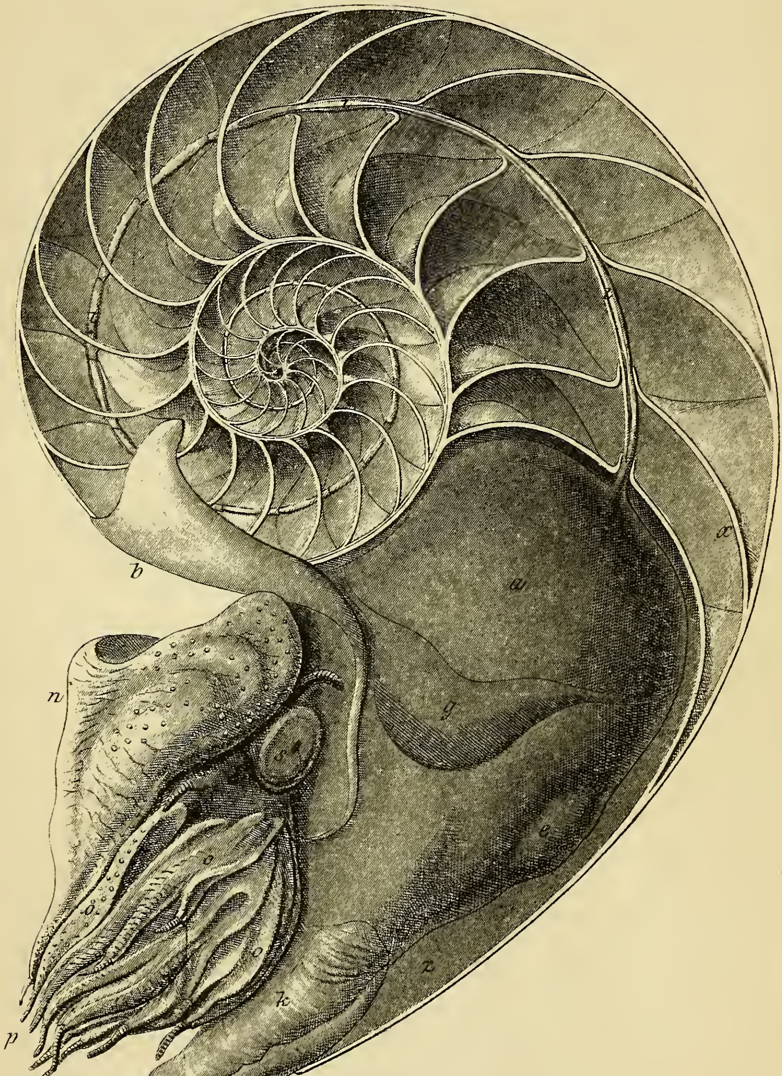
THE STUDENTS' SERIES OF HANDBOOKS

THE PEARLY NAUTILUS

(after Owen)



a — The mantle	*n* — Hood
b — Its dorsal fold	*o o o* Exterior digitations
e — Nidamental Gland	*p* — Tentacles
g — Shell muscle	*s* — Eye
i i i — Siphon	*x x* Septa
k — Funnel	*z* — Last Chamber

J.W. Lowry fc.

A

MANUAL OF THE MOLLUSCA:

A TREATISE

OF

RECENT AND FOSSIL SHELLS.

BY

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Second Edition,

WITH AN APPENDIX OF RECENT AND FOSSIL CONCHOLOGICAL DISCOVERIES TO THE PRESENT TIME,

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WITH NUMEROUS ILLUSTRATIONS,

BY A. N. WATERHOUSE AND J. W. LOWRY.

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PREFACE.

This Manual, which for six years occupied the Author's unceasing attention, was intended as a companion to Gen. Portlock's Geology; and the desire to make it worthy of that association led to an amount of labour and expense which only a very extended circulation will repay.

The plan and title were taken from the "Manuel des Mollusques" of M. Sander Rang, incomparably the best work of its kind—for an acquaintance with which the author was indebted to his friend and master, William Lonsdale—the founder of the "Devonian System" in Geology.

On the subject of classification and nomenclature the Author followed the advice and example of his former colleague in the Geological Society, the late Prof. Edward Forbes; without whose approval he seldom added to, or deviated from, the practice and plan of the "History of British Mollusca."

That he was right in taking this course, has been sanctioned by the highest authority in this country;—since the same scheme has been employed by Prof. Owen in the Hunterian Lectures and Catalogue. It has also been adopted by Dr. E. Balfour in the Madras Museum; by the Rev. Prof. Henslow, in his Report to the British Association on the Formation of Typical Collections; and by Prof. Morris in his Catalogue of British Fossils.

It was the writer's desire, by abstaining from the introduction of personal and peculiar views, and by adhering to whatever was well established and sanctioned by the best examples, to make the work suitable for the use of Natural History Classes in the Universities.

To facilitate reference, and meet the most general requirements, the number of large groups and genera of shells has been restricted as much as possible, and those less important or less understood, have been treated as "sub-genera." A great many duplicate and unnecessary names have been mentioned only, as will be seen by a glance at the Index, where they are printed *in italics;* the writer's own wishes coincide with those of the distinguished botanist Sir J. E. Smith, that "the system should not be encumbered with such names;" but they have been admitted in deference to custom and general opinion.*

The rules of the British Association, intended to secure uniformity, have called into existence a few active opponents, seeking to distinguish themselves by the employment of pre-Linnean and MS. names, on the pretence of carrying out the "law of priority" (p. 48). But this folly has reached its height, and will fall into contempt when it has lost its novelty.†

The investigation of dates is the most disheartening work upon which the time of an author can be employed; it is never safe to take them second-hand, and even reference to the original works is not always satisfactory.‡

Those portions of the work have been treated in most detail which throw light on particular branches of anatomy and physiology; or on great natural history problems, such

* All the blundering and bad spelling of English and French genus-makers will be found carefully recorded in the "Index Generum Malacozoorum," by the accurate and lamented Dr. Herrmannsen, a work indispensable to every writer on Conchology.

† One example will suffice. In an "Athenæum" report, by Prof. E. Forbes, the name "Lottia fulva" was *misprinted* "Jothia fulva;" but although immediately corrected, the *erratum* was formally installed as a "new genus," in the works of Gray, Philippi, Catlow, Adams, and other conchologists!

‡ The *dates* on the title pages of Journals and Transactions of Scientific Societies, are not usually *dates of publication*, but refer to the years *for which* they are issued to the subscribers. It is almost impossible afterwards to correct these false dates.

as the value of species and genera, and the laws of geographical and geological distribution. It is in these departments that the affinity of natural science to the highest kinds of human knowledge is most distinctly seen; and in them the richest and noblest results are to be obtained. For to the thoughtful and earnest investigator, nature ever discloses indications of harmony and order, and reflects the attributes of the Maker.

The recreations of the young seldom fail to exercise a serious influence on after life; and the utility of their pursuits must greatly depend on the spirit in which they are followed. If wisely chosen and conscientiously prosecuted, they may help to form habits of exact observation; they may train the eye and mind to seize upon characteristic facts, and to discern their real import; to discriminate between the essential and the accidental, and to detect the relations of phenomena, however widely separated and apparently unlike. In this way "la belle Science" (as Mr. Gaskoin calls Conchology!) may acquire the influence of pursuits more usually resorted to for mental development and discipline.

The wood-cuts have been principally executed by Miss A. N. Waterhouse, of Marlborough House, from original drawings by the Author; and although printed from stereotypes, they have the advantage of accurately representing what was wished to be shown.

The engravings of Mr. Wilson Lowry speak for themselves; many of the figures are from the specimens in his cabinet; and the interest he has taken in the work will be seen in the care with which the technical characters of the shells are expressed.

The above paragraphs, forming the principal portion of the Preface to the first edition of this work, will suffice to show the objects which the late Author had in view. A few additional words are required in order to indicate in what respects this edition differs from its predecessor. In the first edition the work consisted of three parts, in this it consists of two. In Part I. is comprised the general remarks on the structure, distribution, &c., of the Mollusca, while Part II. is devoted to the Synopsis of the Genera. The chapter on Tunicata has been omitted, since they are more nearly allied to the Polyzoa than to the Mollusca proper, and since the treatment of the Molluscoidan group would have made the work inconveniently bulky. It seemed preferable, therefore, to devote a future volume of the series to the Molluscoida (embracing both the Tunicata and the Polyzoa) than to describe them in the present work. The book has been subjected to a complete revisal, and numerous alterations and additions have been made; but the reviser has interfered as little as possible with the Author's original classification and systematic arrangement.

A. R.

Sept., 1866.

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CHAPTER I.

V

ON THE POSITION OF THE MOLLUSCA IN THE ANIMAL KINGDOM.

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

1. The highest of these groups is separated from the next below it by a sharp line of distinction. In it the main mass of the nervous system is placed on the dorsal side of the body, and is in no instance pierced by the alimentary canal. It is separated from the alimentary canal by a partition, which in most cases is bony, and divided into separate parts, known as vertebræ; while in a few it is cartilaginous, and not divided into distinct parts. Vertebræ are a common feature amongst the *Vertebrata*, as this sub-kingdom is called; but they do not form an essential characteristic, as the name might seem to imply. Distinct organs are devoted to the functions of respiration and circulation; the sexes are generally distinct; each individual is generally developed from a single egg. Blood red.

2. In the second sub-kingdom, or *Mollusca*, which is well exemplified by the common garden snail, the nautilus, and the oyster, the soft parts are in most cases protected by an external shell, which is harder than the bones of the vertebrates, and the covering of the crab and lobster. It consists almost entirely of carbonate of lime, while the bones of the vertebrates contain a large proportion of phosphate of lime. The shells of many of the Brachiopoda, such as *Lingula*, and of a few of the Pteropoda,

such as *Conularia*, are rich in the phosphate of lime. The digestive cavity is completely separated from the walls of the body. The nervous system consists of three pairs of ganglia, except in the Brachiopoda, and these nervous centres are very much scattered. Hence Professor Owen has proposed the term *Heterogangliata* for the great group of Mollusca. The end of the alimentary canal nearest the mouth is surrounded by the ganglia which supply the foot and head.

3. The various tribes of insects, spiders, crabs, starfishes, echinoderms, entozoa, and worms, have no internal skeleton; but to compensate for it, their outer integument is sufficiently hard to serve at once as a support, a covering, and a defence for the soft parts. 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 *Annulosa*. The nervous system consists of ganglia arranged in pairs in the middle line of the body. From this equal lateral development of the nervous centres Professor Owen calls the group *Homogangliata*. The nervous system is traversed by the alimentary canal. The radiated animals form a part of this sub-kingdom.

4. The next sub-kingdom comprises most of the polypes, such as sea-anemones, the fresh-water hydra, and corals, in which the general cavity of the body communicates freely with that of the digestive apparatus, on which account they are called *Cœlenterata*. The soft parts forming the body wall are composed of two distinct membranes; there is no heart; no apparent special respiratory organ; and in most cases very slight traces of a nervous system.

5. All the animals not combined in the above groups, such as the sponges, the foraminifera, and a large proportion of the microscopic animalcules, form the last sub-kingdom, named *Protozoa*. They are characterised by a general absence of any special organ.

There seems to be a much closer relationship between the molluscan and the protozoic sub-kingdoms than between the molluscan and any of the others. It is always easier to pass from the highest part of a sub-kingdom downwards in the scale of nature than to pass upwards. Thus we can step from one form to another without meeting with any marked distinction from the Cephalopods to the Brachiopods, and from them to the

Protozoa. In the same way we can pass from the highest of the Annulosa to the Protozoa. But we cannot find any continuous succession of adult forms which will connect the Annulosa with the Mollusca, or the Mollusca with the Vertebrata.

Much use is made of the terms high and low in speaking of animals; and it is important to bear in mind that they are by no means intended to imply that there is any difference in the degree of perfection, or that one animal is less fitted to subserve the purposes of life than another. By an animal of a low organisation is simply meant one in which all the functions of life are carried on by means of a few organs. The greater the number of organs that are set apart to perform special functions the higher is the animal said to be.

The evidence afforded by geological researches seems to show that the leading types of animal structure have existed from a comparatively early period in the history of the globe; and that all forms which have left any indications of their existence belong to one or other of these types. The oldest fossils known at the present time belong to the Protozoa; but next to them come the Mollusca.

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.

Classes of the Mollusca.

This sub-kingdom consists of two great groups, viz., the *mollusca* proper and the *molluscoida.* 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 either with jaws or with tooth straps.* Cuvier has

* One of the drawbacks to the study of mollusca is the prevalence of such terms as jaws, arms, feet, &c. The reader must not suppose that the parts so designated are

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

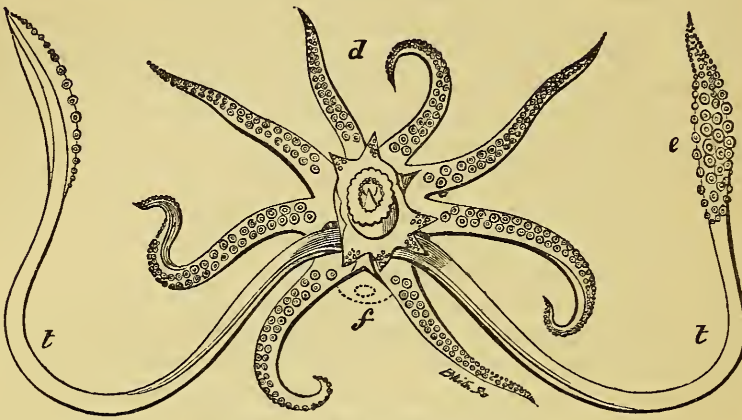


Fig. 1.* Oral aspect of a Cephalopod.

Cephalopoda,† because their feet, or more properly *arms*, are so attached to the head as to form a circle round the mouth.

2. In the *Gasteropoda,*‡ or snails, the under side of the body

Fig. 2. A Gasteropod.§

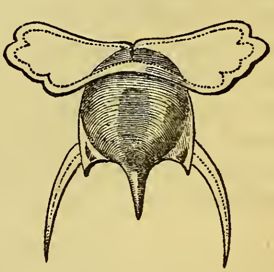


Fig. 3. A Pteropod.‖

forms a single muscular foot, on which the animals creep or glide.

homologous in the vertebrata and in the mollusca. When applied to the latter, the terms are vague and indefinite in meaning.

* Fig. 1. *Loligo vulgaris*, Lam. $\frac{1}{4}$. 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 (*e*). The *dorsal* arms are lettered *d*, the funnel *f*.

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

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

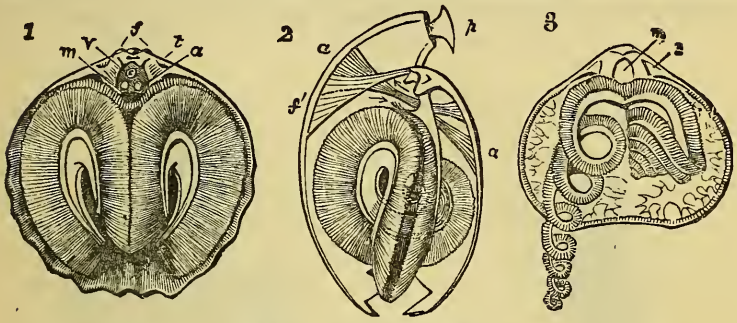
§ Fig. 2. *Helix desertorum*, Forskal. From a living specimen in the British Museum, March, 1850.

‖ Fig. 3. *Hyalæa tridentata*, Lam., from Quoy and Gaimard.

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

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, characterised by modifications in their breathing-organ and shell.

4. The *Brachiopoda* † are bivalves, having one shell placed on the back of the animal, and the other in front; they take their name from two long ciliated arms, developed from the sides of



Figs. 4, 5, 6. Brachiopoda.‡

the mouth, with which they create currents that bring them food. These arms were formerly supposed to take the place of the feet in the previously-mentioned classes. They are, however, essentially breathing organs, and consequently the term *Brachionobranchia* (arm-breathers) has been proposed for the erroneous one of *Brachiopoda* (arm-footed).

5. The *Lamellibranchiata*, § or ordinary bivalves (like the oyster), breathe by two pairs of gills, in the form of flat membranous plates, attached to the mantle; one valve is applied to the right, the other to the left side of the body. This class is sometimes called *Conchifera*.

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. These together with the *Polyzoa*, and perhaps

* *Pteron*, a wing.

† *Brachion*, an arm.

‡ 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 cardinal muscles, by which the valves are opened). (1.) Dorsal valve. These woodcuts have been kindly lent by Mr. J. E. Gray.

§ *Lamellibranchiata*, plate-gilled.

the Brachiopoda, form the sub-class of *Molluscoida*. In the first edition the *Tunicata* were described in detail, but they are omitted in this for reasons stated in the preface.

