in front, produced behind into two very long, united, contractile siphons, with cirrated orifices; mantle-margins very thick in front, united, leaving a small opening for the finger-like foot; gills narrow, prolonged into the branchial siphon.

The shell-fish of this family, the *tubicolidæ* of Lamarck, are burrowers in mud or stone. They are often gregarious, living in myriads near low-water line, but are extracted from their abodes with difficulty.

GASTROCHÆNA, Spengler, 1783.

Type, G. modiolina, Pl. XXIII. fig. 15. (*Gaster,* ventral, *chæna,* gape.)

Shell regular, wedge-shaped, umbones anterior; gaping widely in front, close behind; ligament narrow, external; pallial sinus deep.

Animal with mantle closed, and thickened in front; foot finger-like, grooved, sometimes byssiferous, siphons long, separate only at their extremities; lips simple, palpi sickle-shaped, gills unequal, prolonged freely into the branchial siphon.

G. modiolina perforates shells and limestone; its holes are regular, about

2 inches deep and ½ inch diameter; the external orifice is hour-glass shaped, and lined with a shelly layer which projects slightly. When burrowing in oyster-shells it often passes quite through into the ground below, and then completes its abode by cementing such loose material as it finds into a flask-shaped case, having its neck fixed in the oyster-shell; in some fossil species the siphons were more separated, and the flasks have two diverging necks. The siphonal orifices are rarely 4-lobed; Pl. XXIII. fig. 15 a.

Distr. 10 sp. W. Indies, Brit. Canaries, Medit. Red Sea, India, Mauritius, Pacific Ids. Gallapagos, Panama:—30 fms.

Fossil, 20 sp. Inf. Oolite —. U. States, Europe.

Sub-genus. Chæna, Retz. 1788. C. mumia. Pl. XXIII. fig. 16. (= Fistulana clava, Lam.) *Shell* elongated, contained within a shelly tube; posterior adductor nearly central, with a pedal scar in front; siphonal inflection angular, with its apex joining the pallial line. Tube round, straight, tapering upwards, transversely striated, closed at the lower end when complete, and furnished with a perforated diaphragm behind the valves. *Distr.* Madagascar, India, Philippines, Australia; burrowing in sand or mud.

Fossil, Inf. Oolite —. U. S. Europe, S. India.

Clavagella, Lamarck.

Ex. C. bacillaris, Pl. XXIII. fig. 17.

Shell oblong, valves flat, often irregular or rudimentary, the left cemented to the side of the burrow, when adult, the right always free; anterior muscular impression small, posterior large, pallial line deeply sinuated. Tube cylindrical, more or less elongated, sometimes divided by a longitudinal partition; often furnished with a succession of siphonal fringes above, and terminating below in a disk, with a minute central fissure, and bordered with branching tubuli.

Animal with the mantle closed in front, except a minute slit for the foot, and furnished with tentacular processes; palpi long and slender; gills 2 on each side, elongated, narrow (floating freely in the branchial siphon ?)

Some specimens of the recent *C. aperta* have 3 frills to their tubes, and *C. bacillaris* has twice that number occasionally. They are formed by the siphonal orifices when the animal continues elongating, after having fixed its valve and ceased to burrow; or perhaps, in some instances, when it is compelled to lengthen its tubes upwards by the accumulation of sediment. Brocchi mentions that on breaking the tube of the fossil *C. echinata,* he sometimes found the shell of a *Saxicava* or *Petricola* beside the loose valve of the *Clavagella,* into whose tube they must have entered after its death. *C. elongata* is found in coral; *C. australis* lives at low tide, and spirts out water when alarmed. *Distr.* 6 sp. Medit. Australia, Pacific:—11 fms.

Fossil, 13 sp. U. Green-sand —. Brit. Sicily, S. India.

ASPERGILLUM, Lam. Watering-pot shell.

Type, A. vaginiferum, Pl. XXIII. fig. 18. *Syn.* Clepsydra, Schum.

Shell small, equilateral, cemented to the lower end of a shelly tube, the umbones alone visible externally; tube elongated, closed below by a perforated disk with a minute central fissure; siphonal end plain or ornamented with (1—8) ruffles.

Animal elongated; mantle closed, thickened and fringed with filaments in front; foot conical, anterior, opposed to a minute slit in the mantle; palpi lanceolate; gills long, narrow, united posteriorly, continued into and attached to the branchial siphon.

Distr. 4 sp. Red Sea, Java, Australia, N. Zealand; in sand.

Fossil, 1 sp. (A ? Leognanum, Hœning. *Miocene,* Bordeaux.)

FAMILY XXI. PHOLADIDÆ.

Shell gaping at both ends; thin, white, brittle and exceedingly hard; armed in front with rasp-like imbrications; without hinge or ligament, but often strengthened externally by accessory valves; hinge-plate reflected over the umbones, and a long curved muscular process beneath each; anterior muscular impression on the hinge-plate; pallial sinus very deep.

Animal club-shaped, or worm-like; foot short and truncated; mantle closed in front, except the pedal orifice; siphons large, elongated, united nearly to their ends; orifices fringed; gills narrow, prolonged into the exhalent siphon, attached throughout, closing the branchial chamber; palpi long; anterior shell-muscle acting as substitute for a ligament.

The *Pholadidæ* perforate all substances that are softer than their own valves (p. 242);* the burrows of Pholas are vertical, quite symmetrical, and seldom in contact. The ship-worms (*Teredines*) also make symmetrical perforations, and however tortuous and crowded never invade each other, guided either by the sense of hearing or by the yielding of the wood. The burrow

* M. Cailliaud has proved that these valves are quite equal to the work of boring in limestone, by imitating the natural conditions as nearly as possible, and *making such a hole with them.* Mr. Robertson also, has kept the living Pholades in blocks of chalk, by the sea-side at Brighton, and has watched the progress of the work. They turn from side to side never going more than half-round in their burrow, and cease to work as soon as the hole is deep enough to shelter them; the chalk powder is ejected at intervals by spasmodic contractions from the *branchial* siphon, the space between the shell and burrow being filled with this mud. (Journ. Conch. 1853, p. 311.) It is to be remarked that the condition of the Pholades is always related to the nature of the material in which they are found burrowing; in soft sea-beds they attain the largest size and greatest perfection, whilst in hard, and especially gritty rock, they are dwarfed in size and all prominent points and ridges appear worn by friction. No notice has been taken of the hypothesis which ascribes the perforation of rocks, &c., to *ciliary action,* because, in fact, there is no current between the shell or siphons and the wall of the tube.

has frequently a calcarious lining, within which the shell remains free; *Teredina* cements its valves to this tube when full-grown. The opening of the burrow, at first very minute, may become enlarged progressively by the friction of the siphons, which are furnished with a rough epithelium; but it usually widens with much more rapidity by the *wasting of the surface.* As the timber decomposes the shelly tubes of the *Teredo* project, and as the beach wears away the *pholas* burrows deeper.

PHOLAS, L. Piddock.

Etym. Pholas, a burrowing shell-fish, from *pholeo,* to bore.

Type, P. dactylus, fig. 222. *Ex.* P. Bakeri, Pl. XXIII. fig. 19.

Shell elongated, cylindrical; dorsal margin protected by accessory valves; pallial sinus reaching the centre of the shell.

Animal with a large truncated foot, filling the pedal opening; body with a fin-like termination; combined siphons large, cylindrical, with fringed orifices.

The common piddock is used for bait on the Devon coast; its foot is white and translucent when fresh, like a piece of ice; the *hyaline stylet* (p. 29) lodged in it, is large and curious. *P. costata* is sold in the market of Havannah, where it is an article of food.

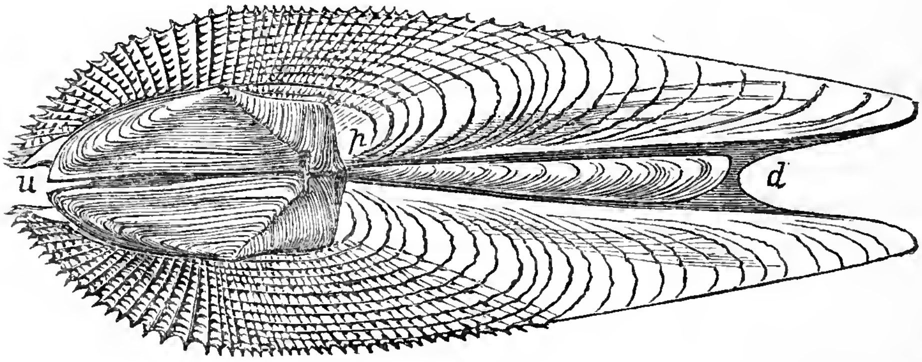


Fig. 222. *Pholas dactylus.* Chalk, Sussex Coast.
u, umbonal valves; *p,* post-umbonal valve; *d,* dorsal valve.

P. dactylus has two accessory valves to protect the umbonal muscle, with a small transverse plate behind; a long unsymmetrical plate fills up the space between the valves in the dorsal region. *P. candida* and *parva* have a single umbonal shield, and no dorsal plate; these differences are only of *specific* value. In *P. crispata,* L. (*Zirfæa,* Leach) the umbonal shield is not distinctly calcified, but there is a small posterior plate; the surface of the valves is divided into two areas by a transverse furrow.

Distr. 25 sp. U. S. Norway, Brit. W. Africa, Medit. Crimea, India, Australia, N. Zealand, W. America:—25 fms.

Fossil, 25 sp. (U. Lias —) Eocene —. U. States, Europe. The secondary species belong to the next group.

PHOLADIDEA, Turton, 1819.

Type, P. papyracea, Pl. XXIII. fig. 20.

Shell globose-oblong, with a transverse furrow; anterior gape large, closed in the adult by a callous plate; 2 minute accessory valves in front of the beaks.

Animal with a fringed disk at the end of the combined siphons, and a horny cup at their base.

Distr. 6 sp. Brit. N. Zealand, Ecuador. Low-tides—10 fms.

Sub-genera. Martesia (Leach) Bl. 1825. M. striata, Pl. XXIII. fig. 21 Valves lengthened behind, when full grown, by a plain border; umbonal valves 1 or 2; dorsal and ventral margins often with narrow accessory valves. 10 sp. W. Indies, Africa, India. *M. striata* burrows in hard timber. *M. terediniformis* was found in cakes of floating wax on the coast of Cuba. (G. B. Sby.) *M. australis* in (fossil ?) resin, on the coast of Australia. *M. rivicola* in timber 12 miles from the sea, in Borneo. *M. scutata*, Eocene, Paris, lines its burrow with shell.

Jouannetia (semicaudata) Desm. (Pholadopsis, Conrad; Triomphalia, Sby.) *Shell* very short, sub-globose; right valve longest behind: anterior opening closed by a callous plate developed from the left valve overlapping the margin of the right valve, and fixed to the single unsymmetrical umbonal plate. *Distr.* 3 sp. Philippines, W. America. *Fossil*, Miocene —. France.

Parapholas, Conrad, P. bisulcata, Pl. XXIII. fig. 22. Valves with 2 radiating furrows. *Distr.* 4 sp. California, Panama, Torres Strts.

XYLOPHAGA, Turton.

Etym. Xulon, wood, *phago*, to eat.

Types, X. dorsalis, Pl. XXIII. fig. 23; X. globosa, Sby. Valparaiso.

Shell globular, with a transverse furrow; gaping in front. closed behind; pedal processes short and curved; anterior margins reflected, covered by 2 small accessory valves; burrow oval, lined with shell.

Animal included within the valves, except the slender contractile siphons, which are furnished with pectinated ridges, and divided at the end; foot thick, very extensile.

Distr. 2 sp. Norway, Brit. S. America. Bores an inch deep, and across the grain, in floating wood, and timbers which are always covered by the sea.

TEREDO (Pliny) Adanson.

Type, T. Norvegica, Pl. XXIII. figs. 26, 27. *Syn.* Septaria, Lam.

Shell globular, open in front and behind, lodged at the inner extremity of a burrow partly or entirely lined with shell; valves 3 lobed, concentrically striated, and with one transverse furrow; hinge-margins reflected in front marked by the anterior muscular impressions; umbonal cavity with a long curved muscular process.

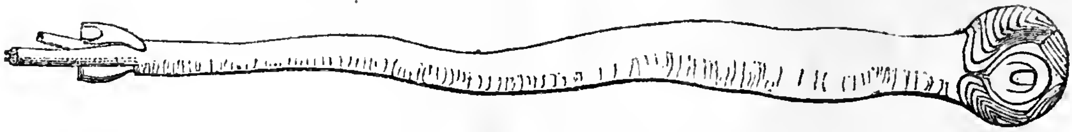


Fig. 223. Ship-worm, *Teredo Norvegica*, removed from its burrow.

Animal worm-like; mantle-lobes united, thickened in front, with a minute pedal opening; foot sucker-like, with a foliaceous border; viscera included in the valves, heart not pierced by the intestine; mouth with palpi; gills long, cord-like, extending into the siphonal tube; siphons very long, united nearly to the end, attached at the bifurcation and furnished with 2 shelly pallets or styles; orifices fringed.