Five of these modifications of the molluscan type of organisation 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 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

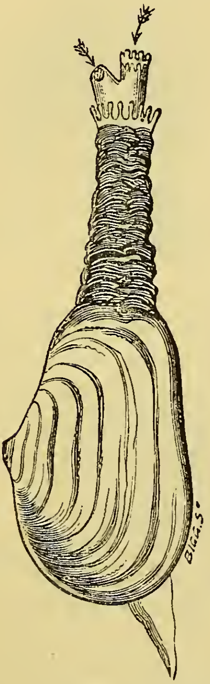


Fig. 7. A Bivalve.†

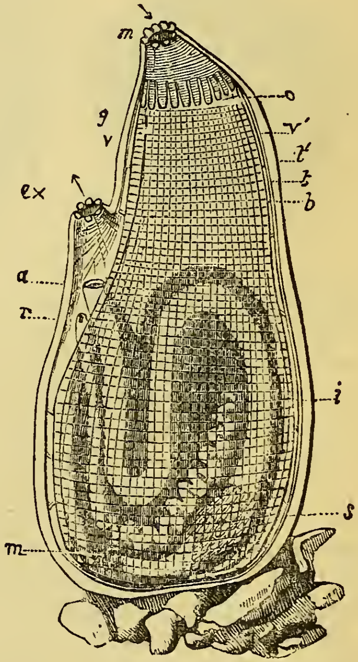


Fig. 8. A Tunicary.‡

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

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

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

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

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.*)

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 aquatic 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 ambulatory, the young are all swimmers; so that 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 constantly accumulating, even in the deepest parts of the sea.

Some of these little creatures shelter themselves beneath the shell of their parent for a time, and many can spin silken threads with which to 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 ship-worm 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 (*pecten 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 nucleobranchs and pteropods swim in the open sea. The cuttle-fish 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, woods, 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 fathoms water; scallop-banks at twenty fathoms. The *terebratulæ* are found at still greater depths, 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, bnt they hold white mustard in abhorrence, 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 headless molluscs live on infusoria, or on microscopic plants, brought to them by the current which their ciliary apparatus perpetually excites; such, too, must be the sustenance of the *magilus*, sunk in its coral bed, and of the *calyptræa*, fettered to its birth-place by its calcareous foot.

The carnivorous tribes prey chiefly on other shell-fish, or on zoophytes; since, with the exception of the cuttle-fishes, their organisation scarcely adapts them for pursuing and destroying other classes of animals. One remarkable exception is formed by the *stilifer*, which lives parasitically on the star-fish and sea-urchin; and another by the *testacella*, 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 bivalves may close, and the operculated nerite retire into his home, but the enemy, with rasp-like tongue, armed with siliceous 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

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

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. Civilised man still swallows the oyster, although snails are no longer reckoned "a dainty dish;" mussel, 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 raccoon 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, in order to prey on the mollusca; the great whale lives habitually on the small floating pteropods; sea-fowl search for the littoral species at every ebbing tide; whilst, in their own element, the marine kind are perpetually devoured by fishes. The haddock is a "great conchologist;" and some rare 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 (*philine*), 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

* See Hugh Miller's "Scenes and Legends of the North of Scotland." The *Kjokkenmödings*, or kitchen refuse-heaps, which have been found so abundantly in Denmark, Scotland, New Zealand, and elsewhere, are sometimes hundreds of yards in length, and composed almost entirely of shells.

their own nation. Scarcely one-half the shelly tribes graze peacefully 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 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. 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, we learn from the observations of Mr. George Roberts, 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 immortalised 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;" *

* The extravagant prices that have been given for rare shells are less to be regretted,

and they are the ornaments of barbarous tribes. The Friendly-Islander wears the orange-cowry as a mark of chieftainship (*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.*

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 immeasurably 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 obtain 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

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 have been much diminished of late years. A *Carinaria*, once "worth 100 guineas" (Sowerby), is now worth 1*s.* only; a wentle-trap which fetched 40 guineas in 1701 (Rumphius) was worth only 20 guineas in 1753, and may now be had for 5*s.* The *Conus gloria-maris* has fetched £50 more than once, and *Cypræa umbilicata* has been sold for £30.

* 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 littoral shells and human skeletons of recent date.

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 whorls; 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 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 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 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 having been enclosed 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 the 7th of March, 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. Advantage was taken of this circumstance for making a sketch of the living animal (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 lay fewer eggs.

* "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.*

† Ann. 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; and the argonaut carries them in her frail boat.

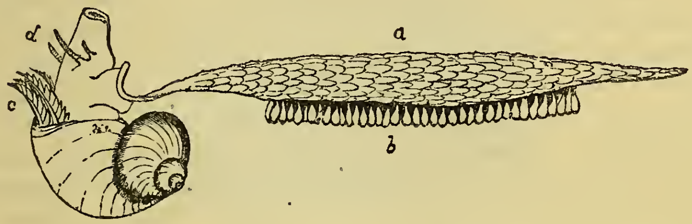


Fig. 9. Ianthina with its raft.

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.

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 sides and upper part of the ring represent the brain, and supply nerves to the eyes, 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 (*sclerotic*), 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 *strombidæ*, the eye is not less highly organised, but in most of the *gasteropoda* it has a more

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

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

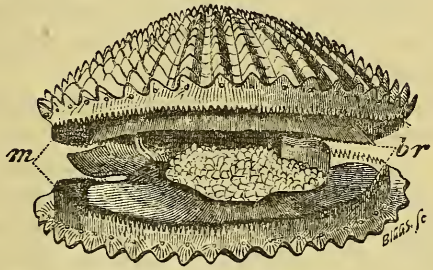


Fig. 10. *Pecten varius.*†

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.

Sense of Hearing. In the highest cephalopods, this organ consists of two cavities in the rudimentary cranium which protects the brain; a small calcareous body or *otolithe* is suspended

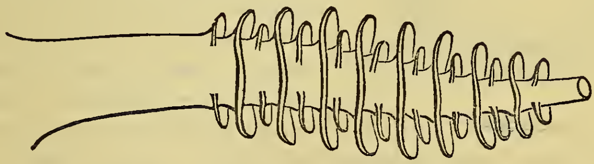


Fig. 11. Tentacle of a Nudibranch.‡

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

* "Each possesses a cornea, lens, choroid, and nerve; they are, without doubt, organs of vision." (*Garner.*) The same conclusion is arrived at by Duvernoy in a paper in the *Annales des Sciences Naturelles* for 1852.

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

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

tritonia and *eolis*, none of the 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, 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.

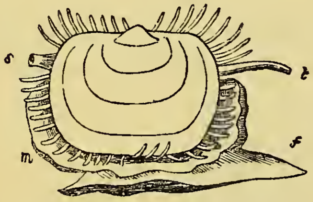


Fig. 12. *Lepton squamosum.*†

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 instance, when it draws in its eye-stalks by a process like the

* Mr. Owen regards the membranous *lamellæ* between the oral tentacles and in front of the mouth, as the seat of the olfactory sense. *See* Fig. 51.

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

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 *); 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 siliceous particles (*spicula*), which renders 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*.

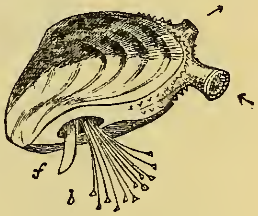


Fig. 13. *Dreissena.*†

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.

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

* The muscular fibres of molluscs frequently present the transverse stripes which characterise *voluntary* muscles in the higher animals. Striped muscular fibre has been observed in *Salpa* (*Huxley*); and in *Waldheimia australis* by Hancock; a strict search was made by that able anatomist for the purpose of discovering such fibre amongst the hingeless brachiopods, but without success. Striped fibres have been seen in the gasteropods.

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

to which they are attached is always indicated by scars (Fig. 14, *a*, *a'*).

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, shows that the animal had retractile siphons; the foot of the animal is withdrawn by *retractor* muscles also attached to the

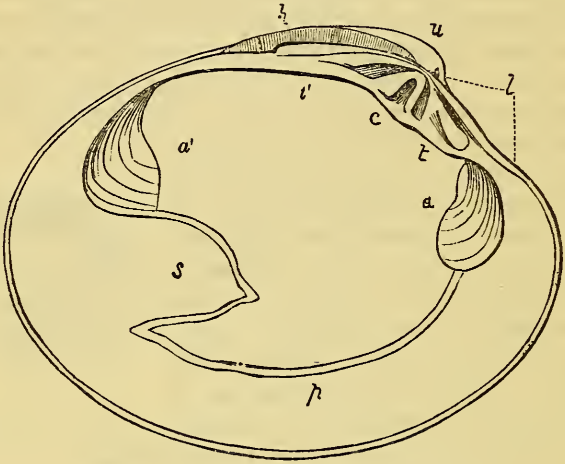


Fig. 14. Left valve of *Cytherea chione.**

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 becomes 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 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

* 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.

palpi, which look like accessory gills (Fig. 18, *l*, *t*). The ciliated arms of the brachiopods occupy a similar position (Figs. 4, 5, 6). 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 siliceous (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 sometimes form a single series, overlapping

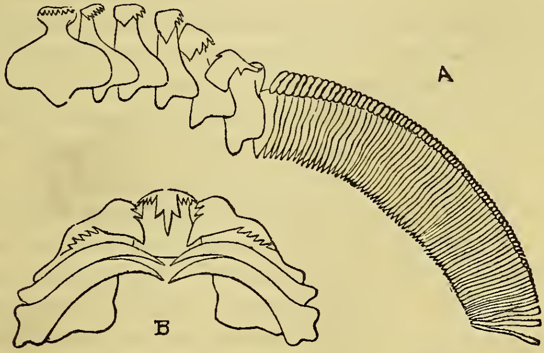


Fig. 15. Lingual Teeth of Mollusca.

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).†

Sometimes the tongue forms a short semicircular ridge, con-

* 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.

† 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.

tained between the jaws; at others, it is extremely elongated, and 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.

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 often broken or blunted. The posterior part of the lingual

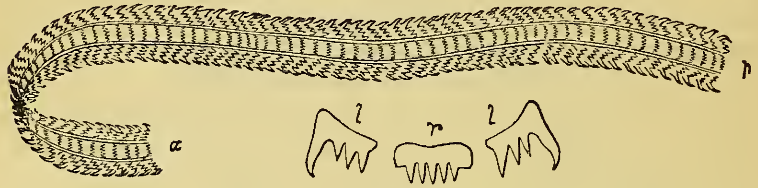


Fig. 16. Tongue of the Whelk.*

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 *bullidæ* the *rachis* of the tongue is unarmed, and the business of comminuting the food is transferred to an organ which resembles the gizzard of a fowl, and is often paved with calcareous 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.

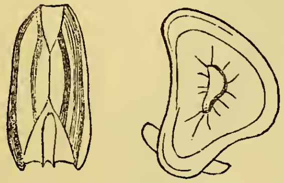


Fig. 17. Gizzard of *Bulla.* †

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 nudi-

* Fig. 16. Lingual ribbon of *buccinum undatum* (original), from a preparation communicated by W. Thomson, Esq., of King's College. *a*, anterior; *p*, posterior; *l*, lateral; *r*, rachidian.

† 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.

branchs, 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 the excurrent orifice, where there are two*), and the excrements are carried away by the water which has already passed over the gills.

Besides the organs already mentioned, the encephalous molluscs 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 *bullidæ*, the milky fluid of *eolis* and the inky secretion of the cuttle-fishes. The gland that secretes this fluid is situated on the mantle. It consists of a thin layer of elongated cells, and is to be found in most gasteropods. The fluid produced appears to have different properties in different species. Thus in *aplysia* and some snails it possesses colour at the moment of being secreted; but in others it is colourless, as, for instance, in *turbo littoralis* and *trochus cinerarius*. In *murex* and *purpura* also it is colourless when secreted; but on being exposed to the sun it becomes first yellowish and ultimately violet, after having passed through various intermediate tints formed by the mixture of yellow, blue, and red. According to M. Lacaze Duthiers it is probable that the Romans obtained their purple dye from three or four species of mollusc, such as *murex trunculus*, and *brandaris*, and *purpura hæmastoma*. A few molluscs 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;

* 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.

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

Aquiferous system. Recent anatomical researches by Messrs. Hancock, Rolleston, Robertson, Williams, and others have thrown considerable doubt upon the existence of any aquiferous system in the mollusca. There are certainly a number of pores which open to the external water; these 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. According to Messrs. Rolleston and Robertson* there is no connection between the blood vascular and the aquiferous systems; and the foot in the lamellibranchiates is distended by means of the aquiferous canals, which they regard as a rudimentary kidney. Agassiz and Lacaze Duthiers, on the other hand, assert that there is a connection between the two systems. The proof relied on by the former observers was that when a coloured injection was forced in through a vein, and an injection of a different colour was sent into the aquiferous canals, two coloured systems of ramification were formed, which the microscope showed to be distinct up to the furthest extremities. Agassiz also used a coloured injection; he states that when it was injected through the large pore in the pedal surface of some species of *pyrula*, not only was the system of canals in the foot filled, but also the whole of the circulatory system. He also states that when a *mactra* is taken out of the water it discharges a quantity of fluid from the foot, which consists of salt water, in which floats

* *Philosophical Transactions*, 1862.

a large number of blood corpuscles. This he regards as a proof of the mixture of blood and sea water within the body of the animal.

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, 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 probably 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 organised 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 repiratory 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 subdivision of the vessels, in which the circulating fluid is exposed to the revivifying influence.

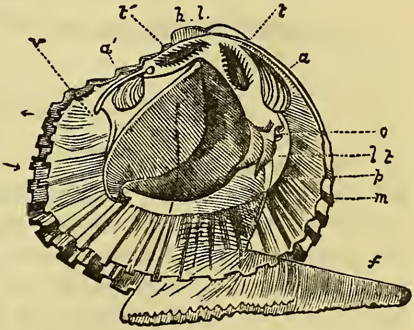


Fig. 18. *Trigonia pectinata.**

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

* *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.

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 specialised, and forming a gill (*branchia*). It is affected by the arms in all the *brachiopoda*, while the mantle serves as an auxiliary. 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).

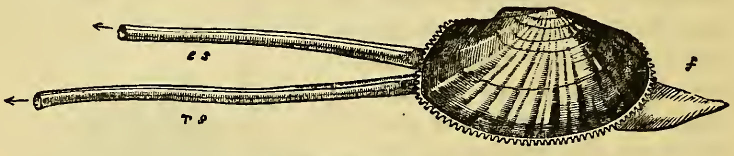


Fig. 19. Bivalve with long siphons.*

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 *nudibranchs*), or protected by a fold of the mantle (as in the *inferobranchs* and *tectibranchs* of Cuvier).‡ But in most the mantle is inflected,

* 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; *f*, foot.

† 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.

‡ Mr. Collingwood (Annals of Nat. Hist. for 1861), in discussing what function these tufts or papillæ perform, concludes that morphologically and physiologically they are not branchiæ.

and forms a vaulted chamber over the back of the neck, in which are contained the pectinated or plume-like gills (Fig. 68). 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. 109). 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 underside 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 characterised by their respiratory conditions, and are of much more nearly equal value.

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

	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*, 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* molluscs.

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

* 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.

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 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.

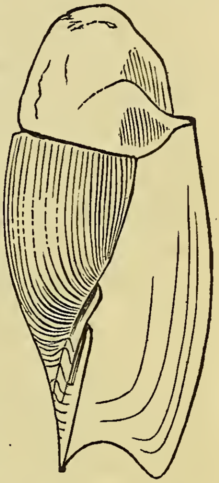


Fig. 20. *Cymba.**

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 orignally 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.*

The *nacreous* shells are formed by alternate layers of very thin membrane and carbonate of lime, but this alone does not

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

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 also found occasionally in the common oyster, in *anodonta cygnea*, *pinna nobilis*, *mytilus edulis*, or common mussel, and in *spondylus gœderopus*. In these they are generally of a green or rose colour. The pearls found in *arca noœ* are violet, and in *anomia cepa* purple. They are similar in structure to the shell, and, like it, consist of three layers; but what is the innermost layer in the shell is placed on the outside in the pearl. The iridescence is due to light falling upon the out-cropping edges of partially transparent corrugated plates. The thinner and more transparent the plates the more beautiful is the iridescent lustre; and this is said to be the reason why sea pearls excel those obtained from fresh-water molluscs. Besides the furrows formed by the corrugated surface there are a number of fine dark lines ($\frac{1}{7700}$ inch apart), which may add to the lustrous effect. In some pearls these lines run from pole to pole like the longitudes on the globe; in others they run in various directions; and in a few the lines on the same pearl have different directions, so that they cross each other. The nucleus frequently consists of a fragment of a brownish-yellow organic substance, which behaves in the same way as epidermis when treated with certain chemical re-agents. Sand is generally said to be the nucleus; but this is simply a conjecture which has gradually become regarded as a fact; it is quite the exception for sand to be the nucleus; as a general rule it is some organic substance. In some districts one kind of nucleus seems to be more common than another; at least, this is how the different results obtained by observers in different localities may be explained. Filippi (*Sull' origine delle Perle.* Translated in Müller's *Archiv.* 1856) found *distoma* to be the nucleus in many cases; Kuchenmeister found that the pearls were most abundant in the molluscs living in the still parts of the river Elster, where the water-mites (*limnochares anodontœ*) existed most numerously. The most generally prevalent nucleus appears to be the bodies or eggs of minute internal parasites, such as *filaria*, *distoma*, *buchephalus*, &c.* 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.