T. navalis is ordinarily a foot long, sometimes 2½ feet; it destroys soft wood rapidly, and teak and oak do not escape; it always bores in the direction of the grain unless it meets the tube of another *Teredo*, or a knot in the timber.* In 1731-2 it did great damage to the piles in Holland, and caused still more alarm; metal sheathing, and broad-headed iron nails have been found most effectual in protecting piers and ship-timbers. The *Teredo* was first recognised as a bivalve mollusc by Sellius, who wrote an elaborate treatise on the subject, in 1733. (*Forbes.*)

T. corniformis, Lam. is found burrowing in the husks of cocoa-nuts and other woody fruits floating in the tropical seas; its tubes are extremely crooked and contorted, for want of space. The fossil wood and palm-fruits (*Nipadites*) of Sheppy and Brabant are mined in the same way. The tube of the giant Teredo (*T. arenaria*, Rumph. Furcella, Lam.) is often a yard long and 2 inches in its greatest diameter; when broken across it presents a radiating prismatic structure. The siphonal end is divided lengthwise, and sometimes prolonged into two diverging tubes. *T. Norvegica* and *T. denticulata* are divided longitudinally and also concamerated by numerous, incomplete transverse partitions, at the posterior extremity.

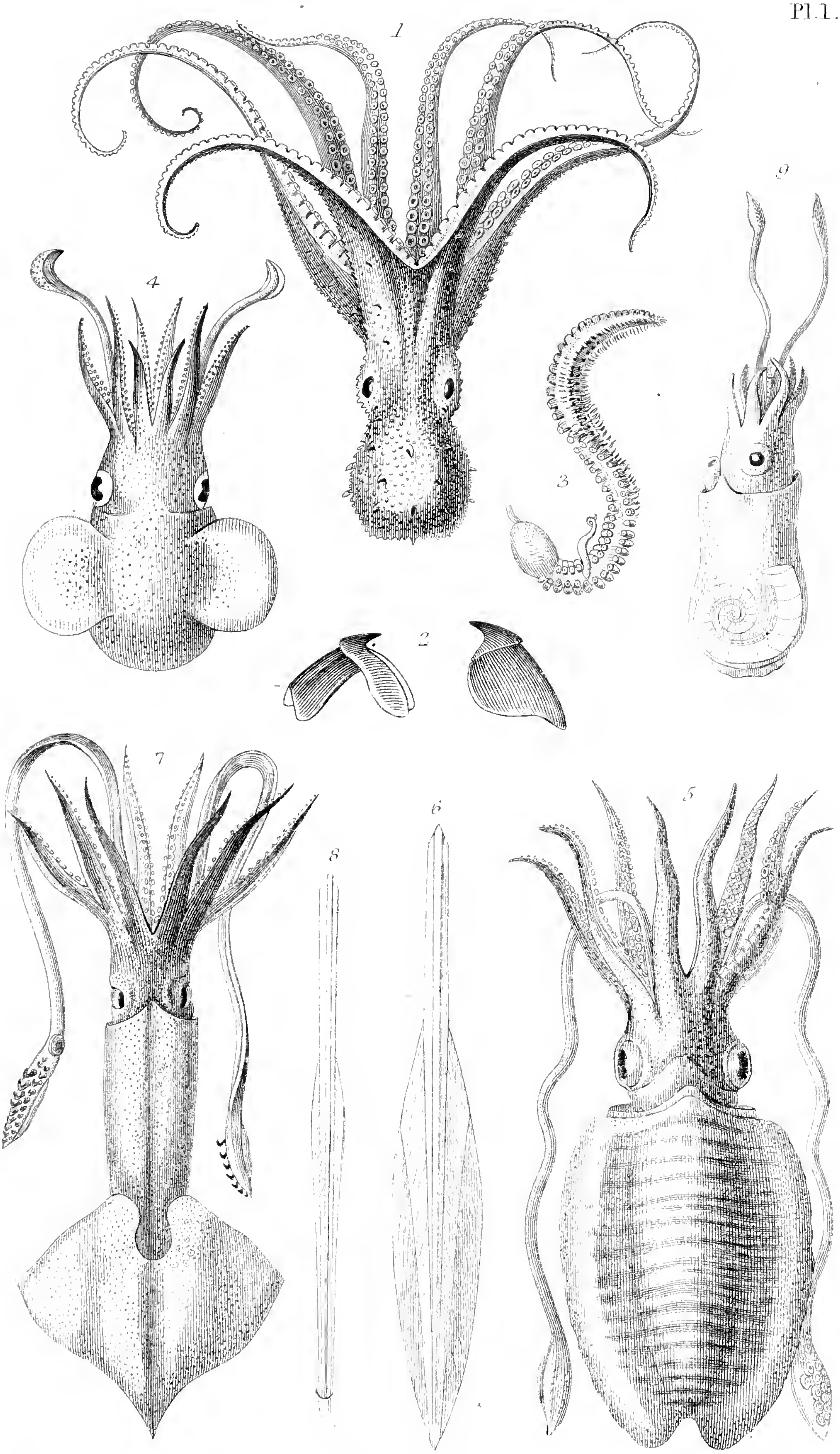
T. bipalmulata (Xylotrya, Leach) has the siphonal pallets elongated and penniform (Pl. XXIII. fig. 28); a species with similar styles occurs in the fossil wood of the Green-sand of Blackdown.

Distr. 14 sp. Norway, Brit. Black Sea; Tropics:—119 fms.

Fossil, 24 sp. Lias —. U. States, Europe.

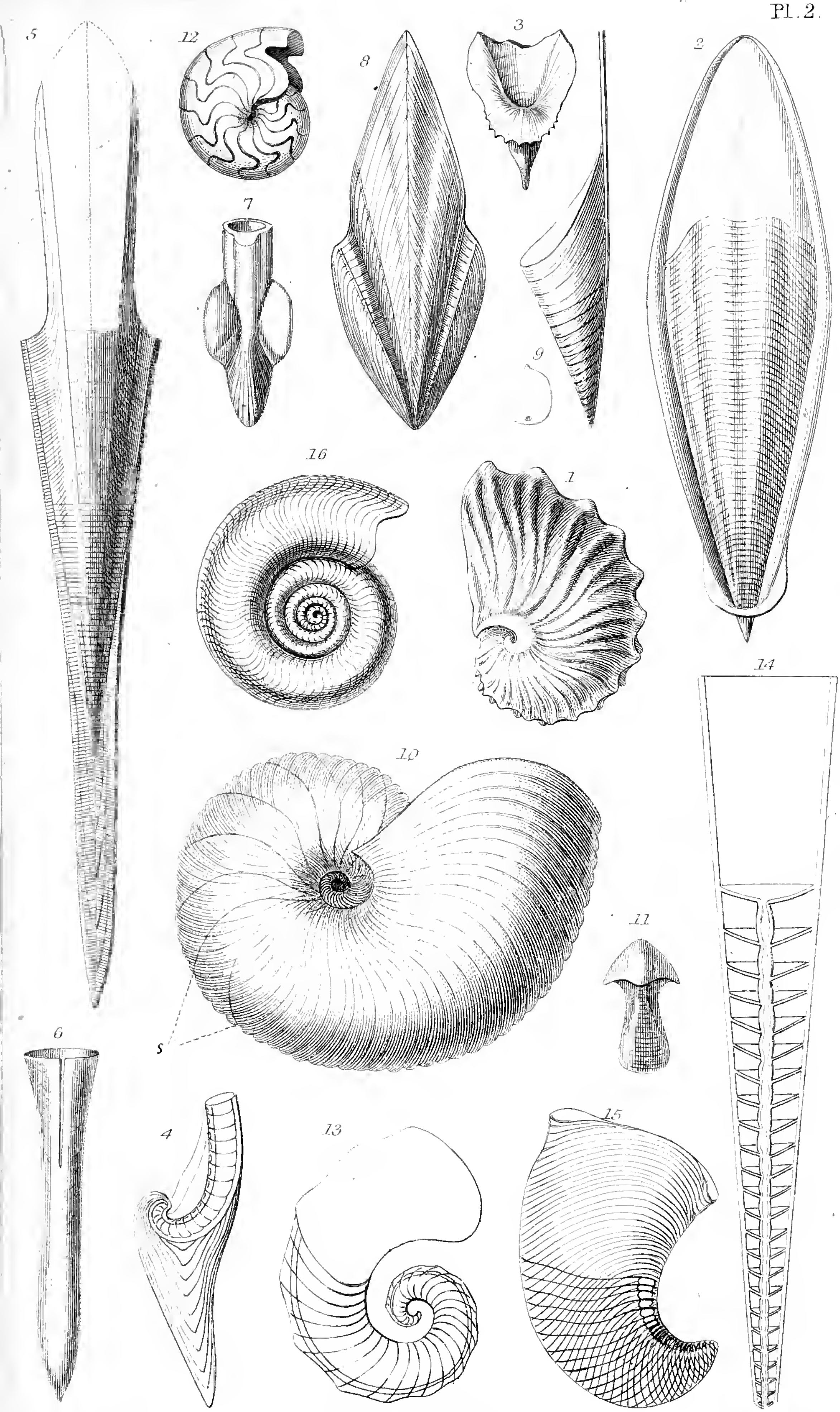
Sub-genus, *Teredina*, Lam. T. personata, Pl. XXIII. figs. 24, 25. *Eocene*, Brit. France. *Valves* with an accessory plate in front of the umbones; free when young, united by their margins to the shelly tube when adult. The tube is sometimes concamerated; its siphonal end is often truncated; and the opening contracted by a lining which makes it hour-glass shaped, or six-lobed (fig. 25a.).

* The operations of the *Teredo* suggested to Mr. Brunel his method of tunnelling the Thames.



S. P. Woodward. London, John Weale, 1851. J. W. Lowry

Pl. 2.



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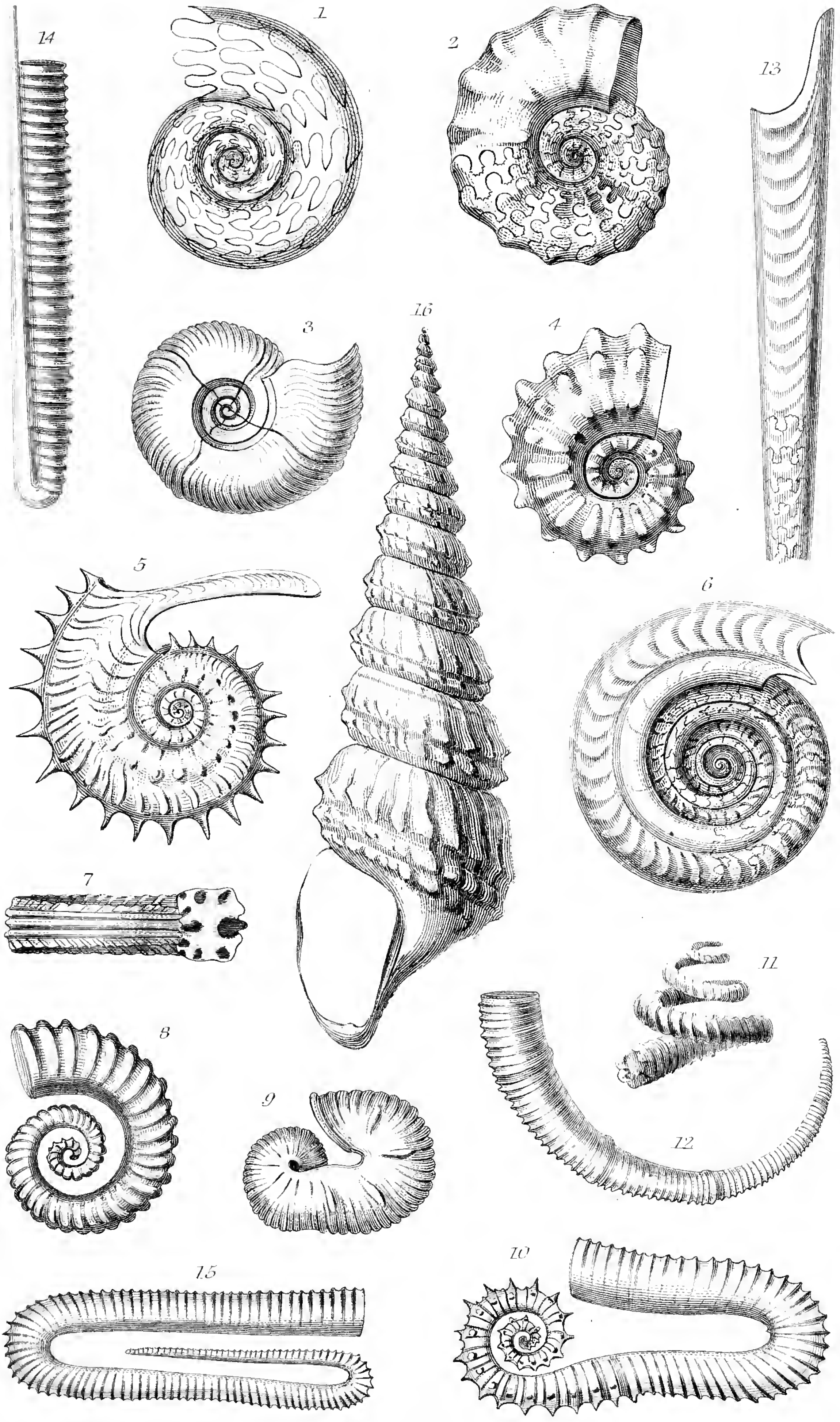