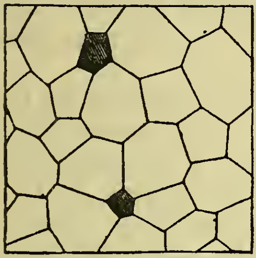


Fig. 21. *Pinna.*

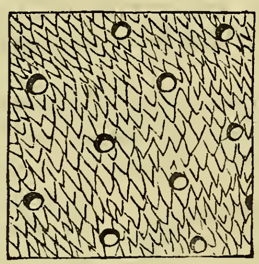


Fig. 22. *Terebratula.*

Fig. 23. Pearl.†

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 network, 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 calcareous spar; in other cases the difference in hardness depends on the proportion of animal matter and the manner in which the layers are aggregated.§

* Drs. Mobius and Kelaart, *Annals of Nat. Hist.*, i., 1858, p. 81.

† 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.

‡ 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.*)

In many bivalve shells there occurs a minute *tubular structure*, which is very conspicuous in some sections of pinna and oyster-shell. This tubular structure is frequently occasioned by the growth of a confervoid sponge, hence great care is required in determining whether the perforations are an essential part of the 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 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*).

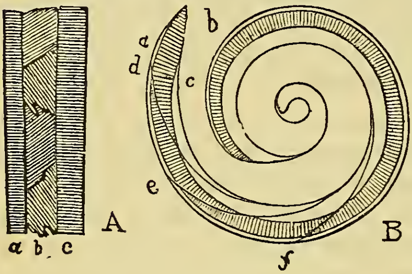


Fig. 24. Sections of a Cone.*

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

* 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.

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 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 molluscs 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 *bithynia* 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 whorls; 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;* 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 extravascular 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 lifetime 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 shell, and even by a sponge (*cliona*), which completely mines the most solid shells. In Dr. Gray's cabinet is the section of a cone, in whose apex a colony

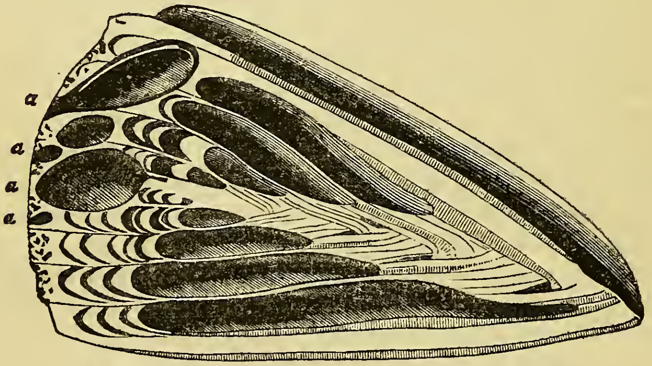


Fig. 25. Section of a Cone perforated by *Lithodomi.*

of *lithodomi* had settled, compelling the animal to contract itself faster 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.

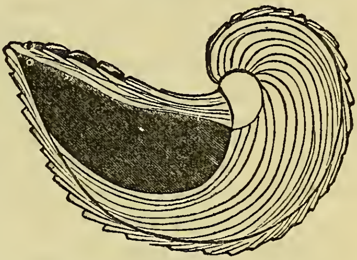


Fig. 26. Section of *gryphæa*.*

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 disc 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 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) develops 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*).

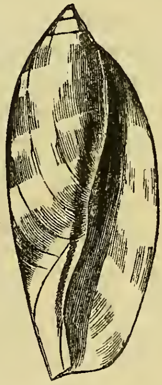


Fig. 27. Young Cowry.†

* 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.

† *Cypræa testudinaria*, L., young.

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 whorls; 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. 93), until, in some cases, all resemblance to the young shell is lost in the adult.

The power which molluscs possess of dissolving portions of their own shells is also exhibited by the *murices* in removing those spines from their whorls 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. Some support is given to this view by the composition of the saliva of *dolium galea* (closely allied to the *purpuræ*), which has been examined by Professor Troschel. A chemical analysis showed that it contained a minute proportion only of organic matter, and consisted of 94 per cent. of water, the remainder being almost entirely muriatic and sulphuric acids, and the sulphates of magnesia, potash, and soda. The secretion is apparently not used to assist digestion, since minute calcareous shells were found in the stomach uninjured. It is not used for perforating stones; and what its function is remains uncertain. We mention these facts here to show that dilute acids are secreted, which in some cases may be used for dissolving away the shell. The saliva, however, has no effect on the inside of the shell of the *dolium;* indeed, it is said to be unalterable by strong acids. (*Monatsberichte der Academie in Berlin*, 1854, p. 486).

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 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

* This is sometimes done by the hermit-crab to the shell it occupies.

each class; enough has been said to show that in the molluscan shell (as in the vertebrate skeleton) indications are afforded of 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 whorls 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 discovered whole races of *neritina*, *paludina*, and *melanopsis*, with whorls 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*, *physa*, and *triforis.* Bivalves less distinctly exhibit variations of this

* 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.

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. 89). 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 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.

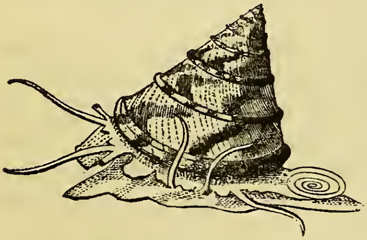


Fig. 28. *Trochus ziziphinus.*†

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,

* 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.

† *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.

and consists of horny layers, sometimes hardened with shelly matter (Fig. 28).

It has been considered by Adanson, and more recently by Dr. 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 *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 *pleuronectidœ* 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*. The *phragmocone* is the representative of the calcareous 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;

* 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.*

† Compare *fissurella* or *trochus* (Fig. 28) with *lepton squamosum* (Fig. 12). The disk of *hipponyx* is analogous to the ventral plate of *hyalœa* 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.

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, respiration 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.—(*Müller.*)

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 *papillæ*, and that, if confined in stale water, they become sickly and lose those organs; in both cases they are quickly renewed under favourable circumstances.

Viviparous reproduction. This happens in a few species of gasteropods, 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.

Oviparous reproduction. The sexes are distinct in the most highly organised (or *diœcious*) mollusca; they are united in the (*monœcious*) land-snails, pteropods, opisthobranchs, and in some of the conchifers. The prosobranchs pair; but in the diœcious acephalans, 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 limneids 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 calcareous 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 enclosed 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. 83). The nidamental capsules of the cuttle-fish are clustered like grapes, each containing but one embryo; those of the calamary are grouped 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. 50, n).

Fig. 29. Spawn of Doris.*

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.‡

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

† 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*, Mull., 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

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 organisation." In the next stage, the development of an organ, fringed with stronger *cilia*, and serving both for locomotion and respiration, shows 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; it is therefore "hatched," or escapes from the egg.

Very little is known respecting the development of Brachiopods. F. Müller has described * an embryo which, it is thought, may belong to *Crania*. It possessed two roundish valves of unequal size, the dorsal being the larger. At the part where the hinge is placed in the adult was a small oval plate. Five pairs of stiff setæ projected from the mantle, and four of them originated from the ventral half. The edge of the mantle in the dorsal valve was beset with numerous finer setæ, which curved over upon the outside of the ventral valve. The alimentary canal filled the posterior half of the space between the valves. There were two auditory capsules and two eyes. The anterior half was occupied by four pairs of cylindrical arms, surrounding a round knob, at the summit of which was the mouth. Locomotion was effected by means of the cilia enveloping the arms, which impelled the animal through the water with the mouth foremost. No circulatory or reproductive organs could be detected.

The young bivalves are hatched before they leave their parent. (*See* page 393) The forms they pass through present distinct differences in several families, so that even in the present state of embryological knowledge, some five or six types of development are known. Even in the same family there may be a great dis-

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 partially 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 recognised purpose.

* *Archiv für Anatomie und Physiologie*, 1860, p. 72; see also Annals of Nat. Hist. for 1860.

similarity, as in the case of the marine and fresh-water forms of the mytilidæ. The following account refers to the type to which the young of *Crenella* belong. 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 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. The development of the young has been noticed in many of the genera of Pteropods. They are divisible into two groups: those in which the body is surrounded with one or more rings of cilia, and those in which these rings are absent.

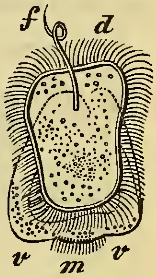


Fig. 30.*

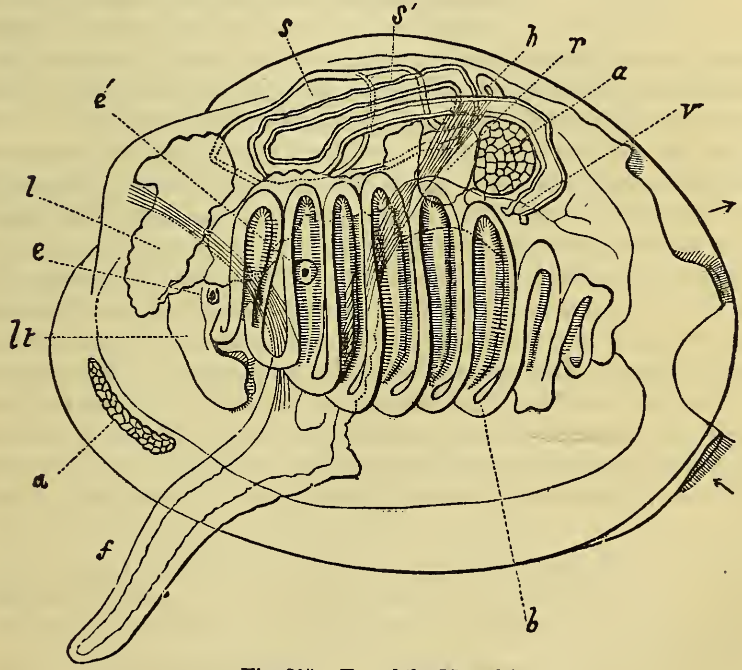


Fig. 30*. Fry of the Mussel.†

Most of the aquatic *gasteropoda* are very minute when

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

† Fig. 30*. Fry of *mytilus edulis*, after Lovén. *e*, eye; *e′*, auditory capsule; *l t*,

hatched, and they enter life under the same form,—that which has been already referred to as permanently characteristic of the *pteropoda*. (Fig. 69.)

The *Pulmonifera* and *Cephalcpoda* produce large eggs, containing 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.

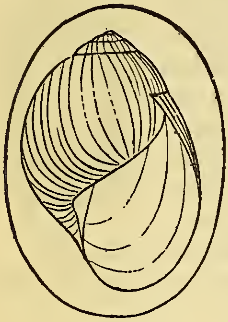


Fig. 31.*

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* mollusc, the insect, or the star-fish; but only to the ovarian stage of the invertebrata, and to more advanced stages of the classes formed upon its own type. And so also with the highest organised *mollusca;* after their first stage they

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.

* Egg and young of *bulimus ovatus*, Müll. 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.*

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 shown and steadfastly maintained, that the "unity of organisation" manifested by the animal world results from the design of a Supreme Intelligence, and cannot be ascribed to the operation of a mechanical "law."

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 recognised only when tolerably close. Resemblances of structure which subsist from a very early age are presumed to imply original relationship; they have been termed *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.

* At least 20,000 recent, and 16,000 fossil species of molluscous animals are known.

† For example, the paper nautilus, from its resemblance to *carinaria*, was long supposed to be the shell of a nucleobranch, 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.

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 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 in most cases 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 organisation; 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 arrangement on a plane surface would fail, for the affinities radiate in all directions, and the "network" to which Fabricius likened them, is as insufficient a comparison as the "chain" of older writers.‡

* 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-branchs.*

‡ The quinary arrangement of the molluscous classes reminds us of the eastern

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 opprobrium in all branches of natural history.*

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 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.

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 added *another hundred* of his own invention!

† This subject was investigated and reported upon by a committee of the British Association in 1842.

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 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 authorities for names given half a century or a century before by Linnæus or Bruguiere. The majority of 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 altered. The *type* of a genus should be the species which best exhibits the characters of the group, but it is not always easy to follow out this rule; and consequently the first on the list is often put forward as the type.

ABBREVIATIONS.

Etym., etymology; *Syn.*, synomym; *Distr.*, distribution; *MS.*, unpublished; *Sp.*, species; *B. M.*, in the British Museum.

Distr., Norway—New Zealand; including all intermediate seas.

Foss., Lias-chalk: implies that the genus existed in these and all intermediate strata. Chalk—; means that the genus has existed from the chalk up to the present time.

Depth—50 fms. implies that the genus is found at all depths between low-water mark and 50 fathoms. A fathom = 6 feet. $\frac{1}{4}$, one-fourth real size; $\frac{4}{1}$, magnified four times.

Lat., breadth; *Long.*, length; *Alt.*, height or thickness. *Unc.*, an inch; *Lin.*, a line or $\frac{1}{12}$ of an inch; *Mill.*, a millimetre or $\frac{1}{25}$ of an inch.

* 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.

CHAPTER II.

GEOGRAPHICAL DISTRIBUTION OF THE MOLLUSCA.

It is one of the most familiar facts in Natural History that many countries possess a distinct Fauna and Flora, or assemblages of animals and plants peculiar to themselves; and it is equally true, though less generally understood, that the sea also has its provinces of animal and vegetable life.

The most important or best known of these provinces are indicated on the accompanying map; different names, in some instances, and different letters and numbers, being employed to distinguish the marine from the terrestrial regions.*

The division of the surface of the globe into natural history provinces ought to be framed upon the widest possible basis. The geographical distribution of every class of animals and plants should be considered in order to arrive at a theory of universal application.

The most philosophical division of the globe into natural provinces has been by Swainson in 1835, and by Dr. Sclater in 1857. The last has been adopted by several naturalists. It was based upon a consideration of the distribution of birds, and has been extended to fishes and amphibia by Dr. Günther. It might be extended to mollusca. In Dr. Sclater's scheme the world is divided into six regions, viz. (1) Palæarctic region: this comprises Europe, North Africa, Asia Minor, Persia, Asia north of the Himalayas, North China, and Japan; (2) Ethiopian or Western Palæotropical region, includes Africa south of the Atlas, Madagascar, Mascarene, Arabia; (3) Indian or Middle Palæotropical region, including Asia south of the Himalayas, Ceylon, Burmah, Malacca, Southern China, Philippines, Borneo, Java, Sumatra, and adjacent islands; (4) Australian or Western Palæotropical region: Australia, New Guinea, New Zealand, and the Pacific Islands; (5) Nearctic or North American region: Greenland, and North America as far as the centre of Mexico;

* The author regrets that, on account of the expense, this map appears without the advantage of colours. He would recommend those who are sufficiently interested in the subject to colour their own copies, distinguishing the shores of the marine provinces by the following tints:—

Blue. 1. Arctic province; 15. Magellanic.
Green. 2. Boreal; 11. Aleutian; 5. Aralo-Caspian.
Orange. 3. Celtic.
Purple. 4. Lusitanian; 10. Japonic; 12. Californian; 18. Trans-Atlantic.
Yellow. 6. W. African; 8. Indo-Pacific; 13. Panamic; 17. Caribbean.
Lake. 7. S. African; 9. Australo-Zealandic; 14. Peruvian; 16. Patagonian.

MOLLUSCAN PROVINCES

1 to 27 Land Provinces 1 to 13 Marine Provinces → Oceanic Currents – – Mountains

(6) Neotropical or South American region: West India Islands, South Mexico, Central and South America, Galapagos. and Falkland Isles. These divisions apply to the land, but it is probable that they will help to throw light on the boundaries of the natural marine provinces.

As will be seen, each of the above regions includes several of the provinces adopted in this work.

The *Land Provinces* hitherto proposed have been chiefly founded on botanical grounds, but the evidence afforded by insects and the higher classes of animals confirms the existence of these divisions.

The *Marine Provinces* have also been investigated by botanists; and the striking peculiarities of the fisheries have been taken into account as well as the distribution of shell-fish and corals.

In order to constitute a distinct province it is considered necessary that at least *one-half* the species should be *peculiar*, a rule which applies equally to plants and animals. Some genera and sub-genera are limited to each province, but the proportion is different in each class of animals and in plants.*

Specific areas. Species vary extremely in their range, some being limited to small areas, while others, more widely diffused, unite the local populations into fewer and larger groups. Those species which characterise particular regions are termed "endemic;" they mostly require peculiar circumstances, or possess small means of migrating. The others, sometimes called "sporadic," possess great facilities for diffusion, like the lower orders of plants propagated by *spores*, and more easily meet with suitable conditions. The space over which a species is distributed is called a "centre," or, more properly, a specific *area.* The areas of one-half the species are smaller (usually much smaller) than a single province.

In each specific area there is frequently one spot where individuals are more abundant than elsewhere; this has been called the "metropolis" of the species. Some species which appear to be nowhere common can be shown to have abounded formerly; and many probably seem rare only because their head-quarters are at present unknown.—(*Forbes.*)

Specific centres are the points at which the particular species are supposed to have been created, according to those who believe that each has originated from a common stock (p. 46);

* The genera of plants amount to 20,000, and consist on an average of only four species apiece! The genera of shells commonly admitted are only 400 in number, and average forty species each. It follows that the areas of the molluscan genera (*cæteris paribus*) ought to be ten times as great as those of plants.

these can only be known approximately in any case. The doctrine that each species originated from a single individual, or pair, created once only, and at one place, derives strong confirmation from the fact that so "many animals and plants are indigenous only in determinate spots, while a thousand others might have supported them as well."*

Generic areas. Natural groups of species, whether called genera, families, or orders, are distributed much in the same manner as species; † not for the same reason, since their constituents are not related by descent, but apparently from the intention of the Creator.

Sub-generic areas are usually smaller than generic; and the areas of orders and families are, as a matter of course, larger than those of the included genera. But it is necessary to remember that groups of the same denomination are not always of equal value; and since species vary in range it often happens that specific areas of one class or family are larger than generic areas of another. The smallest areas are usually those of the forms termed *aberrant;* the *typical* groups and species are most widely distributed.—(*Waterhouse.*)

"When a generic area includes a considerable number of species, there may be found within it a point of maximum (*metropolis*), around which the number of species becomes less and less. A genus may have more centres than one. It may have had unbroken extension at one period, and yet in the course of time and change, may have its centre so broken up

* Mrs. Somerville's Physical Geography, ii. 95.

† "What we call class, order, family, genus, are all only so many names for *genera* of various degrees of extent. Technically a *genus* is a group to which a *name* (as *Ribes*) is applied: but essentially, *Exogens*, *Ranunculaceæ*, *Ranunculus*, are genera of different degrees.

"One of the chief arguments in favour of the *naturalness* of genera (or *groups*), is that derived from the fact that many genera can be shown to be *centralised* in definite geographical areas (*Erica*, for example); *i.e.* we find the species gathered all, or mostly, within an area, which has some one point where the *maximum* number of species is developed.

"But, in *geographical space*, we not unfrequently find that the same genus may have two or more areas, within each of which this phenomenon of a point of *maximum* number of species is seen, with fewer and fewer species radiating, as it were, from it.

"In *time*, however (or, in other words, in *geological distribution*), so far as we know, each generic type has had an unique and continuous range. When once a generic type has ceased it never re-appears.

"A genus is an abstraction, a divine idea. The very fact of the centralisation of groups of allied species, *i.e.* of genera, in space and time, is sufficient proof of this. Doubtless we make many so-called genera that are artificial; but a true genus is natural; and, as such, is not dependent on man's will."—*E. Forbes.* (See An. Nat. Hist. July, 1852, and Jan., 1855, p. 45.)

that there shall appear to be out-lying points. When, however, the history of a natural genus shall have been traced equally through its extension in *time* and *space*, it is not impossible that the area, considered in the abstract, will be found to be necessarily unique."—(*Forbes.*)

To illustrate the doctrine of the *unity of generic areas* Professor Forbes has given several examples, showing that some of the most exceptional cases admit of explanation and confirm the rule. One of these relates to the genus *Mitra*, of which there are 420 species; it has its metropolis in the Philippine Islands, and extends by the Red Sea to the Mediterranean and West Africa, the species becoming few, small, and obscure. Far away from the rest a single species is found on the coast of Greenland. But this very shell occurs fossil in Ireland along with another *mitra* now living in the Mediterranean. Another case is presented by the genus *Panopœa*, of which the eleven living species are widely separated. Of this genus above 100 fossil species are known, distributed over many places within the wide area, on whose margin the relics of this ancient form of life seem to linger like the last ripple of a circling wave.*

According to this view the specific centres are scattered thickly over the whole surface of the globe; those of the genera more thinly distributed; and the points of origin of the large groups become fewer in succession, until we have to estimate the probable position or scene of creation of the primary divisions themselves; and are led to speculate whether there may not have been some common focus—the centre of centres —from which the first and greatest types of life have emanated.

Boundaries of Natural History Provinces. The land provinces are separated by lofty mountains, deserts, seas, and climates; whilst the seas are divided by continents and influenced by the physical character of coast-lines, by climates and currents. These "natural barriers," as they were called by Buffon, retard or altogether prevent the migrations of species in particular directions.

Influence of Climate. Diversity of climate has been the popular explanation of most of the phenomena of geographical distribution, because it is so well known that some species require a tropical amount of warmth, whilst others can endure a great variety of temperature, and some only thrive amidst the rigours of the arctic regions. The character of the vegetation of the zones of latitude has been sketched by Baron Hum-

* The most striking and conclusive instances may be met with in the distribution of the highest classes of vertebrate animals.

boldt; Fabricius and Latreille have divided the world into climatal Insect-provinces; and Professor E. Forbes has constructed a map of the *homoiozoic belts* or zones of marine life. To all these the remark of Mr. Kirby is applicable—that any division of the globe into provinces, by means of *equivalent* parallels and meridians, wears the appearance of an artificial and arbitrary system, rather than of one according to nature. Professor Forbes has been careful to point out that although the "Faunas of regions under similar physical conditions bear a striking resemblance to each other"—this resemblance is produced, "not by identity of species, or even of genera, but by *representation*" (p. 45).

Origin of the Natural History Provinces. Mr. Kirby appears to have been the first to recognise the truth that physical conditions were not the primary causes of the zoological provinces, which he "regarded as fixed by the will of the Creator, rather than as regulated by isothermal lines."* Mr. Swainson also has shown that the "circumstances connected with temperature, food, situation, and foes, are totally insufficient to account for the phenomena of animal geography," which he attributes to the operation of unknown laws.†

The most important contribution towards a knowledge of these "unknown laws" has been made by Professor E. Forbes, who was perhaps the first naturalist ever in a position to avail himself of the great storehouse of facts accumulated by geologists, respecting the distribution of organic life in "the former world." This subject will be referred to again in connection with the subject of Fossil Shells; meanwhile it may be stated that, according to this evidence, the Faunas of the Provinces are of various ages, and that their origin is connected with former (often very remote) geological changes, and a different distribution of land and water over the surface of the globe.

MARINE PROVINCES.

Amongst the genera of marine shells there are some which have been considered particularly indicative of climate. From the Arctic list the following may be taken as examples of the shells of high latitudes; those marked * being found in the southern as well as in the northern hemisphere:—

* Introduction to Entomology.

† Treatise on Geography and Classification of Animals, Lardner's Cabinet Cyclopædia.

Buccinum.	Velutina.	*Crenella.
*Chrysodomus.	Lacuna.	*Yoldia.
*Trophon.	*Margarita.	*Astarte.
Admete.	——	Cyprina.
*Trichotropis.	*Rhynchonella.	Glycimeris.

The following have been thought peculiar to the warmer regions of the sea:

Nautilus.	Conus.	Columbella.	Perna.
Rostellaria.	Harpa.	Cypræa.	Vulsella.
Triton.	Oliva.	Nerita.	Tridacna.
Cancellaria.	Voluta.	Spondylus.	Crassatella.
Terebra.	Marginella.	Plicatula.	Sanguinolaria.

But it must not be inferred that these genera were always characteristic of extreme climates. On the contrary, the whole of them have existed in the British seas at no very remote geological period. *Rhynchonella* and *Astarte* were formerly "tropical shells;" and since the period of the English chalk-formation there have been living *Nautili* in the North Sea, and Cones and Olives in the "London basin." It is not true that the same *species* have been at one time tropical, at another temperate, but the *genera* have in many instances enjoyed a much wider range than they exhibit now. Some of the "tropical" forms are more abundant and extend farther in the Southern hemisphere; several large Volutes range to the extremity of South America, and the largest of all inhabits New Zealand.

The tropical and sub-tropical provinces might be naturally grouped in three principal divisions, viz., the Atlantic, the Indo-Pacific, and the West-American,—divisions which are bounded by meridians of longitude, not by parallels of latitude. The Arctic province is comparatively small and exceptional; and the three most southern Faunas of America, Africa, and Australia differ extremely, but not on account of climate.

If only a small extent of sea-coast is examined, the character of its mollusca will be found to depend very much upon the nature of the shore, the tides, depth, and local circumstances, which will be referred to again in another page. But these peculiarities will disappear when the survey is extended to a region sufficiently large to include every ordinary variety of condition.

It has been stated that each Fauna consists of a number of peculiar species, properly, more than half; and of a smaller number which are common to some other provinces. By ascertaining the direction of the tides and currents, and the circumstances under which the species occur, it may be possible to determine to which province these more widely diffused mollusca originally belonged. And when species occur both recent and fossil it is easy to perceive the direction in which their migrations have taken place.

The Fauna of the Mediterranean has been critically examined by Prof. Forbes and M. Philippi, with this result,—that a large proportion of its population has migrated into it from the Atlantic, and a smaller number from the Red Sea, and that the supposed peculiar species are diminishing so rapidly with every new research in the Atlantic, that it can no longer rank as a province distinct from the Lusitanian.

When the Faunas of the other regions have been tested in the same manner, and disentangled, the result will probably be the establishment of a much greater number of provinces than we have ventured at present to indicate on the map.

It may be desirable to notice here the extraordinary range attributed to some of the marine species. These statements must be received with great hesitation; for when sufficiently investigated, it has usually proved that some of the localities were false, or that more than one species was included. The following are given by Dr. Krauss in his excellent monograph of the South African Mollusca:—

Ranella granifera: Red Sea, Natal, India, China, Philippines, New Zealand.

Triton olearius: Brazil, Mediterranean, Natal, Pacific.

Purpura lapillus: Greenland, (Senegal, Cape).

Venus verrucosa: (W. Indies), Brit. Senegal, Canaries, Mediterranean, Red Sea, Cape (Australia).

Octopus vulgaris: Antilles, Brazil, Europe, Natal, Mauritius, India.

Argonauta argo: (Antilles), Medit., Red Sea, Cape.

Lucina divaricata is said to be "found on the shores of Europe, India, Africa, America, and Australia." (*Gray.*) In this case several species are confounded. The rock-boring *Saxicava* has been carried to all parts of the world *in ballast*, and it remains yet to be ascertained whether *the same species* occurs in a living state beyond the Arctic Seas and North Atlantic.

Lastly, the *money cowry* is always catalogued as a shell of the Mediterranean and Cape, although its home is in the Pacific, and it has no other origin in the Atlantic than the occasional wreck of one of the ships in which such vast quantities of the little shell are annually brought to this country to be exported again to Africa.

I. Arctic Province.

The North Polar Seas contain but one assemblage of *Mollusca*, whose Southern limit is formed by the Aleutian Islands in the Pacific, but in the North Atlantic is determined chiefly by the boundary of floating ice, descending as low as Newfoundland on the West, and thence rising rapidly to Iceland and the North Cape. A very complete general account of the Arctic Mollusca is given by Dr. Middendorff;* those of Greenland have been catalogued and described by Otho Fabricius and Möller;† and more recently by Mörch;‡ 158 species are enumerated by Middendorff, and 202 by Mörch. Scattered notices occur in the Annals of Natural History,§ and the Supplements to the Narratives of the Arctic Voyagers,—Phipps, Scoresby, Franklin, Back, Ross, Parry, and Richardson. The existence of the same marine animals in the Kamtchatka Sea and Baffin's Bay was long since held to prove at least a former North-West passage; but the occurrence of recent sea-shells in banks far inland rendered it probable that even recent elevation of the land in Arctic America might have much reduced the passage. During the "Glacial period," this Arctic Sea, with the same fauna, extended over Britain; over Northern Europe, as far as the Alps and Carpathians; and over Siberia, and a considerable part of North America. The shells now living in the Arctic Seas, are found fossil in the deposits of "Northern Drift," over all these countries; and a few of the species yet linger within the bounds of the two next provinces, especially in tracts of unusual depth. The Arctic shells have mostly a thick greenish epidermis (p. 33); they occur in very great abundance, and are remarkably subject to variation of form, a circumstance attributed by Professor E. Forbes to the influence of the mixture of fresh water produced by the melting of great bodies of snow and ice.

ARCTIC SHELL-FISH.

R. Russian Lapland. F. Finmark. I. Iceland. G. Greenland. D. Davis Straits (west coast). B. Behring's Straits. O. Ochotsk. * British species (living). ** British species (fossil).

Octopus granulatus. G.
Cirroteuthis Mülleri. G.
Rossia palpebrosa. G. P. Regent Inlet.
Onychoteuthis Bergii. F. B.
„ Fabricii. G.
„ amœna. G.
*Ommastrephes todarus. F. Newf.

Limacina arctica. G. O.

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* Malaco-zoologia Rossica; Mem. del' Acad. Imp. des Sc. Petersb. T. 6, pt. 2, 1849.

† Index Molluscorum Grœnlandiæ. Hafn. 1842.

‡ Fortegnelse over Grönlands Blöddyr in H. Rink: Grönland geographisk og statistisk beskrevet, ii. Bind. 1857.

§ Hancock, An. Nat. Hist. vol. 18, p. 323, pl. 5.

Spirialis stenogyra. F.
„ balea. G.
*Clio borealis. N. Zemla. G.

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*Nassa incrassata. F.
*Buccinum undatum, var. Kara. O.
„ hydrophanum. D. Prince Regent Inlet.
„ tenebrosum. R. G. B.
* „ Humphreysianum. R. G.
** „ cyaneum. F. D. G. Icy C. St. Lawrence.
„ glaciale. Kara. O. C. Parry. G. Spitzbergen.
Buccinum angulosum. N. Zemla. Icy C. Spitz.
„ tenue. N. Zemla. G.
„ Groenlandicum. D.
„ undulatum. G.
„ scalariforme. G.
** „ ciliatum. G.
„ boreale (Leach). Baffin's B.
„ sericatum. D. P. Refuge.
* „ Hollböllii (Mangelia, Möl.) G. F.
* „ Dalei. R. B.
Pleurotoma, 13 sp. G.
*Fusus antiquus. N. Zemla. B.
** „ carinatus. G.
* „ contrarius. R. O.
„ deformis. R. Spitz.
** „ despectus. G. Spitz.
„ heros. C. Perry.
„ latericeus. G.
** „ Sabini. D. Mass.
„ pellucidus. D.
„ Kroyeri. G. Spitz.
„ decemcostatus. B. Newf.
* „ Berniciensis. R. B.
„ Spitzbergensis. Spitz.
* „ Islandicus. F.
* „ gracilis. F. R. G. B.
**Trophon clathratus. R. G. B.
** „ scalariformis. Spitz. Newf. B.
** „ Gunneri. F. G.
** „ craticulatus. R. I. G.
* „ Barvicensis. F.
„ harpularius. F. U.S.
* „ truncatus.
*Purpura lapillus. R. G. B.
Mangelia, 9 sp. G.
„ decussata. D.
*Bela turricula. F. G.
* „ rufa. F. G.
**Mitra Grœnlandica. G.
**Admete viridula. R. Spitz. G. B.
*Trichotropis borealis. F. G. B. Prince Regent Inlet.
„ conica. G.
„ insignis. B.
„ bicarinata. B.
*Natica helicoides. R. G. B.
** „ clausa, F. N. Zemla. G. Melville Id. P. Regent Inlet. B.
„ pallida. R. O.
„ flava. N. Zemla. B. Newf.
* „ pusilla (grœnlandica). G. Norway. Spitz.
„ nana. G.
*Velutina lævigata. R B.
* „ flexilis. F.
** „ zonata. R. G.
„ lanigera. G.
Lamellaria prodita. F.
„ Grœnlandica. G. B.
**Scalaria Grœnlandica. F. G. B.
** „ borealis (Eschrichti). G.
Amaura candida. G.
Chemnitzia albula. G.
**Mesalia lactea. G.
**Turritella polaris. G.
Aporrhais occidentalis. Labrador.
*Littorina obtusata. R.
* „ tenebrosa. N. Zemla. D.
„ Grœnlandica. G. F.
* „ palliata (arctica). G.
„ limata. F.
*Lacuna vincta. R. Newf. G.
„ labiosa. F. P. Refuge.
* „ crassior. R.
„ glacialis. G.
* „ pallidula. G.
* „ puteolus. F. Newf.
„ frigida. F.
„ solidula. F.
Hydrobia castanea. R. G.
Rissoa scrobiculata. G.
„ globulus. G.
„ saxatilis. G.
*Skenea planorbis. G. F.
**Margarita cinerea. F. U.S.
* „ undulata. R. G.
* „ alabastrum. F.
* „ helicina. G. White Sea. Spitz.
„ sordida. R. Spitz. G. B.
„ umbilicalis. D. B.
„ Harrisoni. D.
„ glauca. G.
„ Vahlii. G.
* „ costulata. G.
*Puncturella Noachina. F. G.
*Acmæa testudinalis. R. Iceland. G.

**Lepeta cæca. G. F. Spitz. C. Eden.
Pilidium rubellum. F. G. D.
Patella, 4 sp. G.
*Chiton ruber. F. G. Spitz.
* „ albus. F. G.
Dentalium entale. Spitz.