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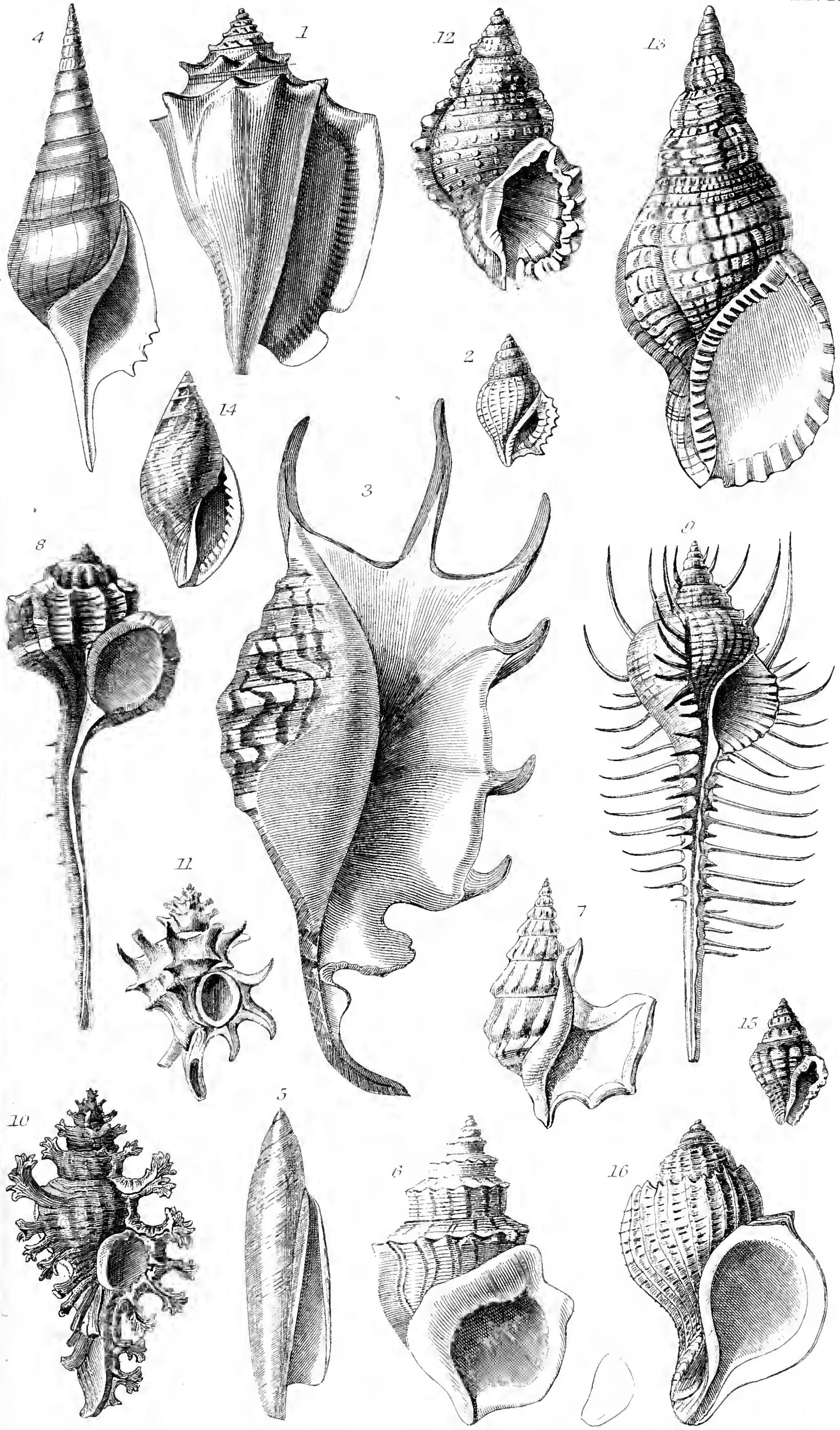
Pl. 4.



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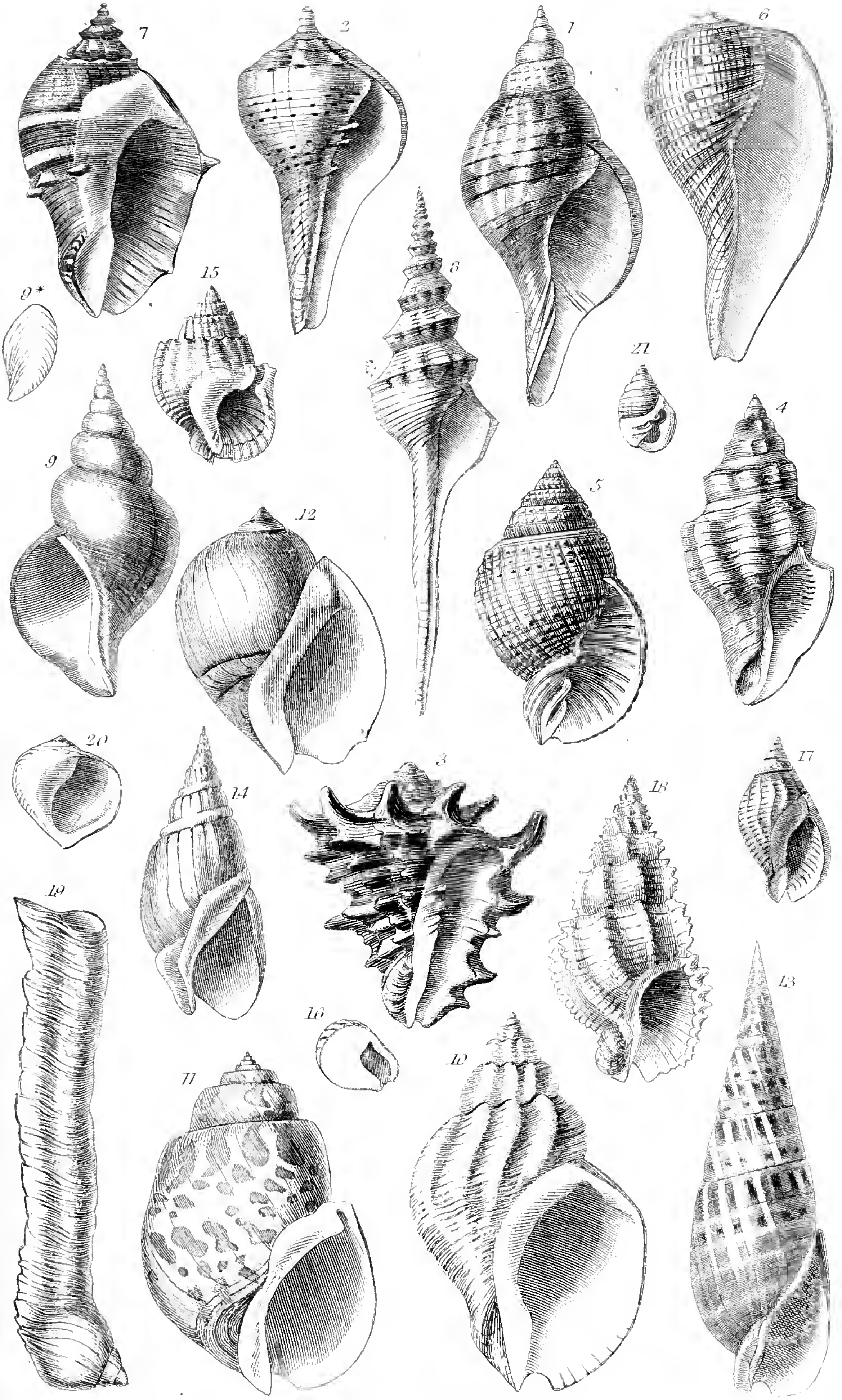

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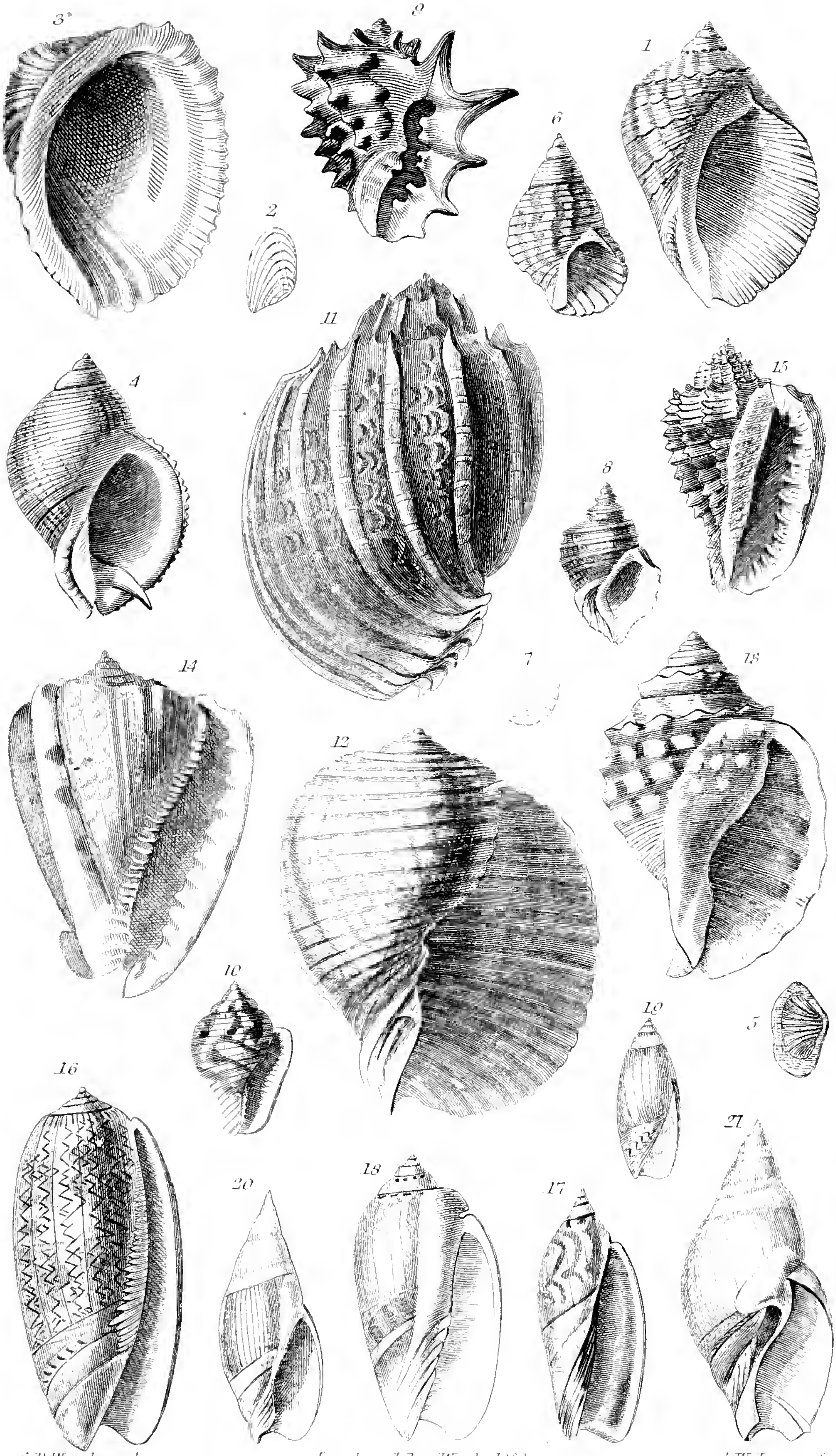

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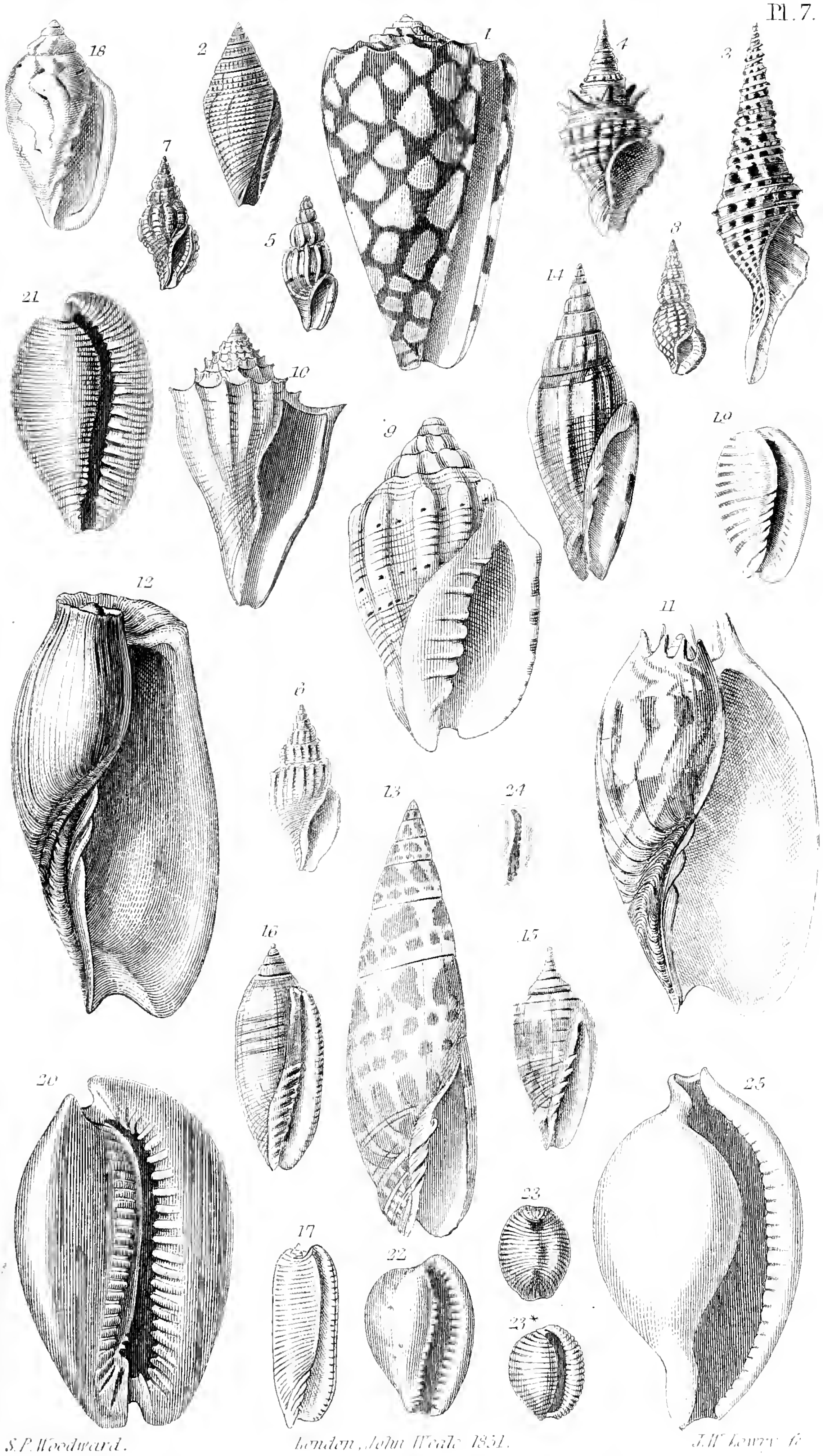
Pl. 7.