Bulla Reinhardi. G.
„ subangulata. G.
*Cylichna alba. G. F. Spitz.
„ turrita. G.
*Philine scabra. Norway. G.
„ punctata (Möll.) G.
Doris liturata. G.
„ acutiuscula. G.
„ obvelata. G.
*Dendronotus arborescens. F. G.
Æolis bodocensis. G.
Tergipes rupium. G.
Euplocamus Holböllii. G.

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*Terebratulina caput-serpentis. Spitz. F. Mass. Medit.
*Waldheimia cranium. F.
„ septigera. F.
Terebratella Spitzbergensis. Sp.
„ Labradorensis. Labr.
**Rhynchonella psittacea. R. Baffin's Bay, 76° N. Melville, I. B.
*Crania anomala. Spitz.

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*Anomia squamula. R.
* „ aculeata. R.
**Pecten Islandicus. F. N. Zemla. Spitz. G. B. St. Lawrence.
„ vitreus. F. Arctic America.
„ Grœnlandicus. R. Spitz. D.
Limatula sulcata. G. F.
*Mytilus edulis. R. G. B.
*Modiola modiolus. R. B.
*Crenella discors (lævigata). G. D. N. Zemla.
* „ decussata. R. G.
* „ nigra. N. Zemla. R. G. D.
** „ faba. G.
„ vitrea. G.
Arca glacialis. P. Regent Inlet.
Nucula corticata. G.
„ inflata. G. D.
Leda buccata. G.
„ macilenta. G.
** „ rostrata (pernula). F. Spitz. Arctic America.
**Leda minuta (Fabr.) F. Spitz. G. D.
** „ lucida. F. (= navicularis? Spitz.)
* „ pygmæa. G. F. Siberia.
**Yoldia arctica Gr. (myalis). G. U.S. Spitzbergen.
** „ lanceolata (arctica B. & S.) Icy Cape.
„ limatula. F. U.S. Kamt.
„ hyperborea. Spitz.
** „ thraciæformis (angularis). G. Mass.
** „ truncata, Br. (Portlandica, Hit.) P. Refuge. Arctic America.
**Astarte borealis (arctica). F. Iceland. G.
** „ semisulcata (corrugata). Kara Sea. N. Zemla. Spitz. P. Regent Inlet. C. Parry. Icy Cape.
* „ elliptica. F. G. Spitz.
* „ sulcata. R. N. Zemla. O.
** „ crebricosta. F. Spitz. Newf.
„ crenata. P. Regent Inlet.
„ Warhami. Davis Str.
„ globosa. G.
* „ compressa. N. Zemla. G.
„ Banksii. Spitz. Baffin's Bay.
*Cardium edule var. rusticum. R.
„ Islandicum. N. Zemla. G.
** „ Grœnlandicum. Kara. Spitz. C. Parry. St. Lawrence.
„ elegantulum. G.
*Cryptodon flexuosus. G. F.
*Turtonia minuta. G. F.
*Cyprina Islandica. R. Labrador.
**Cardita borealis. Mass. O.
**Tellina calcarea. F. G. B.
** „ Grœnlandica. (= Balthica, L.) N. Zemla. Spitz. F. G. B.
** „ edentula. B.
*Mya truncata. R. Spitz. G. C. Parry. B.
** „ Uddevallensis. St. Lawrence. D. P. Regent Inlet. Melville I.
* „ arenaria. N. Zemla. G. O.
**Saxicava rugosa (arctica). N. Zemla. Spitz. G. C. Parry. B.
* „ (Panopæa) Norvegica. White Sea. O.
Machæra costata. Labrador. O.
Glycimeris siliqua. C. Parry. Newf.
*Lyonsia Norvegica. F. O
„ arenosa. G. D. P. Refuge.
**Thracia myopsis. G.
Pandora glacialis. Spitz. Baff. (Leach).

II. Boreal Province.

The Boreal Province extends across the Atlantic from Nova Scotia and Massachusetts to Iceland, the Faeroe and Shetland Islands, and along the coast of Norway from North Cape to the Naze.

Of the 289 Scandinavian shells catalogued by Dr. Lovén,* 217, or 75 per cent. are common to Britain, and 137 range as far as the North coast of Spain.

The boreal shells of America are described by Dr. Gould.† From these lists it appears that out of 270 sea-shells found on the coast of Massachusetts north of Cape Cod, more than half are common to Northern Europe.

Many of the species, it is believed, could only have extended their range so distantly by means of continuous lines of connecting coast, now no longer in existence.‡

BOREAL SHELLS COMMON TO EUROPE AND NORTH AMERICA.

* *British Species.*

*Teredo navalis.
*Pholas crispata.
*Solen ensis.
*(Panopæa) Norvegica.
*Mya arenaria.
* „ truncata.
*Thracia phaseolina (Conradi, Couth).
Mactra ponderosa (ovalis, G.)
? Montacuta bidentata.
*Turtonia minuta.
? Kellia rubra.
? Lepton nitidum (fabagella, Conr. ?)
*Saxicava rugosa (arctica).
Tellina solidula, var. (fusca, Say).
* „ calcarea (sordida, Couth).
*Lucina borealis.
? „ divaricata.
*Cryptodon flexuosus.
*Astarte borealis.
* „ triangularis ? (quadrans, G.)
*Cyprina Islandica.
? (Cardium Islandicum, U.S.—N. Zemla).
Yoldia limatula.
„ arctica, Gr. (= myalis).
*Leda pygmæa.
* „ caudata.
? „ navicularis (lucida, Lovén ?)
*Nucula tenuis.
*Mytilus edulis.
*Modiola modiolus.

* Index Molluscorum Scandinaviæ; extracted from the "Ofversigt af K. Vet. Akad. Forh." 1846. The climate of Finmark is much less severe than Russian Lapland; Hammerfest has an open harbour all the year.

† Report on the Invertebrata of Massachusetts. 1841.

‡ Forbes, Memoirs of the Geol. Survey, i. p. 379. Sir John Richardson, when speaking of the cod-tribe and turbot-tribe, says:—"Most of the fish of this order feed on or near the bottom, and a very considerable number of the species are common to both sides of the Atlantic, particularly in the higher latitudes, where they abound. It does not appear that their general diffusion ought to be attributed to migration from their native haunts, but rather that in this respect they are analogous to the owls, which, though mostly stationary birds, yet include a greater proportion of species common to the old and new worlds than even the most migratory families. Several of the *Scomberoideæ* (Mackerel-tribe) which feed on the surface, have been previously noted as traversing many degrees of longitude in the Atlantic: but the existence of the ground-feeding *Gadoideæ* in very distant localities must be attributed to a different cause, as it is not probable that any of them wander out of soundings or ever approach the mid-seas."—Report Zool. N. America, p. 218.

*Crenella nigra.
* „ discors, L.
* „ decussata (glandula, Tot.)
Pecten Islandicus.
? Ostrea edulis (borealis, Lam. ?)
*Anomia ephippium.
* „ aculeata.
„ squamula?

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*Terebratulina caput-serpentis.
*Rhynchonella psittacea.

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*Dendronotus arborescens.
Polycera Lessonii ?
? Amphisphyra hyalina (debilis ?)
Cylichna alba (triticea, C.)
* „ obtusa (pertenuis).
*Philine quadrata (formosa, St.)

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*Chiton cinereus.
* „ marmoreus.
* „ ruber.
* „ lævis.
* „ asellus.
* „ albus.
*Dentalium (entale, L. ?)
? Lepeta cæca (candida, C.)
*Acmæa testudinalis (amoena, S.)
*Puncturella Noachina.
*Adeorbis divisus (= Skenea serpuloides).
Margarita cinerea.
* „ costulata ? (Skenea).
* „ helicina.
*Margarita undulata.
* „ alabastrum (= occidentalis ?)
Littorina grœnlandica.
* „ tenebrosa (vestita).
„ palliata ?
*Lacuna vincta (divaricata).
* „ puteolus (Montagui).
*Skenea planorbis.
*Velutina lævigata.
„ zonata.
*Lamellaria perspicua.
*Natica helicoides.
„ clausa.
* „ pusilla.
*Scalaria grœnlandica.
(Ianthina communis).
Odostomia producta.
Cancellaria (admete) viridula.
*Trichotropis borealis.
*Fusus antiquus (tornatus).
* „ islandicus.
* „ propinquus.
„ ? rosaceus.
*Trophon muricatus.
* „ clathratus.
„ scalariformis.
„ harpularius.
*Purpura lapillus.
*Buccinum undatum.
* „ (Cominella) Dalei.
*Bela turricula.
* „ Trevelyana.
* „ rufa (Vahlii) ?

**Ommastrephes sagittatus* is also common to both sides of the North Atlantic. The genera,

Machæra,	*Glycimeris*,	*Cardita*, and
Solemya,	*Mesodesma* (*deauratum*),	*Crepidula*,

are peculiar to the American side of the Boreal Province.

Several other species now living on the coast of the U. States occur fossil in England: *e. g. Trophon cinereus*, Say., is believed to be the *Fusus Forbesi*, Strickland, of the Isle of Man; others are marked in the Arctic list.

III. Celtic Province.

The Celtic province, as described by Prof. E. Forbes, includes the British island coasts, Denmark, Southern Sweden, and the Baltic.* The fauna of this region (which includes the principal

* The great work of Messrs. Forbes and Hanley is the standard text book on British *Testacea*. A new work on British *Mollusca* is now being prepared by Mr. J.

herring-fisheries) is essentially Atlantic; many of the species are of ancient origin, and occur fossil in the Pliocene.

The British mollusca described by Forbes and Hanley amount to 682, viz. :—

14 (15) Cephalopoda.	100 Pulmonifera.	175 (172) Acephala.
220 (254) Marine Univalves.	4 (5) Pteropoda.	73 (73) Tunicata.
91 (100) Nudibranchiata.	5 (7) Brachiopoda.	

Of this number two-thirds of the *Nudibranchia*, 55 marine univalves, and 7 bivalve shell-fish, are, at present, only known in British seas; but as most of these are minute or "critical" species, it is considered they will yet be met with elsewhere. In 1857, Mr. M'Andrew was acquainted with 626 marine molluscs, as indicated by the figures in brackets in the summary just given.

A few of the species belong to the Lusitanian province, whose northern limits include the Channel Islands, and just impinge upon our coast.

Phasianella pullus.	Murex corallinus.	Cytherea chione.
Haliotis tuberculata.	Avicula Tarentina.	Petricola lithophaga.
Truncatella Montagui.	Galeomma Turtoni.	Venerupis irus.
Oncidium celticum.	Pandora rostrata.	Cardium rusticum, L. (tuberculatum).
Bulla hydatis.	Ervilia castanea.	
Volva patula.	Mactra helvacea.	

Of the *Gasteropoda* 54 are common to the seas both north and south of Britain; 52 range farther south, but are not found northward of these islands; and 34 which find here their southern limit occur not only in Northern Europe, but most of them in Boreal America. Nearly half of the bivalves range both north and south of Britain; 40 extend southward only, and about as many more are found in Scandinavia, 27 of them being common to N. America. (*Forbes.*)

In the lists of Arctic and Boreal shells the British species are distinguished by an asterisk.

According to Mr. M'Andrew's estimate in 1850, 406 British shell-bearing mollusca were then known, of which

217 or 53	per cent. were common to	Scandinavia.
246 or 61	,, ,,	North of Spain.
227 or 56	,, ,,	S. Spain and Medit.
97 or 24	,, ,,	Canary Islands.

G. Jeffreys. The *Nudibranchiata* alone have been more fully described in the publications of the Ray Society, by Messrs. Alder and Hancock. For the marine zoology of the coasts of Denmark the "Zoologia Danica" of O. F. Müller is still the most important work.

The following are at present peculiar to Britain :—

Assiminea, sp.	Odostomia, 19 sp. ?	Montacuta ferruginosa.
Jeffreysia, sp.	Buccinum fusiforme.	Argiope cistellula.
Otina otis.	Fusus Berniciensis.	Pecten niveus.
Rissoa, sp.	„ Turtoni.	Syndosmya tenuis.
Stylifer turtoni.	Natica Kingii.	Thracia villosiuscula.

The most common edible species are :—

Ostrea edulis.	Mytilus edulis.	Fusus antiquus.
Pecten maximus.	Cardium edule.	Littorina littorea.
„ opercularis.	Buccinum undatum.	

Amongst the species characteristic of the Celtic province—or most abundant in it—are the following :—

Trophon muricatus.	Littorina littoralis.	Venus striatula.
Nassa reticulata.	Trochus Montagui.	„ casina.
Natica Montagui.	„ millegranus.	Donax anatinus.
„ monilifera.	„ tumidus.	Solen ensis.
„ nitida.	Patella vulgata.	Pholas candida.
Velutina lævigata.	„ pellucida.	Mactra elliptica.
Turritella communis.	Acmæa virginea.	„ solida
Aporrhais pes-pelecani.	Chiton cinereus.	Periploma prætenuis.
Rissoa cingillus.	Scaphander lignarius.	Thracia distorta.
Scalaria Trevelyana.	Tellina crassa.	Syndosmya prismatica.

The wide expanse of the Baltic affords no shell-fish unknown to the coasts of Britain and Sweden. The water is brackish, becoming less salt northward, till only estuary shells are met with, and the Littorinæ and Limnæans are found living together, as in many of our own marshes. This scanty list is taken from the Memoirs of Dr. Middendorff and M. Boll.

Buccinum undatum.	Neritina fluviatilis.	Tellina Balthica.
Purpura lapillus.	Limnæa auricularia.	„ tenuis.
Nassa reticulata.	„ ovata.	Scrobicularia piperata.
Littorina littorea.	Mytilus edulis.	Mya arenaria.
Patella (tarentina).	Donax (trunculus).	„ truncata.
Hydrobia muricata.	Cardium edule var.	

Meyer and Möbius collected the following species at Kiel :—

Chiton cinereus.	Rissoa parva.	Cerithium reticulatum.
Acmæa testudinalis.	Littorina littorea.	Nassa reticulata.
Rissoa labiosa.	„ littoralis.	Buccinum undatum.
„ inconspicua.	„ tenebrosa.	Fusus antiquus.
„ ulvæ.	Lacuna vincta.	
„ ventrosa.	„ pallidula.	

IV. Lusitanian Province.

The shores of the Bay of Biscay, Portugal, the Mediterranean, and N. W. Africa, as far as Cape Juby, form one important province, extending westward in the Atlantic as far as the Gulf-weed bank, so as to include Madeira, the Azores, and Canary Islands.*

In the Atlantic portion of the province occur the following genera, not met with in the Celtic and Boreal seas, although two of them, *Mitra* and *Mesalia*, occur on the coast of Greenland :—

Argonauta.	Cancellaria.	Auricula.	——
Philonexis.	Sigaretus.	Pedipes.	Spondylus.
Chiroteuthis.	Crepidula.	Ringicula.	Avicula.
——	Mesalia.	Umbrella.	Solemya.
Conus.	Vermetus.	Glaucus.	Chama.
Pleurotoma.	Fossarus.	——	Crassatella.
Marginella.	Planaxis.	Carinaria.	Lithodomus.
Cymba.	Litiopa.	Firola.	Ungulina.
Mitra.	Truncatella.	Atlanta.	Galeomma.
Terebra.	Solarium.	Oxygyrus.	Cardita.
Columbella.	Bifrontia.	——	Cytherea.
Pisania.	Turbo.	Cleodora.	Petricola.
Dolium.	Monodonta.	Cuvieria.	Venerupis.
Cassis.	Haliotis.	Creseis.	Mesodesma.
Triton.	Gadinia.	——	Ervilia.
Ranella.	Siphonaria.	Megerlia.	Panopæa.

Spain and Portugal.

The coast of Spain and Portugal is less known than any other part of the province, but the facilities for exploration are in some respects greater than in the Mediterranean, on account of the tides. Shell-fish are more in demand as an article of food here than with us, and the Lisbon market afforded to Mr. M'Andrew the first indication that the genus *Cymba* ranged so far north.

On the coasts of the Asturias and Gallicia, especially in Vigo Bay, Mr. M'Andrew obtained, by dredging, 212 species, of a

* In the northern part of the Lusitanian province are the Pilchard fisheries; in the Mediterranean, the Tunny, Coral, and Sponge fisheries.

The Gulf-weed banks (represented in the map) extend from 19° to 47° in the middle of the North Atlantic, covering a space almost seven times greater than the area of France. Columbus, who first met with the *sargasso* about one hundred miles west of the Azores, was apprehensive that his ships would run upon a shoal. (*Humboldt.*) The banks are supposed by Professor E. Forbes to indicate an ancient coast-line of the Lusitanian land-province, on which the weed originated. Dr. Harvey states that species of *Sargassum* abound along the shores of tropical countries, but none exactly correspond with the Gulf-weed (*S. bacciferum*). It never produces fructification—the "berries" being air-vesicles, not fruit—but yet continues to grow and flourish in its present situation, being propagated by breakage. It may be an abnormal condition of *S. vulgare*, similar to the varieties of *Fucus nodosus* (Mackayi) and *F. vesiculosus* which often occur in immense strata; the one on muddy sea-shores, the other in salt marshes, in which situations they have never been found in fructification. (*Manual of British Algæ, Intr.* 16, 17.)

somewhat northern character, 50 per cent. of them being common to Norway, and 86 per cent. common to the south of Spain.