S. P. Woodward. London, John Weale 1851. J. W. Lowry fc.

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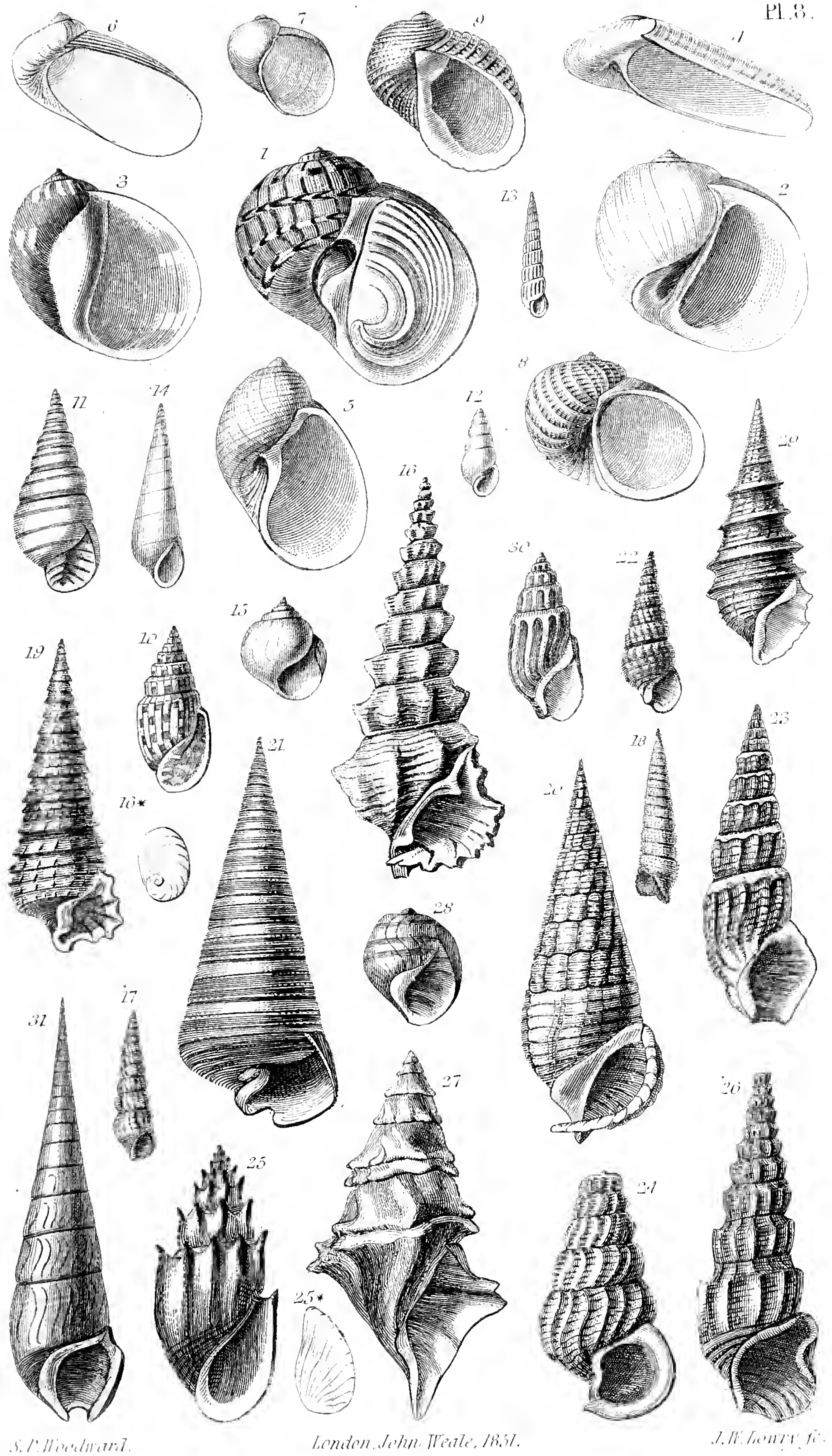
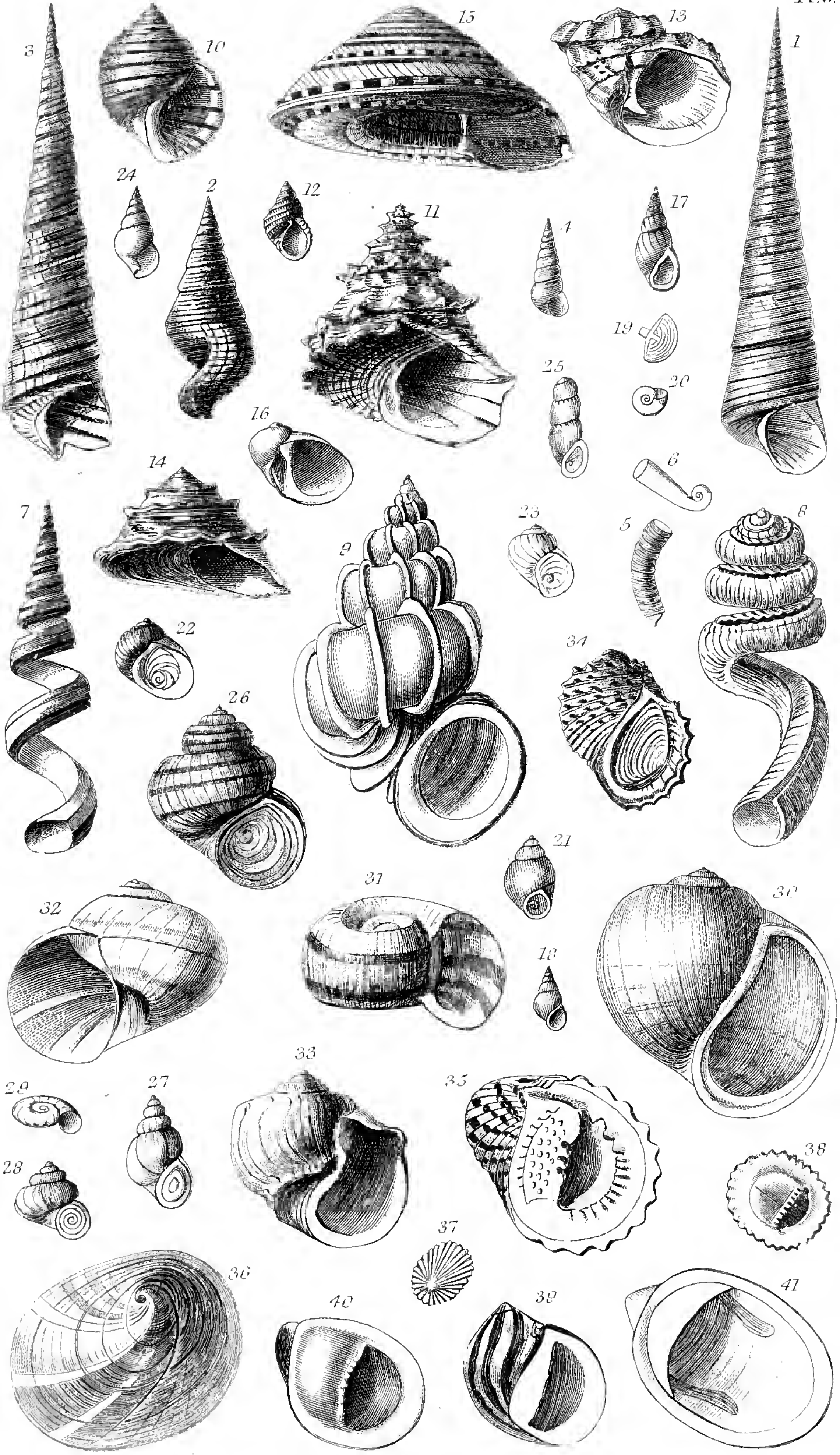


S. P. Woodward. London, John Weale, 1851. J. W. Lowry fc.

Pl. 9.



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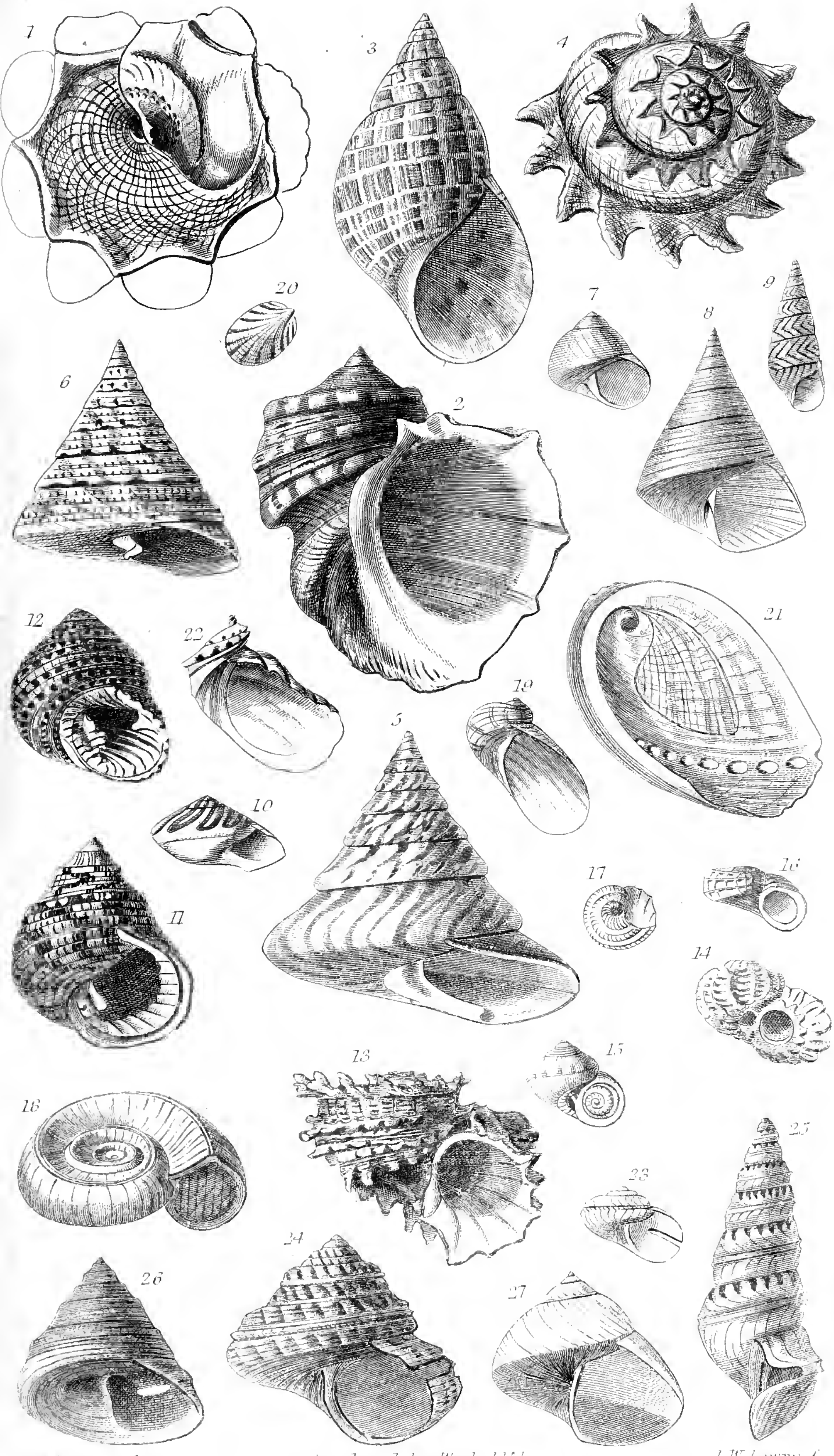
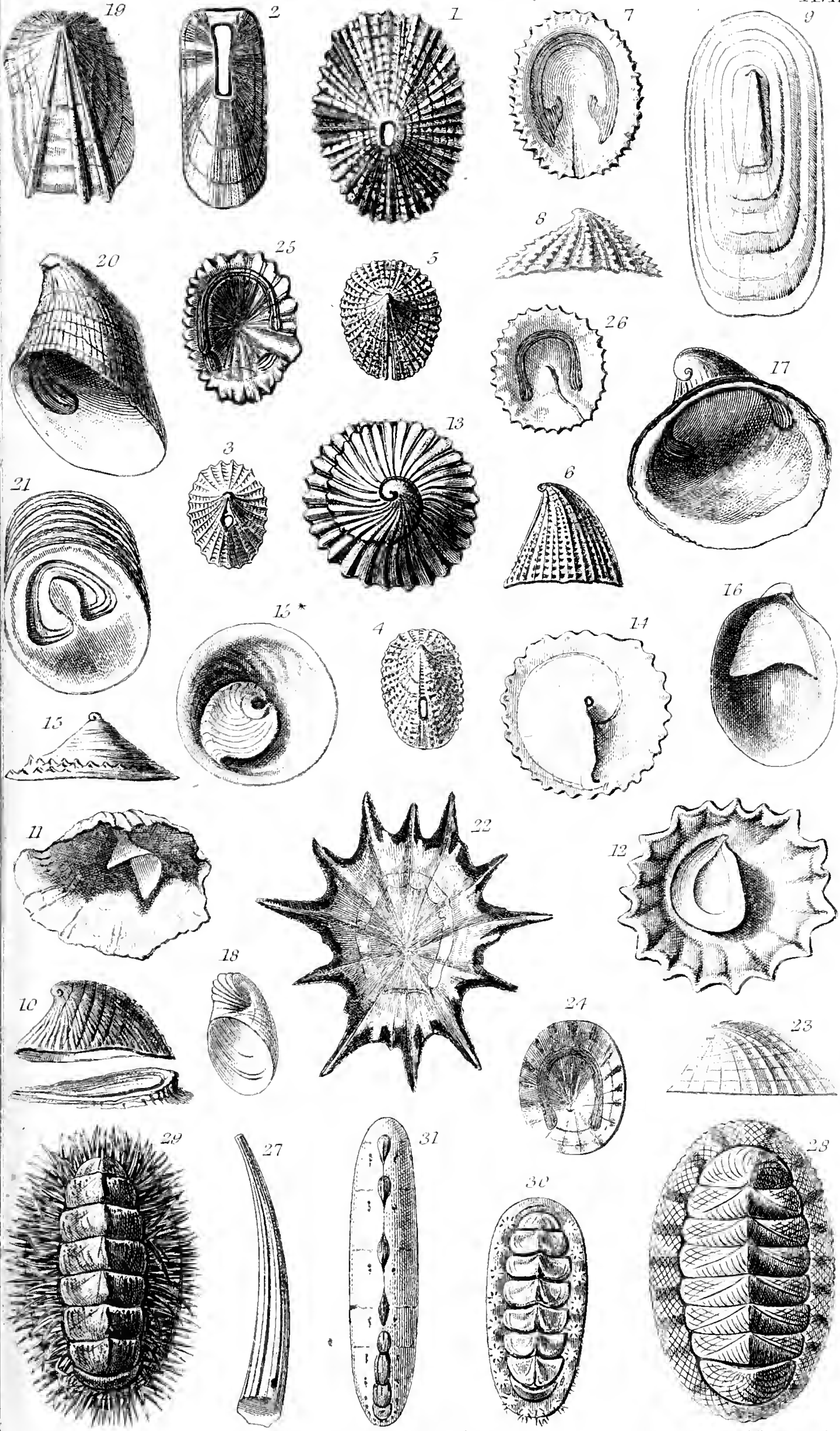


S. P. Woodward   London. John Weale 1851   J. W. Lowry fc.



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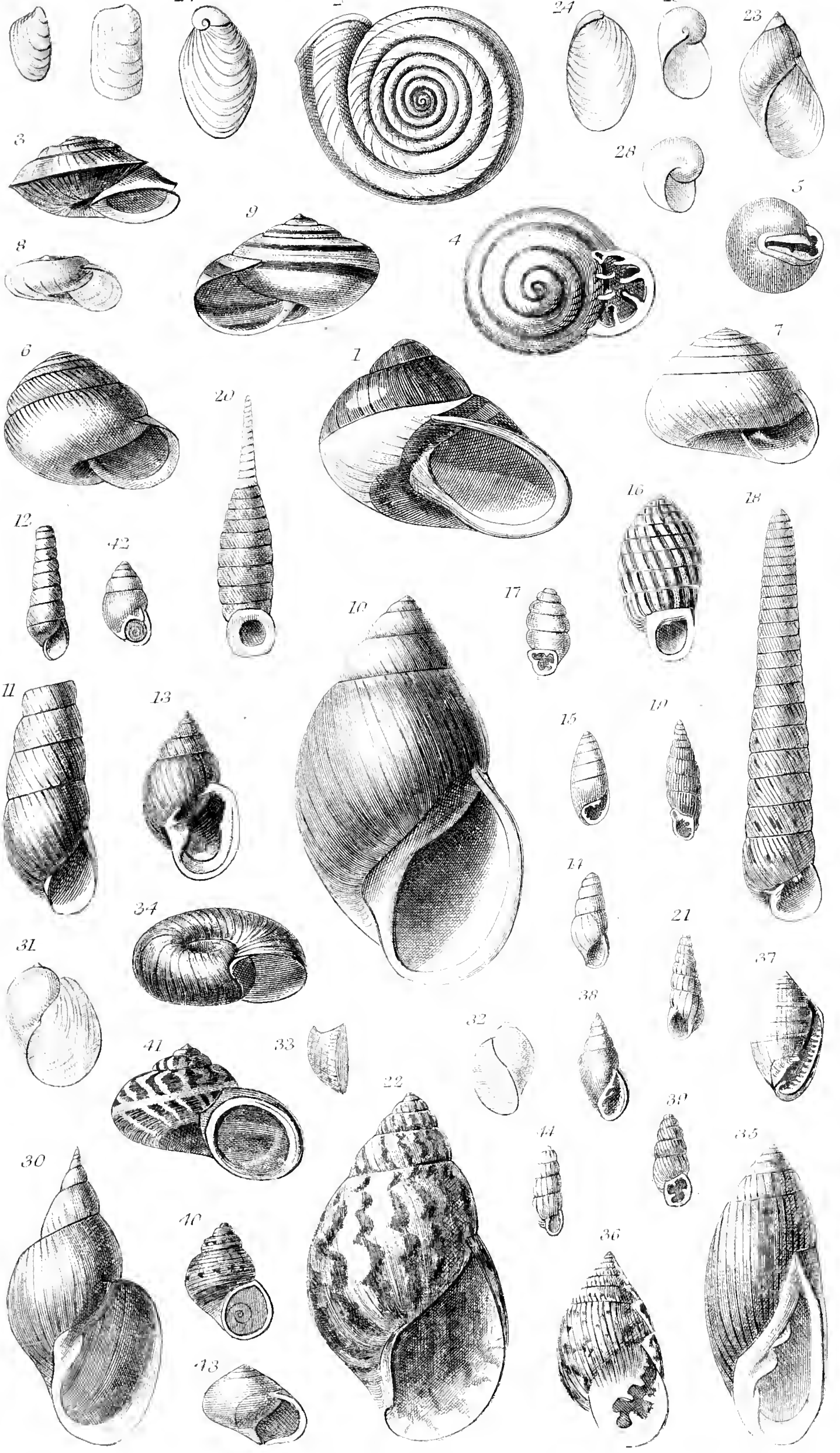
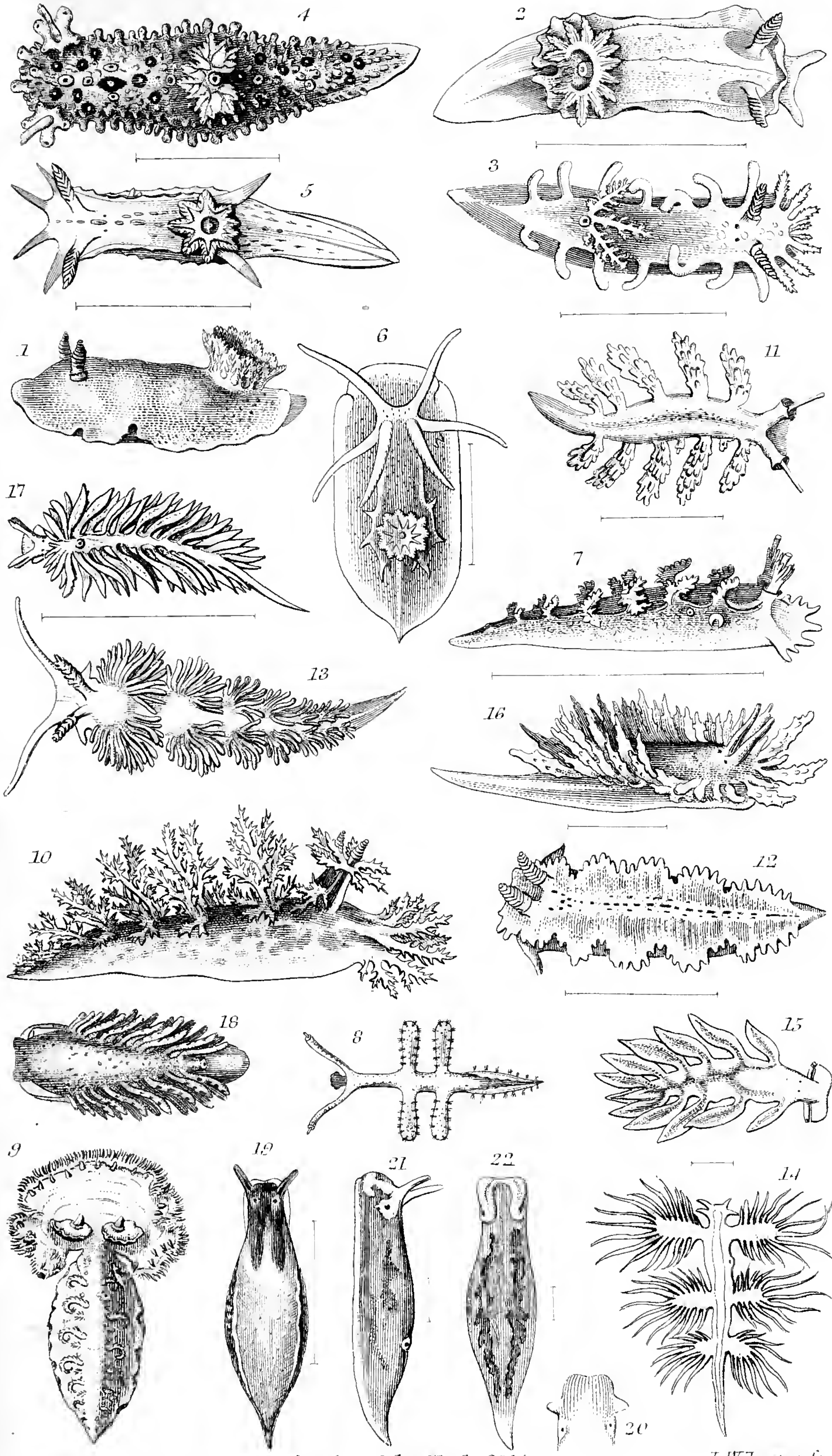


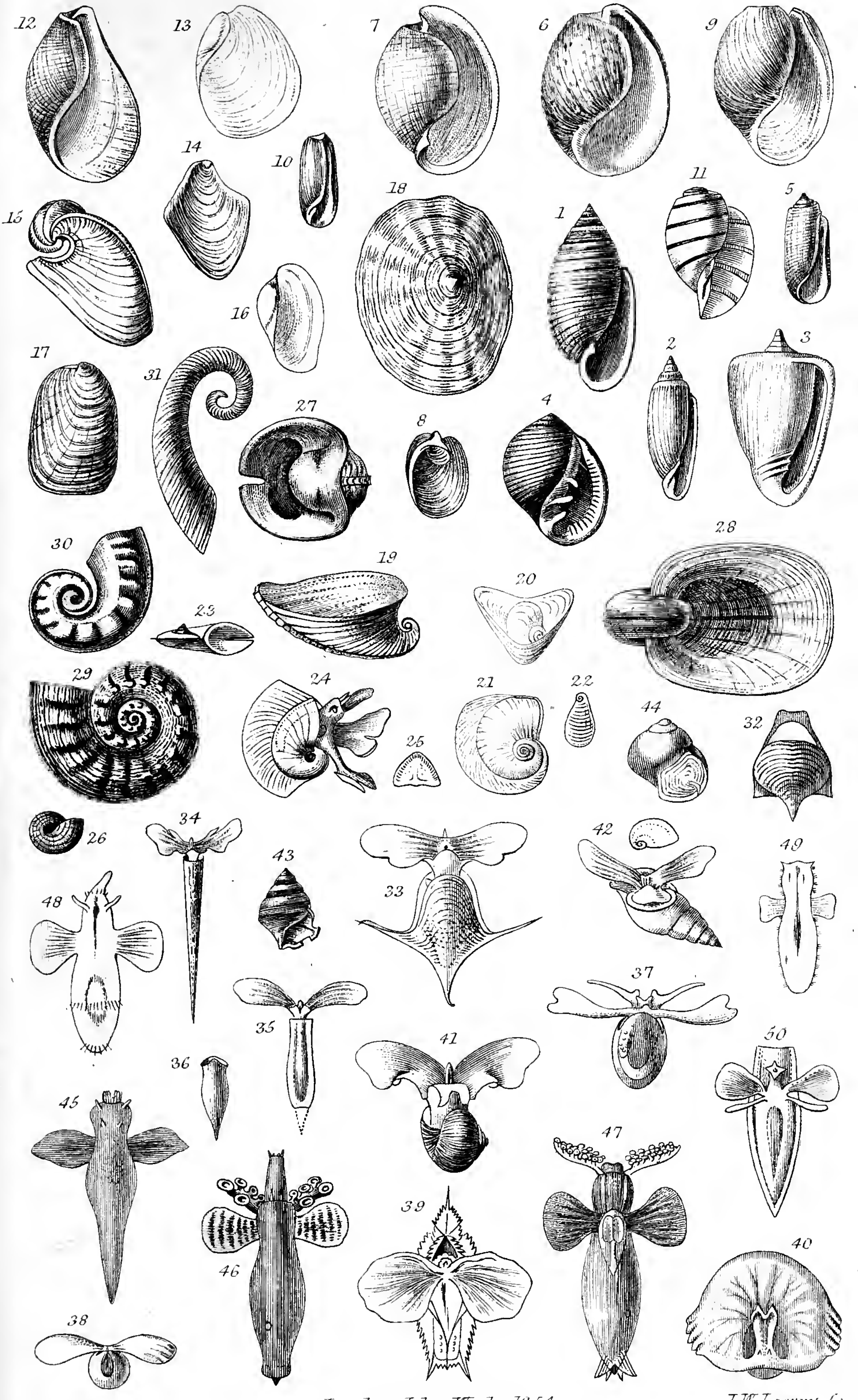
S. P. Woodward. London John Weale 1851. J. W. Lowry fc.