On the southern coast of the Peninsula 353 species were obtained, of which only 28 per cent. are common to Norway and 51 per cent. to Britain.

The identical species are chiefly amongst the shells dredged from a considerable depth (35—50 fathoms); the littoral species have a much more distinct aspect.

The shells of the coast of Mogador are generally identical with those of the Mediterranean and Southern Peninsula.

Canary Islands. The shells of the Canaries collected by MM. Webb and Berthelot,* and described by M. D'Orbigny, amount to 124, to which Mr. M'Andrew has added above 170. Of the 300 species 17 per cent. are common to Norway, 32 per cent. to Britain, and 63 per cent. to the coasts of Spain and the Mediterranean. Two only are W. Indian shells, *Neritina viridis* and *Columbella cribaria.* Of the African shells found here, and not met with in more northern localities, the most remarkable are:—

Crassatella divaricata.	Ranella lævigata.	Cymba proboscidalis.
Cardium costatum.	Cassis flammea.	Conus betulinus.
Lucina Adansoni.	„ testiculus.	„ Prometheus.
Cerithium nodulosum.	Cymba Neptuni.	„ Guinaicus.
Murex saxatilis.	„ porcina.	„ papilionaceus.

Madeira. Mr. M'Andrew obtained 156 species at Madeira, of which 44 per cent. are British, 70 per cent. common to the Mediterranean, and 83 to the Canaries. Amongst the latter are the two W. Indian shells before mentioned, and the following African shells:—

Pedipes.	Mitra fusca.	Patella crenata.
Littorina striata.	„ zebrina.	„ guttata.
Solarium.	Marginella guancha.	„ Lowei.
Scalaria cochlea.	Cancellaria.	„ Candei.
Natica porcellana.	Monodonta Bertheloti.	Pecten corallinoides.

Azores. Amongst the littoral shells which range to the Azores, are Pedipes, Littorina striata, Mitra fusca, and Ervilia castanea; the other species obtained there are Lusitanian. (*M'Andrew.*)

The Mediterranean fauna is known by the researches of Poli, Delle Chiaje, Philippi, Verany, Milne-Edwards, Professor E. Forbes, and Deshayes. In its western part it is identical with that of the adjacent Atlantic coasts; the number of species diminishes eastward, although reinforced by a considerable

* Hist. Naturelle des Iles Canaries; the list of shells is reprinted, with the additions made by Mr. M'Andrew, as one of the Catalogues of the British Museum.

number of new forms as yet only known in the Mediterranean; and a few accessions (about 30) of a different character from the Red Sea. The total number of shell-bearing species is estimated at 600, viz.:—

Cephalopoda	1	Nucleobranchiata	6	Lamellibranchiata	200
Pteropoda	13	Gasteropoda	370	Brachiopoda	10

On the coast of Sicily, M. Philippi has found altogether 619 marine mollusca, viz.:—

Bivalves	188	Pteropoda	13	Gasteropoda	319
Brachiopoda	10	Nudibranchs	54	Cephalopoda	15

Of the 522 which are provided with shells, 162 have not been found fossil, and are presumed to be of post-tertiary origin, so far as concerns their presence in the Mediterranean. The remaining 360 occur fossil in the newer tertiary strata, along with nearly 200 others which are either extinct or not known living on those coasts; a few of them are living in the warmer regions of Senegal, the Red Sea, and the West Indies:—

Senegal.	*Antilles.*	*Red Sea.*
Lucina columbella.	Lucina pennsylvanica.	Argonauta hians.
Cardium hians.	Vermetus intortus.	Dentalium elephantinum.
Terebra fusca.		Terebra duplicata.
	Morocco.	Phorus agglutinans.
	Trochus strigosus.	Niso terebellum.
		Pecten medius.
		Diplodonta apicalis.

Most of them, however, are of northern origin, such as:—

Saxicava rugosa	Tellina crassa.	Rhynchonella psittacea.
(Panopæa) Norvegica.	Cyprina Islandica.	Patella vulgata.
Mya truncata.	Leda pygmæa.	Eulimella Scillæ.
Periploma prætenuis.	Limopsis pygmæa.	Buccinum undatum.
Lutraria solenoides.	Ostrea edulis.	Fusus contrarius.

Of the 522 Sicilian testacea, about 35 (including 10 oceanic species) are common to the West Indies—if the species have been correctly determined; 28 are stated, with more probability, to be common to West Africa, including *Murex Brandaris* and other common species; 74, including *Murex trunculus*, are common to the Red Sea; *Crania ringens* cannot be distinguished from the species found in New South Wales (*Davidson*); and *Columbella corniculum* ranges from the north coast of Spain to Australia, the specimens from these distant localities being only distinguishable as geographical varieties. (*Gaskoin.*) Six other species are included in Menke's Australian Catalogue, but require verification.

The following genera, nine of which are naked molluscs, are supposed to be now peculiar to the Mediterranean; the small number of species show they are aberrant or expiring forms. *Cassidaria,* and *Thecidium* are ancient, widely-distributed genera, and the Mediterranean *Thecidium* occurs fossil in Brittany and the Canaries.

Thysanoteuthis, 2 sp.	Scæurgus, 1.	Morrisia, 2.
Verania, 1.	Pleurobranchæa, 1.	Thecidium, 1.
Dosidicus, 1.	Tethys, 1.	Scacchia, 2.
Doridium, 1.	Cassidaria, 6	
Icarus, 1.	Pedicularia, 1.	

The genera *Fasciolaria*, *Siliquaria*, *Tylodina*, *Notarchus*, *Verticordia ? Clavagella,* and *Crania,* occur only in this portion of the Lusitanian province.

Amongst the peculiar species are :—

Nassa semistriata.	Argiope cuneata.	Artemis lupinus.
Fusus crispus.	Clavigella angulata.	Trigona nitidula.
Tylodina Rafinesquii.	Spondylus Gussonii.	Lucinopsis decussata.
Crania rostrata.	Astarte bipartita.	

Ægean Sea. Prof. E. Forbes obtained 450 species of mollusca in the Ægean, belonging to the following orders :—

Cephalopoda	4	Nudibranchs	15	Brachiopoda	8
Pteropoda	8	Opisthobranchs	28	Lamellibranchs	143
Nucleobranchs	7	Prosobranchs	217	Tunicata	22

Of these 71 were new species, but several have since been found in the Atlantic, and even in Scotland.* The only marine air-breather met with was *Auricula myosotis.*

Black Sea. In the northern part a few Aralo-Caspian shells are found, otherwise the Black Sea only differs from the Mediterranean in the paucity of its species; Dr. Middendorff enumerates 68 only. The water is less salt, and there is no tide, but a current flows constantly through the Dardanelles to the Mediterranean.†

Lorenz‡ found 178 molluscs at Quarnero, of which 75 were bivalves, and 88 univalves; 75 of them extended their range into the Ægean Sea, 58 into the Boreal province. Few only appeared to be peculiar to the Adriatic.

* Trans. Brit. Assoc. (for 1843), 1844, p. 130.

† A current from the Atlantic sets in perpetually through the Straits of Gibraltar, and there is scarcely any tide; it only amounts to one foot at Naples and the Euripus, two feet at Messina, and five at Venice and the Bay of Tunis.

‡ Physikalische Verhältnisse und Vertheilung der Organismen im Quarnerischen Golfe. Wien, 1863.

V. Aralo-Caspian Province.

The only inland salt-seas that contain peculiar shell-fish are the Aral and Caspian. The shells chiefly consist of a remarkable group of Cockles which burrow in the mud (see fig. 213, p.402). No explorations have been made with the dredge, but other species, probably still existing in these seas, have been found in the beds of horizontal limestone which form their banks and extend in all directions far over the *steppes*. This limestone is of brackish water origin, being sometimes composed of myriads of *Cyclades*, or the shells of *Dreissena* and *Cardium*, as in the islets near Astrakhan. It is believed to indicate the former existence of a great inland sea, of which the Aral and Caspian are remnants, but which was larger than the present Mediterranean at an age previous to that of the Mammoth and Siberian Rhinoceros. The present level of the Caspian is 83 feet below that of the Black Sea; that of the Aral has been stated to be 117 feet higher than the Caspian, but is probably not very different; their waters are only brackish, and in some parts drinkable. The steppe limestone rises to a level of 200—300 feet above the Caspian; it spreads eastward to the mountains of the Hindoo Kush and Chinese Tartary, southward over Daghestan and the low region E. of Tiflis, and westward to the northern shores of the Black Sea. The extent to which it has been traced is represented by oblique lines on the map.* Some of the Caspian shells still exist in the Sea of Azof and the estuaries of the Dnieper and Dniester. Our information upon this seldom-visited region is derived from the works of Pallas, Eichwald,† Krynicki,‡ Middendorff, and Sir Roderick Murchison.

Aralo-Caspian Shells.

A, Aral; C, Caspian; B, Black Sea.

The Species marked * are found also in the Steppe limestone.

*Cardium edule, L. C. (very small) B. Baltic.
„ edule, var. (rusticum, Chemn.) A. C. B. Icy Sea.
*Didacna trigonoides, Pal. C. (Azof. M. Hommaire).
„ Eichwaldi, Kryn. (crassa, Eich.) C. B. (Nikolaieff).
Monodacna Caspia, Eich. C.
„ pseudo-cardium, Desh. (pontica, Eich.) B.
Adacna læviuscula, Eich. C.
„ vitrea, Eich. C. A.

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* From a sketch kindly prepared by Professor Ramsay.

† Geogr. des Kaspischen Meeres, des Kaukasus und des Südlichen Russlands. Berlin, 1830. Fauna Caspio-Caucasica, 1841.

‡ Bull. des Nat. Moscow, 1837.

*Adacna edentula, Pallas. C.
„ plicata, Eich. C. B. (Dniester, Akerman, Odessa).
„ colorata, Eich. C. B. (Azof, Dnieper).
*Mytilus edulis, L. C. C. (not in Middendorff's list).
„ latus, Chemn. B.
*Dreissena polymorpha, Pal. C. B.

Paludinella stagnalis, L. (pusilla Eich.) C. B. (Odessa) Ochotsk.
* „ variabilis, Eich. C.
*Neritina liturata, Eich. C. on sea-weed.
*Rissoa Caspia, Eich. C.
„ oblonga, Desm. B.
„ cylindracea, Kryn. B.*

The following species are described by Eichwald, from the steppe limestone. (Murchison, Russia, p. 297.)

"Paludina" Triton.
„ exigua.
Rissoa conus.
„ dimidiatus.
Bullina Ustuertensis.

Mactra Caspia.
„ Karagana.
Cyclas Ustuertensis.
Mytilus rostriformis.

Donax priscus.
Monodacna propinqua.
„ intermedia.
„ Catillus.
Adacna prostrata.

No other inland bodies of salt water are known to have peculiar marine shells; those of the modern deposits, in Mesopotamia (at Sinkra and Warka), collected by Mr. W. K. Loftus, are species still abounding in the Persian Gulf.†

VI. West African Province.

The tropical coast of Western Africa is rich in conchological treasures, and far from being wholly explored. The researches of Adanson,‡ Cranch (the naturalist to the Congo expedition§), and the officers of the Niger expedition, have left much to be done. Dr. Dunker has described 149 species in his *Index Moll. Guineæ, coll. Tams.* Cassel, 1853.

At *St. Helena,* Mr. Cuming collected 16 species of sea-shells, 7 of them new. *Littorina Helenæ* is found on the shore of St. Helena, and *L. miliaris* and *Nerita Ascensionis*, at Ascension.

* The *Velutina* (*Limneria*) *Caspiensis*. A. Ad. was founded on a specimen of *Limnæa Gebleri, Midd.* (1851), from Bernaoul, Siberia.

† A species of coral (*Porites elongata*, Lam.), now living at the Seychelles, has been said to be found in the Dead Sea (*v.* Humboldt's Views of Nature, Bohn ed. p. 260); also *Melania costata* and *M. Jordanica*, according to M. Schubert.

‡ Hist. Nat. de Senegal, 4to. Paris, 1757. This able but eccentric naturalist destroyed the utility of his own writings by refusing to adopt the bi-nomial nomenclature of Linnæus, and employing instead the most barbarous chance-combinations of letters he could invent.

§ Appendix to Captain Tuckey's Narrative (1818), by Dr. Leach.

West African Shells.

Onychoteuthis, 3 sp.
Cranchia, 2 sp.
Strombus rosaceus.
Triton ficoides.
Ranella quercina.
Dolium tessellatum.
Harpa rosea.
Oliva hiatula.
Pusionella.
Nassa Pfeifferi.
Desmoulinsia.
Purpura nodosa.
Rapana bezoar.
Murex vitulinus.
„ angularis.
„ megaceros.
„ rosarius.
„ duplex.
„ cornutus.
Clavella? filosa.
„ afra.
Lagena nassa.
Terebra striatula.
„ ferruginea.
? Halia priamus.
Mitra nigra.
Cymba.

Marginella.
Persicula.
Pleurotoma mitriformis.
Tomella lineata.
Clavatula mitra.
„ coronata.
„ bimarginata.
„ virginea.
Conus papilionaceus.
„ genuinus.
„ testudinarius.
„ achatinus.
„ monachus.
Natica fulminea.
Cypræa stercoraria.
„ picta.
Vermetus lumbricalis.
Cerithium Adansonii.
Turritella torulosa.
Mesalia.
Littorina punctata.
Collonia.
Clanculus villanus.
Haliotis virginea.
„ coccinea.
Nerita Senegalensis.
„ Ascensionis.

Pecten [illegible]bbus.
Arca v[illegible]r cosa.
„ senilis.
Cardium ringens.
„ costatum.
Lucina columbella.
Ungulina rubra.
Diplodonta rosea.
Cardita ajar.
Artemis africana.
„ torrida.
Cyclina Adansonii.
Trigona bicolor.
„ tripla.
Cytherea tumens.
„ africana.
Venus plicata.
Tellina.
Strigilla Senegalensis.
Gastrana polygona.
Mactra depressa.
„ rugosa.
„ nitida.
Pholas clausa.
Tugonia anatina.

—

Discina radiosa.

VII. South African Province.

The fauna of South Africa, beyond the tropic, possesses few characters in common with that of the western coast, and is more like the Indian Ocean fauna, as might be expected from the direction of the currents. But, together with these it has a large assemblage of marine animals found nowhere else, and the "Cape of Storms" forms a barrier between the populations of the two great oceans, scarcely less complete than the far-projecting promontory of South America. The coast is generally rocky, and there are no coral-reefs; accumulations of sand are frequent, and sometimes very extensive, like the Agulhas Bank. The few deep-sea shells which have been obtained off these banks possess considerable interest, but explorations in boats are said to be difficult, and often impossible on account of the surf. Shells from the Cape are too frequently dead and water-worn specimens picked up on the beach. The shell-fish of South Africa have been collected and described by Owen Stanley, Hinds, A. Adams, and especially by Dr. Krauss, who has published a very complete monograph.* Of 400 sea-shells recorded in this work, above 200 are peculiar, and most of these belong to a few littoral genera. Only 11 species are common to the coast of Senegal, whilst 18 are found in the Red Sea; 15 species are said to be found in Europe; all the others, not peculiar, exist on the E. coast of Africa.

South African Shells.

Panopæa natalensis.
Solen marginatus.
Mactra spengleri.
Gastrana ventricosa.
Nucula pulchra, Hinds.
(L'Agulhas bank, 70 fm.)
Pectunculus Belcheri, 120 fm.
Modiola Capensis.
„ pelagica, Forbes.
Septifer Kraussi.

—

Terebratulina abyssicola, 132 fm.
Terebratella (Kraussia).
„ rubra.
„ cognata.
„ pisum.
„ Deshayesii, 120 fm.

—

Chiton, 16 sp.
Patella, 20 sp.
„ cochlea.
„ compressa.
Patella apicina.
„ longicosta.
„ pectinata, &c.
Siphonaria, 5 sp.
Pupillia (aperta).
Fissurella, 10 sp.
Crepidula, 4 sp.
Haliotis sanguinea.
Delphinula granulosa.
„ cancellata.
Trochus, 22 sp.
Turbo sarmaticus.
Littorina Africana 7 sp.
Phasianella, 6 sp.
Bankivia varians.
Turritella, 4 sp.
Pleurotoma, 6 sp.
Clionello (sinuata).
Typhis arcuatus.
Triton dolarius.
„ fictilis, 50-60 fm.
Harpa crassa.
Cominella ligata.
„ lagenaria.
„ limbosa.
Cominella tigrina.
Bullia lævissima.
„ achatina.
„ natalensis.
Nassa plicosa.
„ capensis.
Cyclonassa Kraussi.
Eburna papillaris.
Columbella, 5 sp.
Ancillaria obtusa.
Mitra, 5 sp.
Imbricaria carbonacea.
Voluta armata.
„ scapha.
„ abyssicola, 132 fm.
Marginella rosea.
Trivia ovulata.
Cypræa, 22 sp.
Luponia algoënsis.
Cyprovulum (capense).
Conus, 8 sp.