PL. 13.



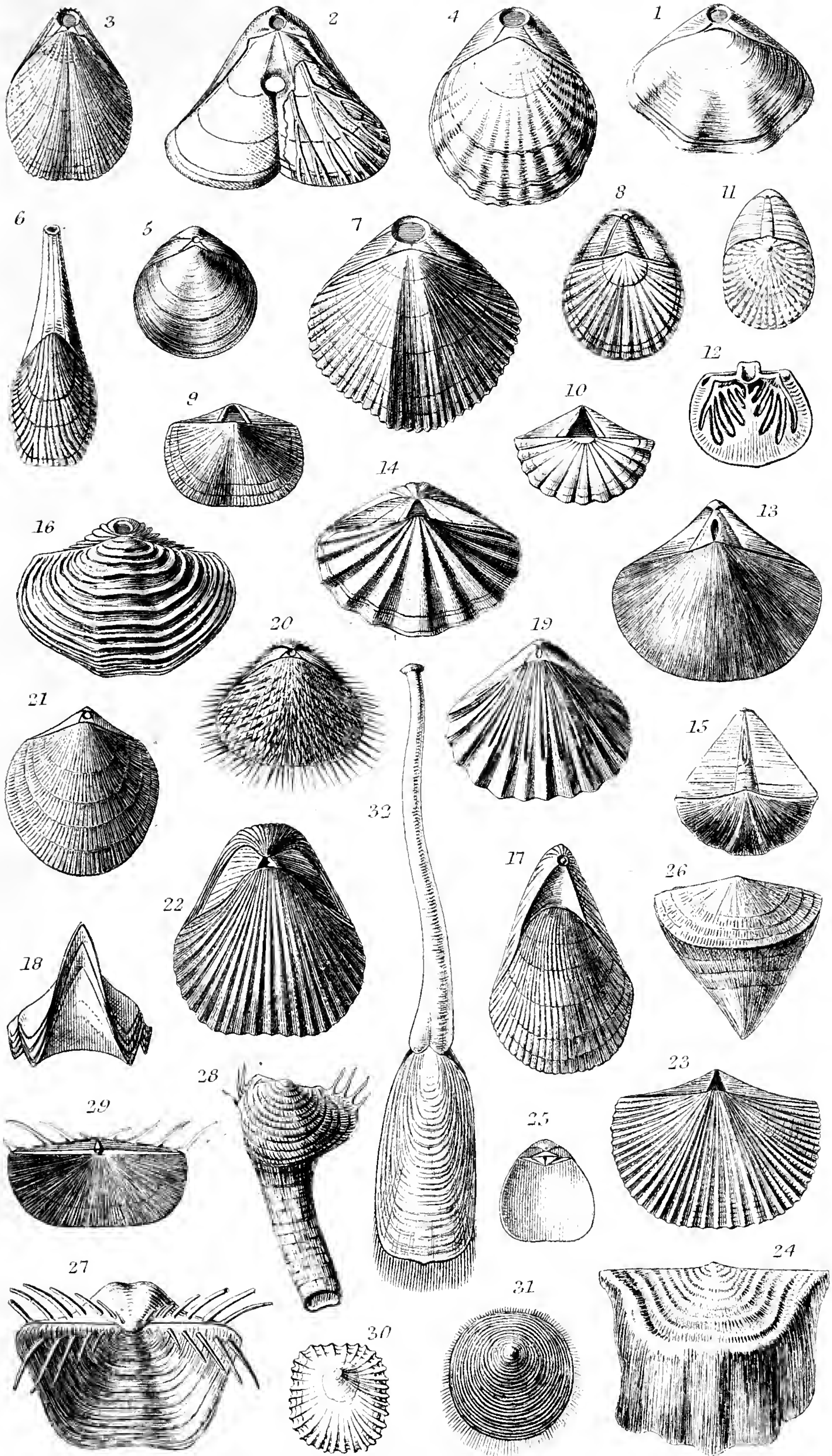
S. P. Woodward   London, John Weale, 1854.   J. W. Lowry fc.

Pl. 14.

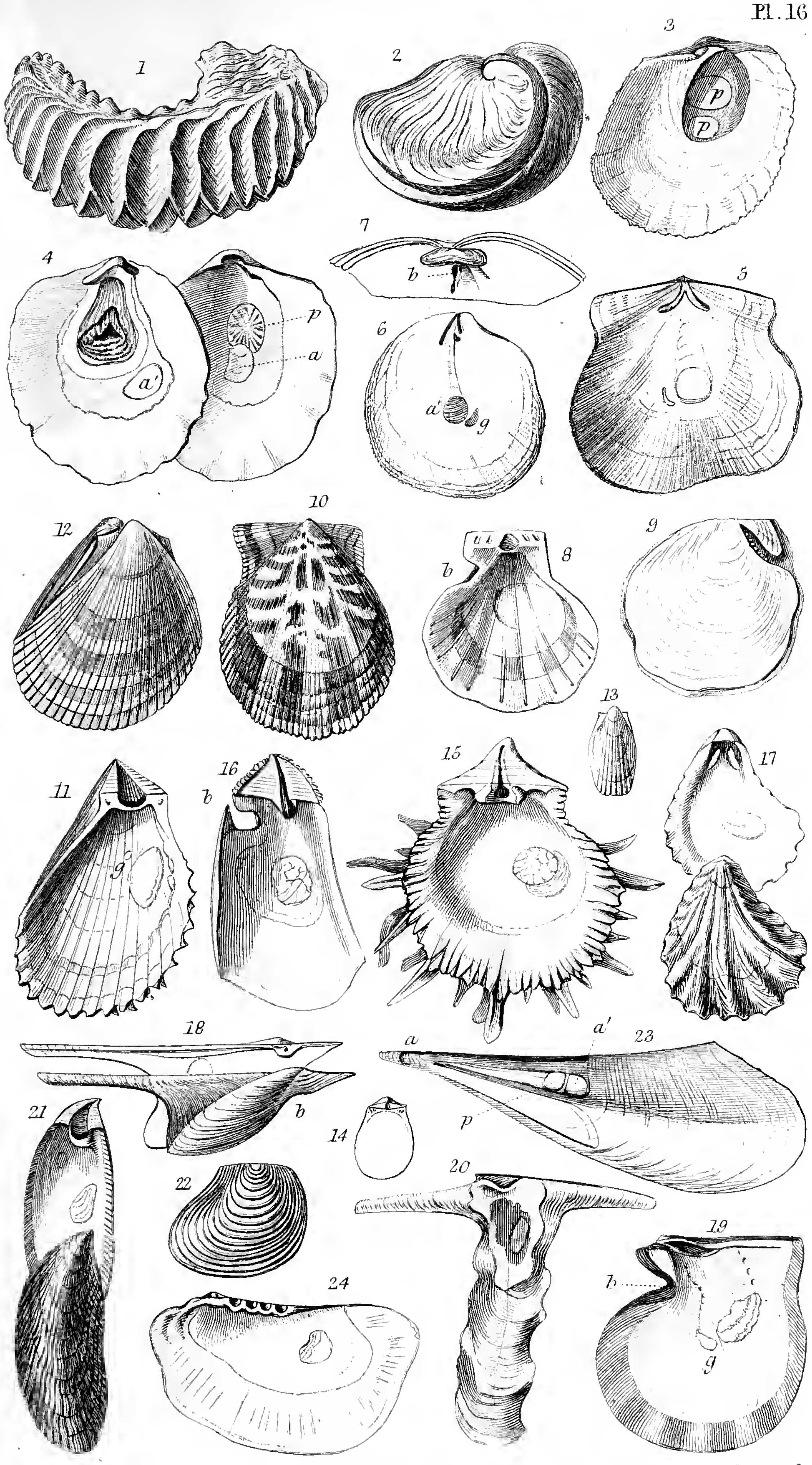


S.P. Woodward. London, John Weale 1854. J.W. Lowry fc.

Pl. 15.



S. P. Woodward   London, John Weale, 1854.   J. W. Lowry fc.



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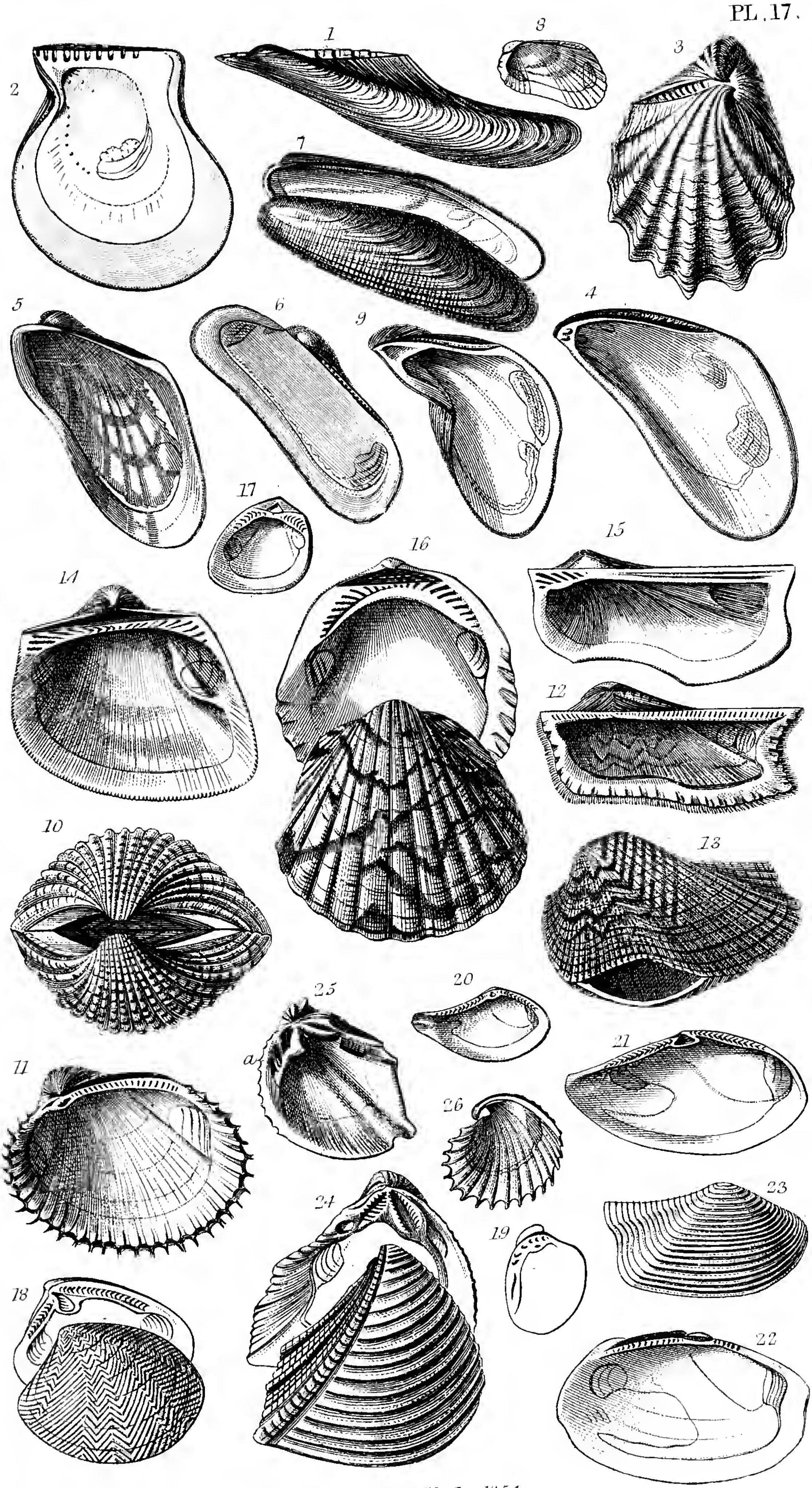
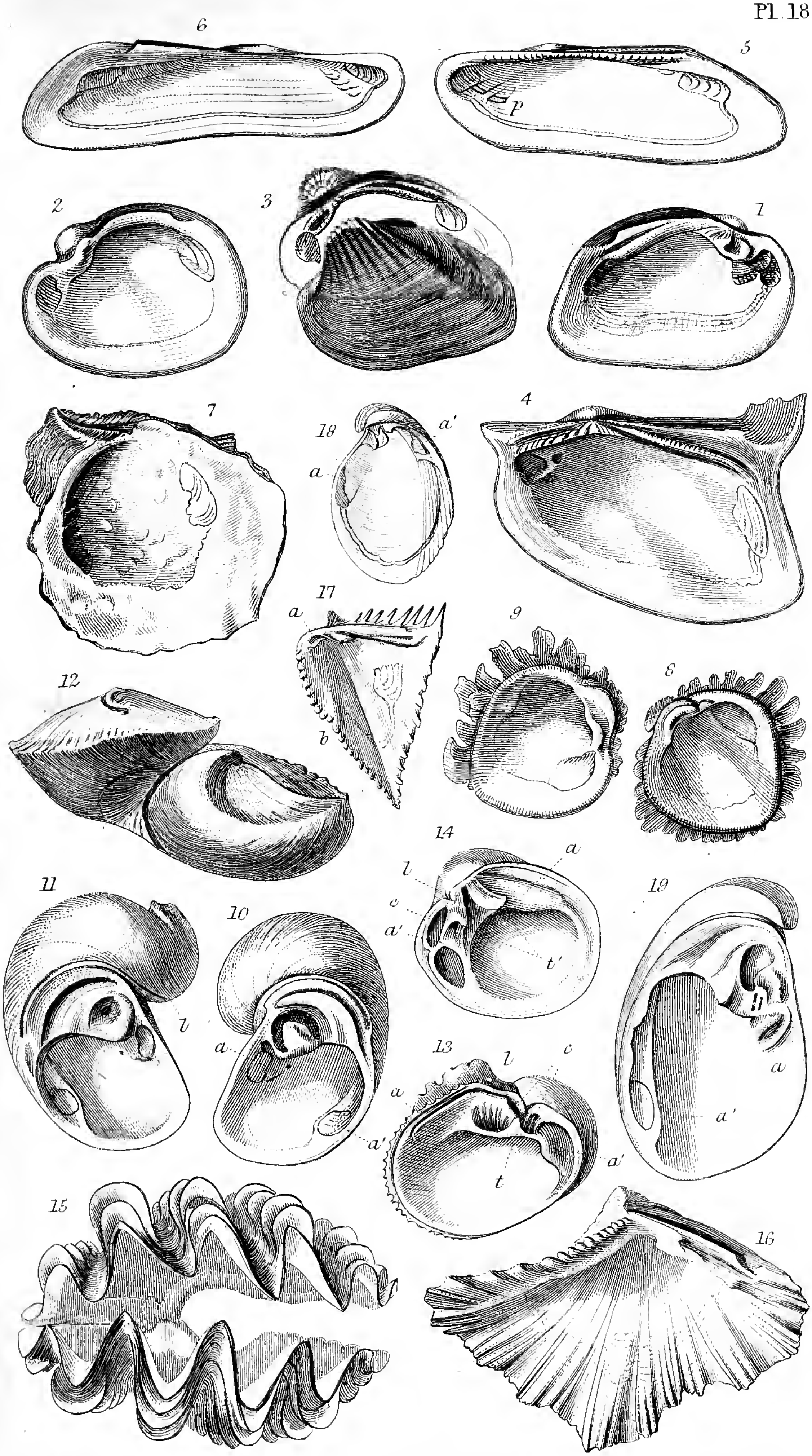
PL. 17.