—

Octopus argus.
Sepia, 4 sp.

The following are stated to be common to the Cape and European seas.†

Saxicava (arctica?) Greenland, Medit.
Tellina fabula, Brit. Medit.
Lucina lactea, Medit. Red Sea.
„ fragilis, Medit.
Venus verrucosa, W. Indies? Brit. Senegal, Canaries, Red Sea, Australia?
Tapes pullastra, North Sea.
„ geographica, Medit.
Arca lactea, Medit.
Chama gryphoides, Medit. Red Sea.
Pecten pusio, Brit.

—

Diphyllidia (lineata?) N. Brit. Medit.
Eulima nitida, Medit.
Purpura lapillus?? (not in Medit.)
Nassa marginulata.
Octopus vulgaris? Brit.
Argonauta argo, Medit.

VIII. Indo-Pacific Province.

This is by far the most extensive area over which similar shell-fish and other marine animals are distributed. It extends from Australia to Japan, and from the Red Sea and east coast

* Die Südafrikanischen Mollusken, 4to. Stutt. 1848.

† Marks of doubt are added to some of the species, and others are omitted.

of Africa to Easter Island in the Pacific, embracing three-fifths of the circumference of the globe and 45° of latitude. This great region might, indeed, be subdivided into a number of smaller provinces, each having a particular association of species and some peculiar shells, such as the Red Sea, the Persian Gulf, Madagascar, &c.; but a considerable number of species are found throughout the province, and their general character is the same.* Mr. Cuming obtained more than 100 species of shells from the eastern coast of Africa, identical with those collected by himself at the Philippines, and in the eastern coral islands of the Pacific.† This is pre-eminently the region of coral reefs, and of such shell-fish as affect their shelter. The number of species inhabiting it must amount to several thousands. The Philippine Islands have afforded the greatest variety, but their apparent superiority is due, in a measure, to the researches of Mr. Cuming; no other portion of the province has been so thoroughly explored.‡

Amongst the genera most characteristic of the Indo-Pacific, those marked (*) are wholly wanting on the coasts of the Atlantic, but half of them occur fossil in the older tertiaries of Europe. Those *in italics* are also found on the west coast of America.

*Nautilus.	*Magilus.	Stomatella.	Hemicardium.
*Pteroceras.	*Melo.	Gena.	*Cypricardia.
*Rimella.	*Mitra.*	*Broderipia.	*Cardilia.
*Rostellaria.	*Cylindra.	*Rimula.	**Verticordia.*
*Seraphs.	*Imbricaria.	*Neritopsis.	*Pythina.
Conus.	Ovulum.	*Scutellina.	Circe.
Pleurotoma.	**Pyrula* (type).	*Linteria.	*Clementia.
*Cithara.	*Monoptygma.	*Dolabella.	*Glaucomya.
**Clavella.*	Phorus.	*Hemipecten.	*Meröe.
*Turbinella (typ.)	Siliquaria.	*Placuna.	Anatinella.
Cyllene.	*Quoyia.	*Malleus.	Cultellus.
Eburna.	*Tectaria.	*Vulsella.	*Anatina.
Phos.	*Imperator.*	*Pedum.	*Chæna.
Dolium.	Monodonta.	**Septifer.*	*Aspergillum.
Harpa.	Delphinula.	*Cucullæa.	*Jouannetia.
*Ancillaria.	*Liotia.*	*Hippopus.	**Lingula.*
*Ricinula.	*Stomatia.	*Tridacna.	*Discina.*

The strictly littoral species vary on each great line of coast: for example, *Littorina intermedia* and *Tectaria pagodus* occur on

* See Mrs. Somerville's Physical Geography, ii. p. 233.

† Journal Geol. Soc. 1846, vol. ii. p. 268.

‡ Mr. Cuming collected 2,500 species of sea-shells at the Philippines, and estimates the total number at 1,000 more. The genera most developed are *Conus*, 120 sp.; *Pleurotoma*, 100; *Mitra*, 250; *Columbella*, 40; *Cypræa*, 50; *Natica*, 50; *Chiton*, 30; *Tellina*, 50.

the east coast of Africa; *Littorina conica* and *melanostoma*, in the Bay of Bengal; *Littorina sinensis* and *castanea*, and *Haliotis venusta*, on the coast of China; *Littorina scabra* and *H. squamata*, in N. Australia; *H. asinina*, New Guinea; and *L. picta*, at the Sandwich Islands.

Red Sea (Erythræan).

Of the 408 mollusca of the Red Sea, collected by Ehrenberg and Hemprich, 74 are common to the Medit., from which it would seem that these seas have communicated since the first appearance of some existing shells. Of the species common to the two seas 40 are Atlantic shells which have migrated into the Red Sea by way of the Medit., probably during the newer pliocene period; the others are Indo-Pacific shells which extended their range to the Mediterranean at an earlier age.

The genera wanting in the Medit. but existing in the Red Sea, show most strikingly their diversity of character, and the affinity of the latter to the Indian fauna.

Pteroceras.	Ancillaria.	Siphonaria.	Limopsis.
Strombus, 8 sp.	Harpa.	Placuna.	Tridacna.
Rostellaria.	Ricinula.	Plicatula.	Crassatella.
Turbinella.	Magilus.	Pedum.	Trigona.
Terebra.	Pyramidella.	Malleus.	Sanguinolaria.
Eburna.	Parmophorus.	Vulsella.	Anatina.
Oliva.	Nerita.	Perna.	Aspergillum.

Other genera become abundant, such as *Conus*, of which there are 19 species in the Red Sea, *Cypræa* 16, *Mitra* 10, *Cerithium* 17, *Pinna* 10, *Chama* 5, *Circe* 10.

Persian Gulf.

The marine zoology of the Persian Gulf and adjoining coast has not been yet explored.* The following shells were picked up on the beach at Kurrachee by Major Baker, with many others evidently new, but not in a satisfactory state for description. (1850.)

Rostellaria curta.	Purpura persica.	Sigaretus sp.
Murex tenuispina var.	„ carinifera.	Odostomia sp.
Pisania spiralis.	Columbella blanda.	Phorus corrugatus.
Ranella tuberculata.	Oliva subulata.	Planaxis sulcata.
„ spinosa.	„ Indusica.	Imperator Sauliæ.
„ crumena.	„ ancillaroides.	Monodonta sp.
Triton lampas.	Cypræa Lamarckii.	Haliotis sp.
Bullia sp.	„ ocellata.	Stomatella imbricata.
Eburna spirata.	Natica pellis-tigrina.	„ sulcifera.

* The "Brindled Cowry" (*Cypræa princeps*), from the Persian Gulf, was valued at £50.

Fissurolla Ruppellii.
„ Indusica.
„ salebrosa.
„ dactylosa.
„ funiculata.
Pileopsis tricarinatus.
Nerita ustulata.
Dentalium octangulatum.
Ringicula sp.
Bulla ampulla.
Anomia achæus.
„ enigmatica.
Pecten sp.
Spondylus sp.
Plicatula depressa.
Mytilus canaliculatus.
Arca obliquata.
„ sculptilis, &c.
Chama sp.
Lucina sp.
Cardium fimbriatum.
„ latum.
Cardium impolitum.
„ pallidum.
„ assimile.
Venns pinguis.
„ cor.
„ purpurata.
Meroë Solandri.
„ effossa.
Trigona trigonella ?
Artemis angulosa.
„ exasperata.
„ subrosea ?
Venerupis sp.
Petricola sp.
Tapes sulcosa.
„ Malabarica.
Cypricardia vellicata.
Cardita crassicostata ?
„ calyculata.
„ Tankervillii.
Mactra Ægyptica, &c.
Tellina angulata.
Tellina capsoides.
Mesodesma Horsfieldii.
Psammobia sp.
Syndosmya sp.
Semele sp.
Solen sp.
Solecurtus politus.
Donax scortum.
„ scalpellum.
Sanguinolaria diphos.
„ violacea.
„ sinuata.
Corbula sp.
Diplodonta sp.
Anatina rostrata.
Pandora sp.
Martesia sp.
Pholas australis.
„ Bakeri, Desh.
„ orientalis.
(Meleagrina v. p.416).

At the *Cargados* or St. Brandon shoals, north of Mauritius, *Voluta costata*, *Conus verrucosus*, *Pleurotoma virgo*, and *Turbinella Belcheri* have been obtained by dredging.

Collections of marine shells have been made at Madagascar and the Mascarene Islands by Sganzin, and at the Seychelles by Dufo. The number obtained at the latter place was 263, of which 220 were univalves. Two of the univalves, viz., *Dolium galea* and *Cypræa helvola*, and two of the bivalves, are found in the Mediterranean.

IX. Australo-Zelandic Province.

Most remote from the Celtic seas, this province is also most unlike them in its fauna, containing many genera wholly unknown in Europe, either living or fossil, and some which occur fossil in rocks of a remote period. The province includes New Zealand, Tasmania, and extra-tropical Australia, from Sandy Cape, on the east, to the Swan River. The shells, which are nearly all peculiar, have been catalogued by Gray,* Menke,† and Forbes.‡ Of the following genera some are peculiar (*), others attain here their greatest development:—

* Travels in New Zealand, by Dr. E. Dieffenbach. 8vo., London, 184[illegible].
† Moll. Nov. Hollandiæ, 1843.
‡ Narrative of the Voyage of H.M.S. *Rattlesnake*, 1846-50, by J. Macgillivray. applement by Professor E. Forbes.

*Pinnoctopus.	*Macgillivraia.	Cypricardia.	Imperator.
*Struthiolaria.	*Amphibola.	Mesodesma.	Monoptygma.
Phasianella.	*Trigonia.	Terebratella.	Siphonaria.
Elenchus.	*Chamostrea.	Spirula.	Pandora.
Bankivia.	*Myadora.	Oliva.	Anatinella.
Rotella.	*Myochama.	Conus.	Clavagella.
*Macroschisma.	Crassatella.	Voluta.	Placunomia.
Parmophorus.	Cardita.	Terebra.	Waldheimia.
Risella.	Circe.	Fasciolaria.	Crania.

Some of the genera of this province are only met with elsewhere at a considerable distance :—

Solenella—Chili.	Bankivia—Cape.	Rhynchonella—Arctic seas.
Panopæa—Japan.	Kraussia—Cape.	Trophon—Fuegia ; „
Monoceros—Patagonia.	Solemya—Medit.	Assiminea—India ; Brit.

Amongst the littoral shells of South Australia are *Haliotis elegans*, *H. rubicunda*, and *Littorina rugosa*. *Haliotis iris* and *Littorina squalida* are found on the shores of N. Zealand ; and *Cyprovula umbilicata* in Tasmania.

Mr. Gray's New Zealand list amounts to 104 marine species, among which are three volutes, including *V. magnifica*, the largest of its genus ; *Strombus troglodytes*, *Ranella argus*, the great *Triton variegatus ;* 6 Cones (all doubtful), *Oliva erythrostoma*, *Cypræa caput-serpentis*, *Ancillaria australis*, *Imperator heliotropium*, *Chiton monticularis*, &c.

Venus Stutchburyi and *Modiolarca trapezina* have been found at Kerguelen's Id. and *Patella illuminata* at the Auckland Ids.

X. Japonic Province.

The Japanese Islands and Corea represent the Japonic province. Our knowledge of its molluscan fauna is still scanty, notwithstanding the successful researches of Mr. Adams. Upwards of 130 species were collected in the harbour of Decima, by Dr. Nuhn, of which 113 were Prosobranchiates.

Octopus areolatus.	Purpura, 5 sp.	Haliotis Japonica.
Sepia chrysopthalma.	Fusus.	„ discus.
Sepiola Japonica.	Cancellaria nodulifera.	„ gigantea.
——	Mitra.	Bulla Coreanica.
Conus Sieboldi.	Strombus corrugatus.	Siphonaria Coreanica.
Pleurotoma Coreanica.	Cypræa fimbriata.	Pecten asperulatus.
Terebra serotina.	„ miliaris.	„ Japonicus.
„ stylata.	Mangelia, 4 sp.	Spondylus Cumingii.
Eburna Japonica.	Triforis, 5 sp.	Nucula mirabilis.
Cassis Japonica.	Natica, 5 sp.	„ Japonica.
Murex eurypterus.	Trochus, 15 sp.	Cardium Bechei.
„ rorifluus.	Radius birostris.	Crassatella compressa.
„ plorator.	Cerithium longicaudatum.	Diplodonta alata.
„ Burneti.	Imperator Guilfordiæ.	„ Coreanica.

Isocardia Moltkiana.
Venus Japonica.
Cyclina orientalis.
Cytherea petechialis.
Artemis sericea.
„ bilunata.
Artemis Sieboldi.
„ Japonica.
Circe Stutzeri.
Tapes Japonica.
Petricola radiata.
Solen albidus.
Panopæa Japonica.
Terebratulina Japonica.
„ angusta.
Waldheimia Grayi.
Terebratella Coreanica.
„ rubella.

XI. Aleutian Province.

The Boreal province is represented on the northern coasts of the Pacific, where, according to Dr. Middendorff, the same genera and many identical species are found. In addition to those indicated in the Arctic list (p. 57), the following species occur at the Shantar Ids. in the Sea of Ochotsk (O), Saghalien, the Kuriles (K), Aleutians and Sitka (S).

Patella (scurra). S.
Acmæa, 3 sp. S.
Pilidium commodum. O.
Paludinella. 3 sp. O.
Littorina, 6 sp. O. K. S.
Turritella Eschrichtii. O.
Margarita sulcata. A.
Trochus, 6 sp. S.
Scalaria Ochotensis.
Crepidula Sitchana.
„ minuta. S.
„ grandis. A.
Fissurella violacea. S.
„ aspera. S.
Haliotis Kamtschatica.
„ aquatilis. K.
Velutina coriacea. K.
„ cryptospira. O.
Trichotropis inermis. S.
Purpura decemcostata. (Mid.) S.
„ Freycineti. O. S.
„ septentrionalis. S.
Pleurotoma Schantarica.
„ simplex. O.
Murex monodon. S.
„ lactuca. S.
Fusus (Chrysodomus) Sitchensis.
„ decemcostatus. A.
„ Schantaricus.
Fusus Behringii.
„ Baerii. A.
„ luridus. S.
Buccinum undatum var. Schantaricum.
„ simplex. O.
„ Ochotense.
„ cancellatum. A.
„ ovoides. O.
Pisania scabra. A.
Bullia ampullacea. O.
Onychoteuthis Kamtschatica.

Terebratella frontalis. O.
Placunomia macroschisma. O.
Pecten rubidus. S.
Crenella vernicosa. O.
„ cultellus. Kamt.
Nucula castrensis. S.
Pectunculus septentrionalis. A.
Cardita borealis. O.
Cardium Nuttalli. S.
„ Californicum. S.
Saxidomus Petiti. S.
„ giganteus. S.
Petricola cylindracea. S.
„ gibba. S.
Tellina lutea. A. nasuta. S.
„ edentula. A.
Lutraria maxima. S.

The influence of the Asiatic coast-current is shown in the presence of two species of *Haliotis*, whilst affinity with the fauna of W. America is strongly indicated by the occurrence of *Patella* (*scurra*), three species of *Crepidula*, two of *Fissurella*, and species of *Bullia*, *Placunomia*, *Cardita*, *Saxidomus*, and *Petricola*, which are more abundant, and range farther north than their allies in the Atlantic.

Additional information on the fauna of this province has been recently supplied by Mr. Lord, the naturalist to the British North American Boundary Commission Expedition, and by Dr. Kennerley, the naturalist to the American North-west Boundary Exploring Expedition. The results obtained are discussed by Dr. P. P. Carpenter.*

Provinces on the Western Coast of America.

The mollusca of the Western coast of America are equally distinct from those of the Atlantic and those inhabiting the central parts of the Pacific.

Mr. Darwin states in his Journal (p. 391) that "not one single sea-shell is known to be common to the Islands of the Pacific and to the west coast of America," and he adds that "after the comparison by Messrs. Cuming and Hinds of about 2000 shells from the Eastern and Western coasts of America, only one single shell was found in common, namely the *Purpura patula*, which inhabits the West Indies, the coast of Panama, and the Gallapagos." Even this single identification has since been doubted. Mr. Cuming, who resided many years at Valparaiso, did not discover any West India specimens on that coast, and M. D'Orbigny makes the same observation. On the other hand M. Mörch, of Copenhagen, says he has received *Tellina operculata* and *Mactra alata* from the west coast and also from Brazil; and M. Deshayes gives the following extraordinary ranges in his "Catalogue of *Veneridæ* in the British Museum":—

Artemis angulosa, Philippines—Chili.
Cytherea umbonella, Red Sea—Brazil.
,, maculata, W. Indies—Philippines, Sandwich.
,, circinata, W. Indies—West coast America.