S. P. Woodward.

London, John Weale, 1854.



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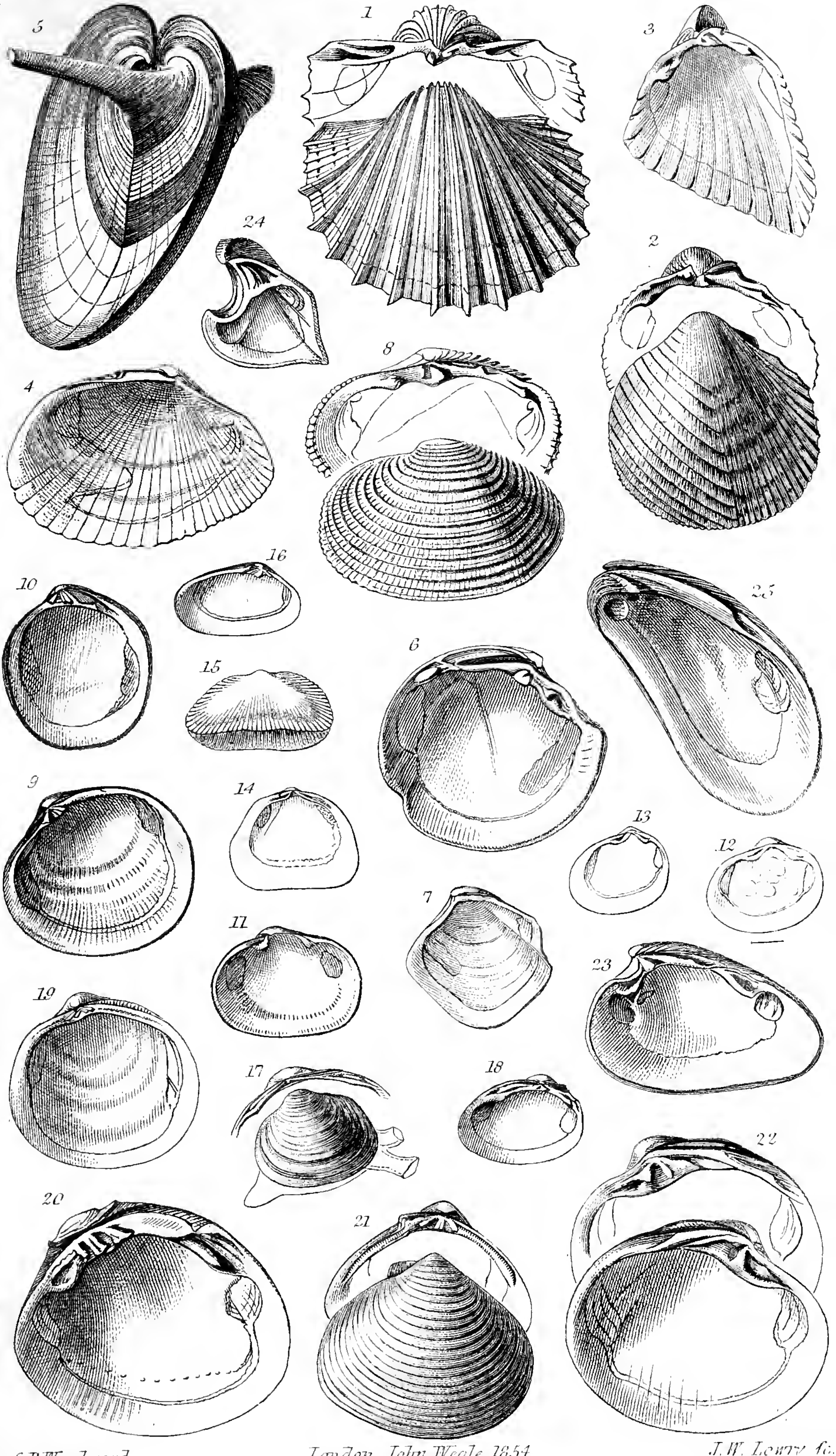

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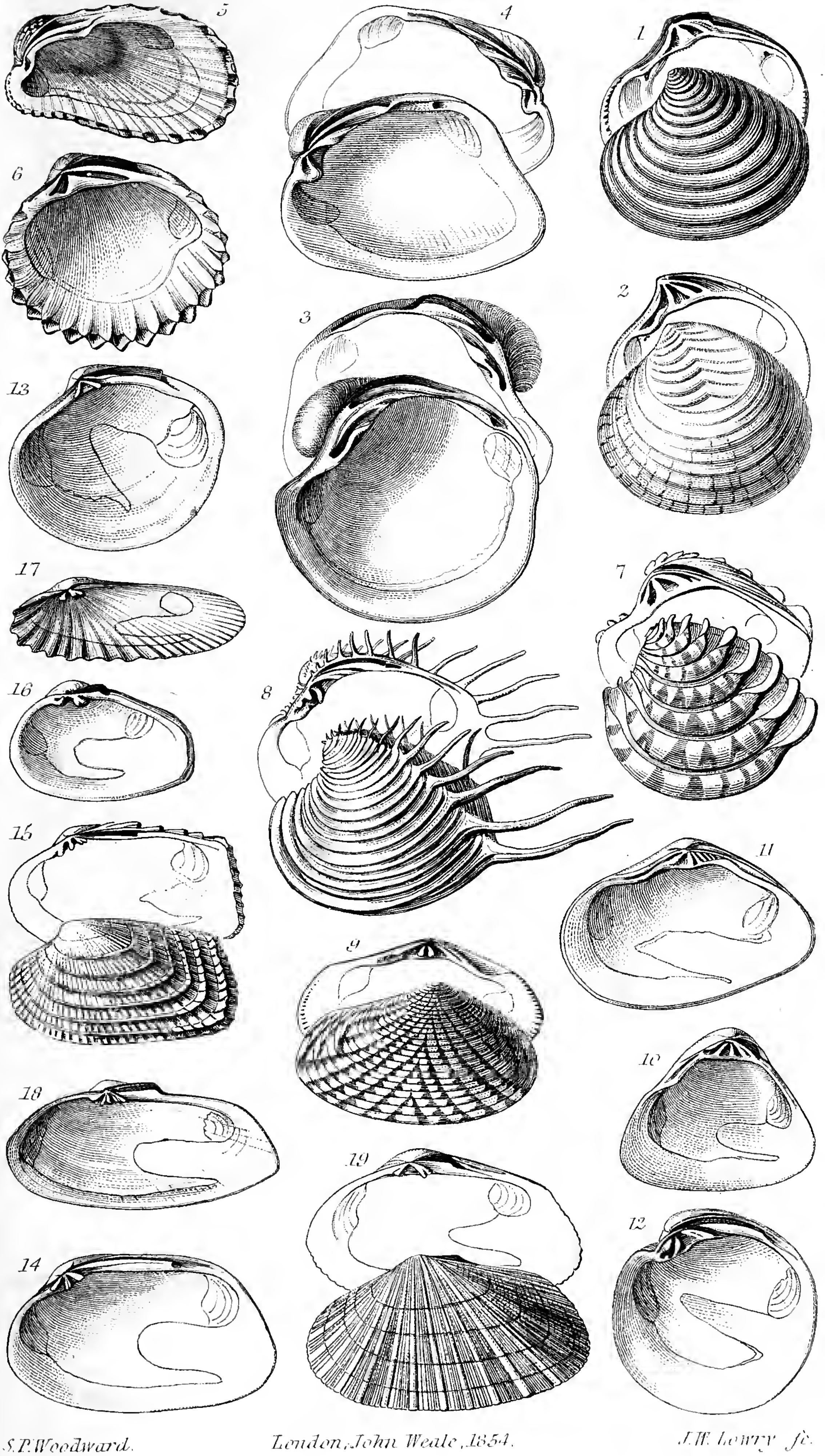

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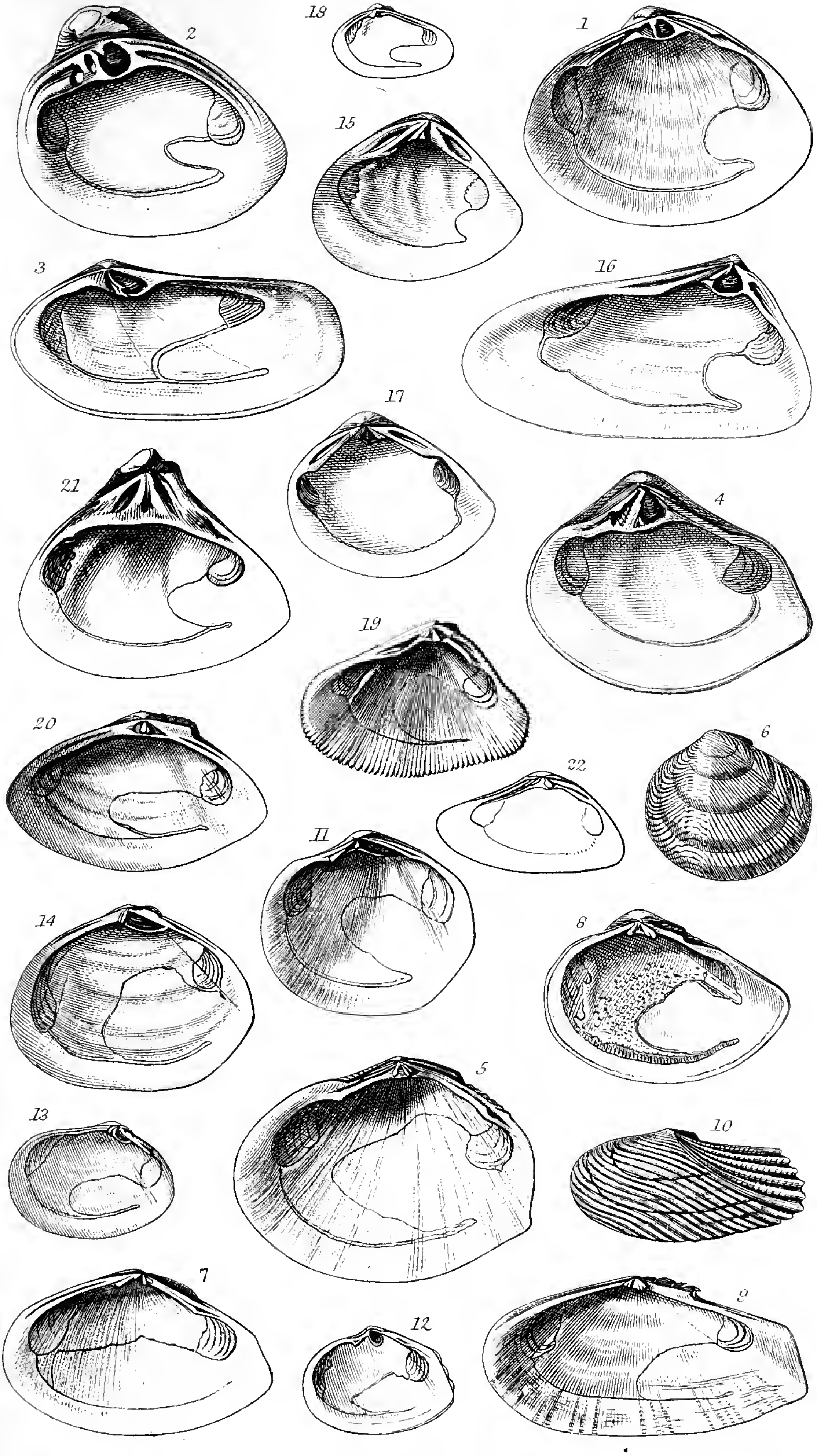
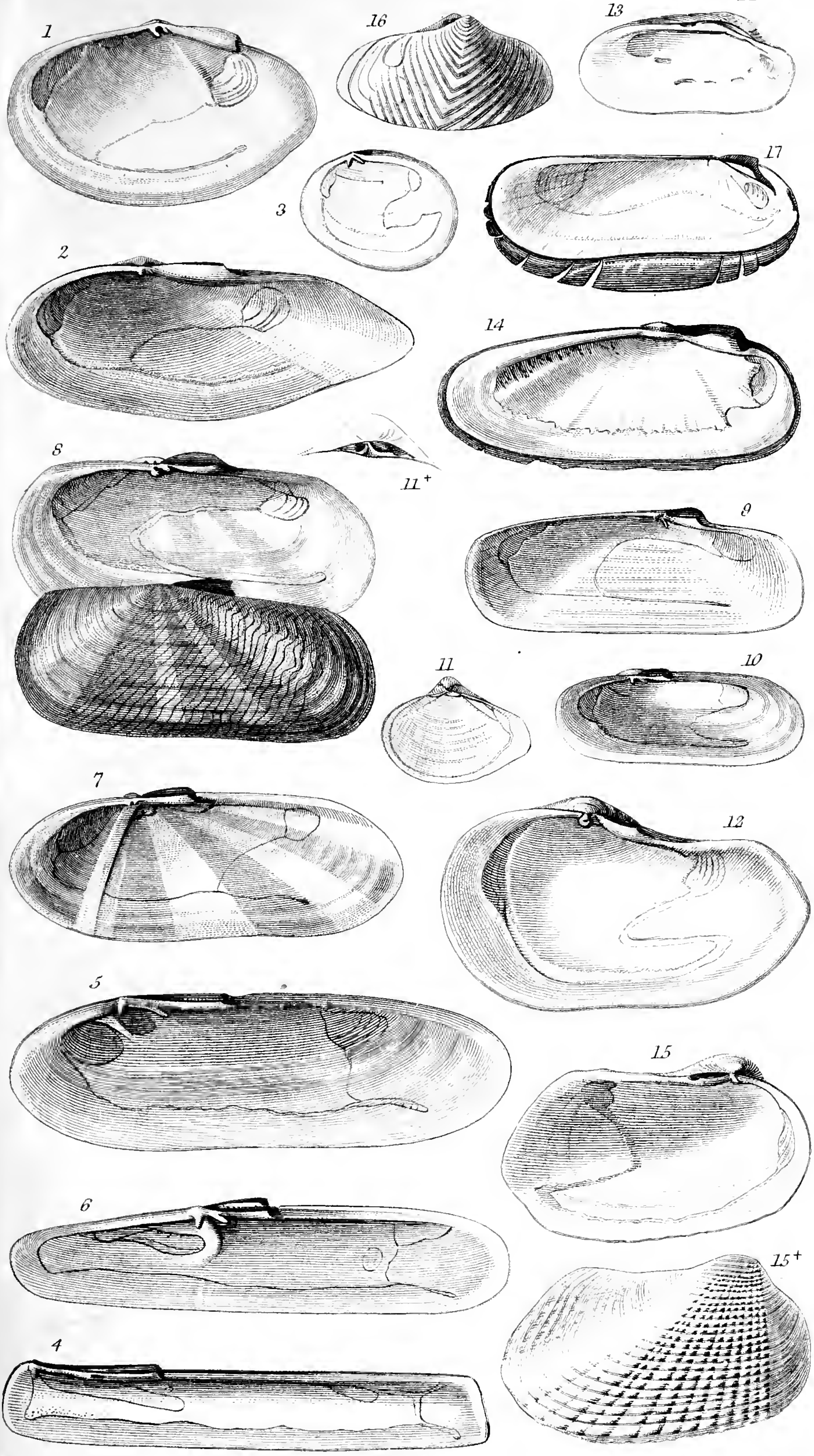


S. P. Woodward. London, John Weale 1854. J. W. Lowry fc.

Pl. 22.



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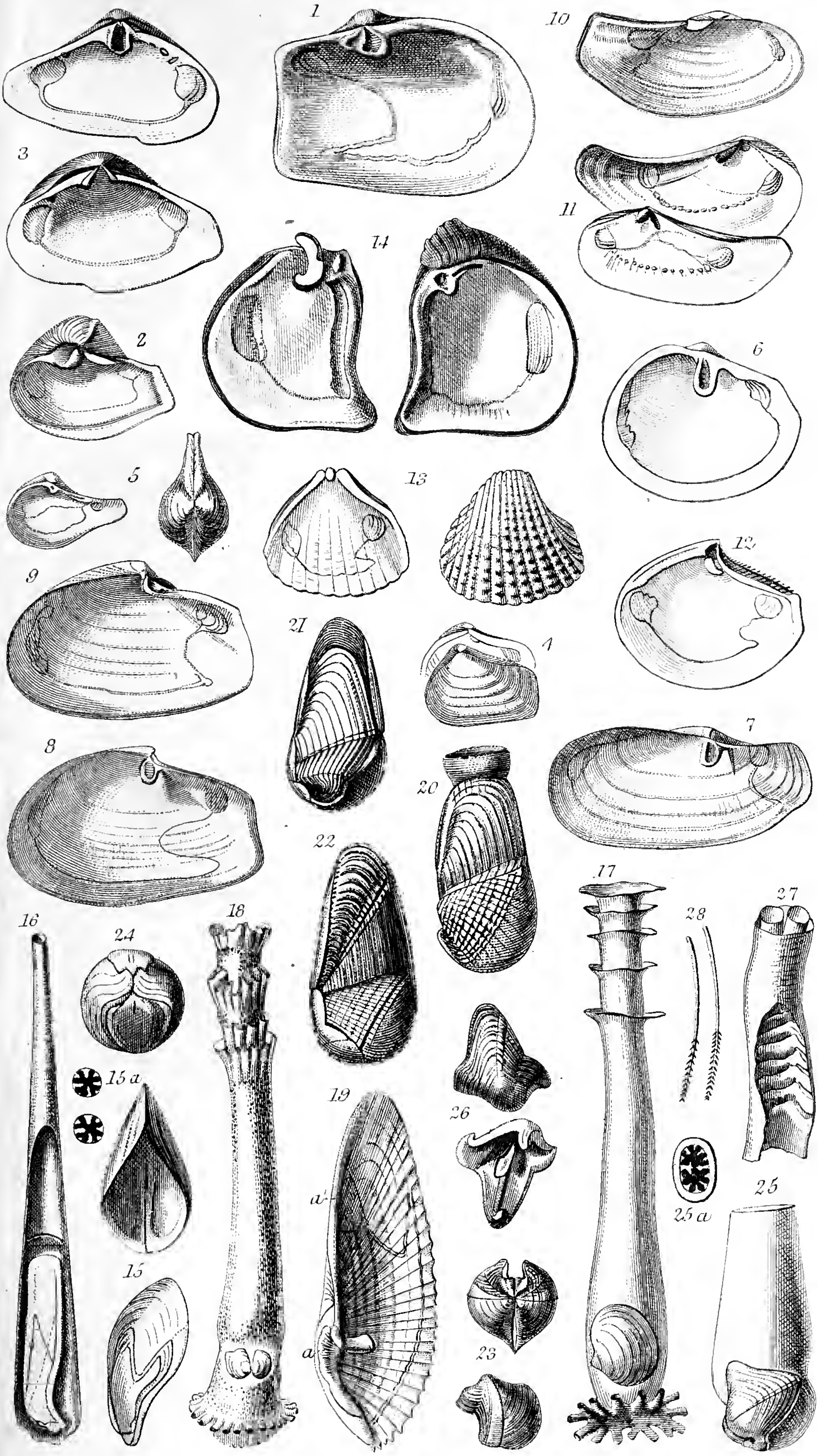

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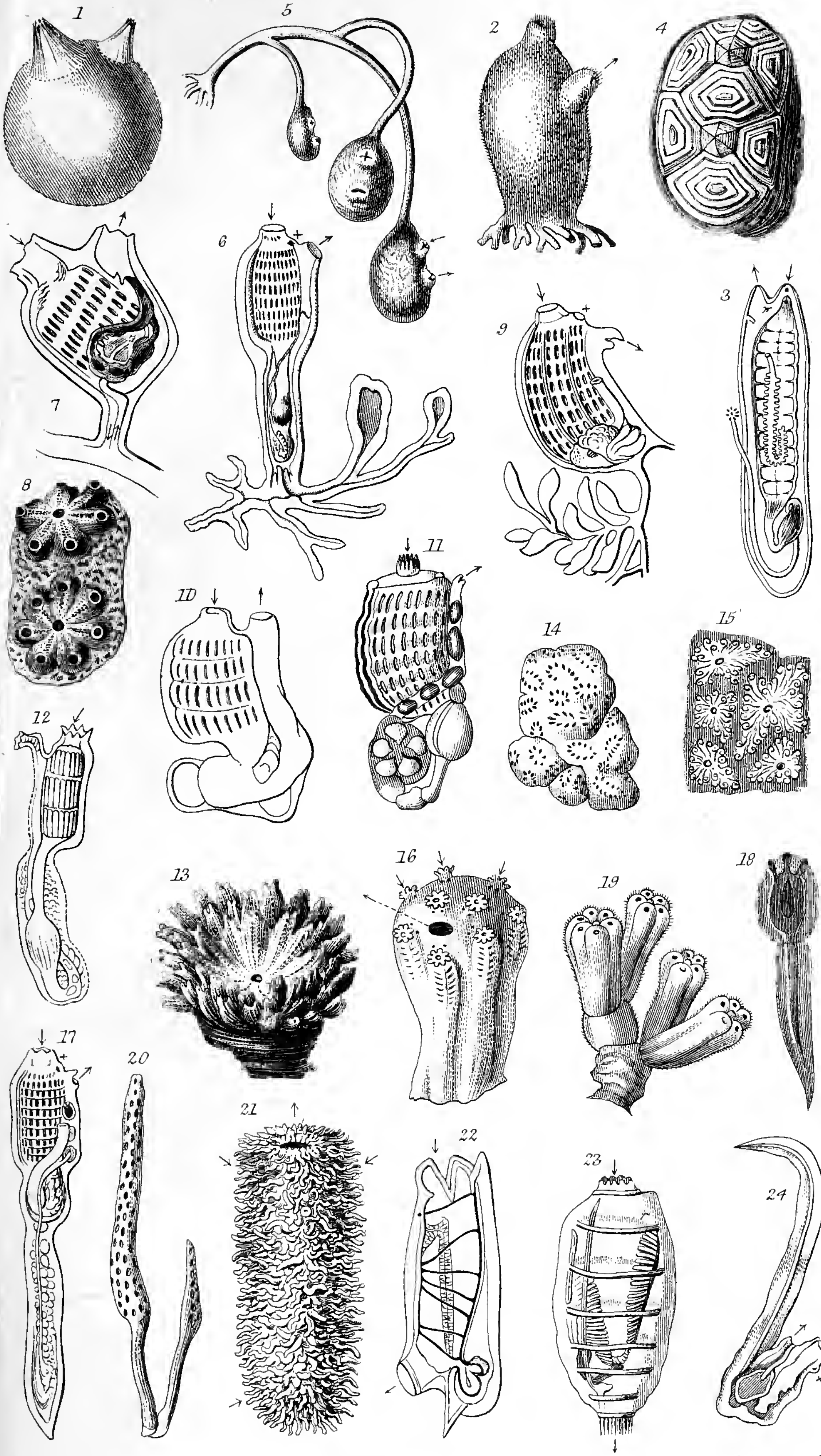

S. P. Woodward. London, John Weale, 1854. J. W. Lowry fc.

EXPLANATION OF THE PLATES.

The principal specimens figured were kindly communicated by Mrs. J. E. Gray, Mr. Hugh Cuming, Major W. E. Baker, Mr. Laidlay of Calcutta, Mr. Pickering, Sir Chas. Lyell, Mr. Sylvanus Hanley, Mr. James Tennant, and Mr. Lovell Reeve.

The fractions shew the number of times (or diameters) the figures are reduced, or magnified.

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a,a' adductor impressions.
p, pedal muscles.
g, suspensors of the gills.
b, byssal foramen or notch.

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* The figures marked are left valves; (interiors).

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* The figures marked are *left* valves.

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† The animal of *Hyria* has two siphonal orifices.

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* The figures marked are *left* valves.

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* The figures marked are *left* valves (interiors).

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PLATE XXIII.

* The interiors marked are *left* valves.

Myacidæ.

Anatinidæ.

Gastrochænidæ.

Pholadidæ.

PLATE XXIV.

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* Magnified figures of zoïds separated from the common mass.

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