In these instances there is doubtless some mistake, either about the locality or the shell. As regards the last, Mr. Carrick Moore has shown that the error has arisen from confounding the *Cytherea alternata* of Broderip with *C. circinata* of Born. M. D'Orbigny collected 628 species on the coast of S. America, —180 from the eastern side, and 447 from the Pacific coast, besides the *Siphonaria Lessonii* which ranges from Valparaiso in Chili to Maldonado on the coast of Uruguay.† These shells belong to 110 genera, of which 55 are common to both coasts,

* British Association Report for 1863.

† The dispersion of this coast shell may perhaps have taken place at the time when the channel of the river S. Cruz formed a strait, joining the Atlantic and Pacific oceans, like that of Magellan. (Darwin, p. 181.) Mr. Couthouy makes 3 sp.—*Siphonaria Lessonii*, nearly smooth, Atlantic coast; *S. antarctica*, ribbed, Pacific coast; and *S. lateralis*, thin, oblique, Fuegia.

while 34 are peculiar to the Pacific, and 21 to the Atlantic side of S. America; an extraordinary amount of diversity, attributable partly to the different character of the two coasts—the eastern low, sandy or muddy; the western rocky, with deep water near the shore.*

The comparison of the shells of Eastern and Western America is of considerable interest to geologists; for if it is true that any number of living species are common to the Pacific and Atlantic shores, it becomes probable that some portion of the Isthmus of Darien has been submerged *since* the Eocene Tertiary period. Any opening in this barrier would allow the Equatorial current to pass through into the Pacific—there would be no more Gulf stream—and the climate of Britain might, from this cause alone, become like that of Newfoundland at the present day.

Although geological researches seem to show that not only the Isthmus of Darien, but even the Rocky Mountains, were sufficiently submerged during the Miocene Epoch to allow of the free intermingling of the waters of the Atlantic and Pacific, yet the special temperate molluscan fauna of E. and W. America are very dissimilar. There are no grounds for believing a single species to be identical. There are, however, a large number of species (upwards of 50) living on both sides of the *northern* portion of the continent, and the majority of these exist in the British seas.

XII. Californian Province.

The shells of Oregon and California have been collected and described by Mr. Hinds,† Mr. Nuttall,‡ Mr. Couthouy, naturalist of the American Exploring Expedition;§ Mr. Cooper, Dr. Gould, Mr. Binney,‖ Dr. Kennerley, Colonel Jewitt, and others.¶

Shells common to U. California and Sitka. (Middendorff.)

Littorina modesta.	Trochus ater.	Trochus euryomphalus.
„ aspera.	„ mœstus.	Petricola cylindracea.
Fissurella violacea.	„ Fokkesii.	Lutraria maxima.
„ aspera.		

* Voyage dans l'Amérique Méridionale. 1847, t. v. p. v.

† Voyage of H.M.S. *Sulphur;* Zoology by R. B. Hinds, 4to. 1844.

‡ Described by T. A. Conrad. Journ. Acad. N. S. Philadelphia, 1834.

§ Gould in Bost. Nat. Hist. Soc. Proceedings, 1846; and U. S. Exploring Exped. (Commander Wilkes), vol. xii, Mollusca, with Atlas. 4to. Philad. 1852.

‖ Explorations for a railroad route from the Mississippi to the Pacific Ocean. 1856.

¶ P. P. Carpenter on Mollusca of West Coast of North America. British Association Report for 1863.

Scarcely any species are common to this province (extending from Puget Sound to the peninsula) and the Bay of California, which belongs to the Panamic province. The most important genera are Chiton, 18 species; Acmæa, 11 species; Fissurella, 6 species; Haliotis, 6 species; Trochus, 15 species; Purpura, 9 species. The following list probably contains some shells which should be referred to the Panamic province.

Fusus Oregonensis.
Murex Nuttalli.
Monoceros unicarinatus.
„ punctatus.
Cancellaria urceolata.
Trivia Californica.
Natica herculea.
„ Lewisii.
Calyptræa fastigiata.
Crepidula exuviata.
„ navicelloides.
„ solida, &c.
Imperator Buschii.
Haliotis Cracherodii.
„ fulgens.
„ corrugata.
Fissurella crenulata.
„ cucullata.
Puncturella, 2 sp.
Dentalium politum.
Patella, 15 sp.
Acmæa scabra.
„ pintadina.
Chiton Mertensii.
Chiton scrobiculatus, &c.
Cleodora exacuta.

—

Waldheimia Californica.
Discina Evansii.

—

Anomia pernoides.
Placunomia cepa.
Hinnites giganteus.
Perna, 1. Pinna, 2.
Mytilus, 1. Pecten, 2.
Mytilimeria Nuttalli.
Modiola capax.
Chama lobata.
Cardita ventricosa.
Cardium, 4.
Lucina, 3.
Chironia Laperousii.
Solecardia eburnea.
Venus Californiensis.
„ callosa.
Artemis ponderosa.
Saxidomus Petiti.
„ Nuttalli.
Saxidomus giganteus.
Venerupis cordieri.
Petricola mirabilis.
Mactra, 2. Donax, 1.
Tellina Bodegensis.
„ secta, &c.
Semele decisa.
Cumingia Californica.
Sanguinolaria Nuttalli.
Lutraria Nuttalli.
Platyodon cancellatus.
Amphichæna Kindermanni.
Lyonsia, 1. Thracia, 1.
Pandora, 1. Saxicava, 2.
Cyathodonta undulata.
Sphenia Californica.
Periploma argentaria.
Solecurtus subteres.
Machaera lucida.
„ maxima.
Mya truncata.
Panopæa generosa.
Pholas Californica.
„ concamerata.

XIII. Panamic Province.

The Western coast of America, from the Gulf of California to Payta in Peru, forms one of the largest and most distinct provinces. The shells of Mazatlan and the Gulf have been imperfectly catalogued by Menke. The Mazatlan mollusks have been examined by Mr. P. P. Carpenter, who enumerates 654 species. The total number of marine shells known belonging to this province is 1,341. Amongst these are included 27 Chitonidæ, 13 Acmæidæ, 18 Fissurellidæ, 64 Trochoidæ, 28 Calyptræidæ, 69 Pyramidellidæ, 59 Buccinidæ, and 90 Muricidæ. The gulf of California, together with the adjacent coast as far as Mazatlan and St. Blas, has yielded 768 shells (502 univalves and 266 bivalves), of which 439 also occur in the Gulf of Panama, while 117 extend into S. America; 635 species are known from the Gulf of Panama; of these, 266 are peculiar to the district, and 163 also occur in S. America. The fauna of the Panama province is remarkably distinct from the other W. American provinces, and especially the Caribbæan. At one time it was thought that it did not possess a single species identical with any occurring in the West Indies or the east side of America. Dr. P. Carpenter, however, has shown that 35 marine shells (15 univalves and 20 bivalves) occur on both sides of the Isthmus of Darien, and this number has been lately increased.

A few of the species even extend as far as W. Africa according to Dr. Carpenter; he mentions 15, and among them the following:—*Crepidula unguiformis*, *C. aculeata*, *Hipponyx antiquatus*, *Bankivia varians*, *Natica maroccana*, *Marginella cœrulescens*, *Nitidella guttata*, *Purpura pansa*. Five species are common to Mazatlan and the British coasts, viz., *Kellia suborbicularis*, *Lasea rubra*, *Saxicava arctica*, *Cytherea Dione*, *Hydrobia ulvæ*. Still more remarkable is the absence of resemblance between the faunas of Panama and those of the Indo-Pacific area, there being only seven forms common to the two. Thus, *Cytherea petichialis* occurs in Japan; *Nassa acuta*, in Australia; and *Oliva Duclosii*, *Natica maroccana*, *Nitidella cribaria*, *Hipponyx barbatus*, *H. Grayanus*, are scattered over the Pacific ocean.

The river-openings of this coast are bordered by mangroves, amongst which are found *Potamides*, Arcas, Cyrenas, Potamomyas, Auriculas, and Purpuras, whilst *Littorinæ* climb the trees and are found upon their leaves. The ordinary tide at Panama amounts to 16 or 20 feet, the extreme to 28 feet, so that once a fortnight a lower zone of beach may be examined and other shells collected. The beach is of fine sand, with reefs of rocks in the bay.

Gallapagos Islands.—Out of 111 sea-shells collected here by Mr. Cuming, 43 are unknown elsewhere; 25 occur in Mazatlan, 22 in Central America, 38 in Panama, but only 11 in South America.

Littoral shells common to Panama and the Gallapagos (C. B. Adams.)

Cypræa rubescens.	Columbella nigricans.	Turbinella cerata.
Mitra tristis.	Ricinula reeviana.	Pleurotoma eccentrica.
Planaxis planicostatus.	Cassis coarctata.	Hipponyx radiata.
Purpura carolinensis.	Oniscia tuberculosa.	Fissurella macrotrema.
Columbella atramentaria.	Conus brunneus.	„ nigro-punctata.
„ bicanalifera.	„ nux.	Siphonaria gigas.
„ hæmastoma.	Strombus granulatus.	

Panama shells.

Strombus gracilior.
Murex erythrostomus.
,, regius.
,, imperialis.
,, radix.
,, brassica.
,, monoceros, &c.
Rapana muricata.
,, Kiosquiformis.
Myristica patula.
Ricinula clathrata.
Purpura, many sp.
Monoceros, many sp.
,, brevidentatus.
,, cingulatus.
Clavella ? distorta.
Oliva porphyria.
,, splendidula, &c.
Northia pristis.
Harpa crenata.
Malea ringens.
Mitra Inca, &c.
Terebra luctuosa, &c.
Conus regularis, &c.
Pleurotoma, many sp.
Cancellaria goniostoma.
,, cassidiformis.
,, chrysostoma.
Columbella, many sp.
Columbella strombiformis.
Marginella curta.
Cypræa nigro-punctata.
Trivia.
Pyrula ventricosa.
Natica glauca.
Pileopsis hungaricoides.
Crucibulum auriculatum, &c.
Trochita mamillaris.
Crepidula arcuata, &c.
Littorina pulchra.
Turritella Californica.
Truncatella, 2 sp.
Cœcum, 8 sp.
Imperator unguis, &c.
Trochus pellis serpentis.
Vitrinella, 12 sp.
Nerita ornata.
Patella maxima.

———

Discina strigata.
,, Cumingii.
Lingula semen.
,, albida.
,, audebardi.

———

Placunomia foliacea.
Ostrea æquatorialis.
Spondylus princeps.
Pecten magnificus.
Arca lithodomus, &c.
Pectunculus tessellatus, &c.
Nucula exigua.
Leda, 5 sp.
Cardium senticosum.
,, maculosum.
Cardita laticosta.
Gouldia Pacifica.
Cytherea, many sp.
Venus gnidia.
,, histrionica.
Artemis Dunkeri.
Trigona crassatelloides.
Cyclina subquadrata.
Venerupis foliacea,
Petricola Californica, &c.
Tellina Burneti.
Cumingia coarctata.
Semele, 7 sp.
Saxicava purpurascens.
Gastrochæna.
Solecurtus lucidus.
Lyonsia brevifrons.
Pandora arcuata, &c.
Pholas melanura, &c.
Parapholas.
Jouannetia pectinata.

XIV. Peruvian Province.

The coast of Peru and Chili, from Callao to Valparaiso, affords a large and characteristic assemblage of shells, of which only a small part have been catalogued, although the district has been well explored, especially by D'Orbigny, Cuming, and Philippi. M. D'Orbigny collected 160 species, one-half of which are common to Peru and Chili, whilst only one species (*Siphonaria Lessonii*) found at Callao was also met with at Payta, a little beyond the boundary of the region. Mr. Cuming obtained 222 species on the coast of Peru, and 172 in Chili. Hupè has described 201 species in Gay's work on Chili. The island of Juan Fernandez is included within this province. Only a few of the Peruvian mollusks can be here enumerated.

Onychoteuthis peraptoptera.

———

Æolis Inca.
Doris Peruviana.
Diphyllidia Cuvieri.
Posterobranchæa.
Aplysia Inca.
Tornatella venusta.
Chiton, many sp.
Patella scurra.
Acmæa scutum.
Crucibulum lignarium.

Trochita radians.
Crepidula dilatata.
Fissurella, many sp.
Liotia Cobijensis.
Gadinia Peruviana.
Littorina Peruviana.
„ araucana.
Rissoina Inca.
Cancellaria buccinoides.
Sigaretus cymba.
Fusus Fontainei.
Murex horridus.
Ranella ventricosa.
Triton scaber.
Nassa dentifera.
Columbella sordida.

Oliva Peruviana.
Rapana labiosa.
Monoceros giganteus.
„ crassilabris.
„ acuminatus.
Purpura chocolata.
Concholepas.
Mitra maura.

———

Terebratella Fontainei.
„ Chilensis.
Discina lamellosa.
„ lævis.

———

Pholas subtruncata, &c.
Lyonsia cuneata.

Solen gladiolus.
Solecurtus Dombeyi.
Mactra Byronensis.
Mesodesma Chilensis.
Cumingia lamellosa.
Semele rosea, &c.
Petricola, many sp.
Saxidomus opacus, &c.
Cyclina Kroyeri.
Venus thaca.
Crassatella gibbosa.
Nucula, many sp.
Leda, many sp.
Solenella Norrisii.
Lithodomus Peruvianus.
Saxicava solida.

XV. Magellanic Province.

This region includes the coasts of Tierra del Fuego, the Falkland Islands (Malvinas), and the mainland of South America, from P. Melo, on the east coast, to Concepcion, on the west. It is described by M. D'Orbigny and Mr. Darwin (Journal, p. 177 et seq.). Philippi also has given attention to it; he assigns 88 species to the district near the Straits of Magellan. Only 15 species are known from the Malvinas, and 11 of these have not been met with elsewhere. The southern and western coasts are amongst the wildest and stormiest in the world; glaciers in many places descend into the sea, and the passage round Cape Horn has often to be made amidst icebergs floating from the south polar continent. The greatest tides in the straits amount to 50 feet. "In T. del Fuego the giant sea-weed (*Macrocystis pyrifera*) grows on every rock from low-water mark to 45 fathoms, both on the outer coast and within the channels; it not only reaches up to the surface, but spreads over many fathoms and shelters multitudes of marine animals, including beautiful compound Ascidians, various patelliform shells, Trochi, naked mollusca, cuttle-fish, and attached bivalves. The rocks, at low water, also abound with shell-fish which are very different in their character from those of corresponding northern latitudes, and even when the genera are identical the species are of much larger size and more vigorous growth."*

Shells of the Magellanic Province (* Falkland Islands).

Buccinum antarcticum.
„ Donovani?
Bullia cochlidium.

Monoceros imbricatus.
„ glabratus.
„ calcar.

Trophon Magellanicus.
Voluta Magellanica.
„ ancilla.

* Shell-fish are here the chief support of the natives as well as of the wild animals. At Low's harbour a sea-otter was killed in the act of carrying to its hole a large Volute, and in T. del Fuego one was seen eating a cuttle-fish.—*Darwin.*

Natica limbata.
Lamellaria antarctica.
Littorina caliginosa.
Chemnitzia Americana.
*Scalaria brevis.
*Trochita pileolus.
Crepidula Patagonica.
Trochus Patagonicus.
*Margarita Malvinæ.
*Scissurella conica.
*Fissurella radiosa.
Puncturella conica.
Nacella cymbularia.
*Patella deaurata.
*Patella barbara.
* ,, zebrina.
Siphonaria lateralis.
Chiton setiger.
Doris luteola.
Æolis Patagonica.
*Spongiobranchæa.
Spiralis? cucullata, 66° S.

Terebratella crenulata.
* ,, Magellanica, many varieties.
Waldheimia dilatata.
Pecten Patagonicus.
Pecten corneus.
Mytilus Magellanicus.
*Modiolarca trapezina.
Leda sulculata.
*Cardita Thouarsii.
*Astarte longirostris.
*Venus exalbida.
*Cyamium antarcticum.
Mactra edulis.
*Lyonsia Malvinensis.
Pandora cistula.
Saxicava antarctica.
Octopus megalocyathus.

XVI. Patagonian Province.

From S. Catharina, south of the Tropic, to P. Melo. This coast-line has shifted considerably since the era of its present fauna. M. D'Orbigny and Mr. Darwin observed banks of recent shells, especially *Potamomya labiata*, in the valley of La Plata and the Pampas around Bahia Blanca. Mr. Cuming also met with *Voluta Brasiliana*, and other living shells, in banks 50 miles inland. Of 79 shells obtained by M. D'Orbigny on the coast of N. Patagonia, 51 were peculiar, 1 common to the Falkland Ids., and 27 to Maldonado and Brazil. At Maldonada 37 species were found, 8 being special, 10 common to N. Patagonia, 2 to Rio, and 17 to Brazil. Of the latter 8 range as far as the Antilles; viz.:

Crepidula aculeata.
,, protea.
Pholas costata.
Mactra fragilis.
Venus flexuosa.*
Lucina semi-reticulata.
Modiola viator.
Plicatula Barbadensis.

At Bahia Blanca, in lat. 39° S., the most abundant shells observed by Mr. Darwin (p. 243) were

Oliva auricularia.
,, puelchana.
Oliva tehuelchana.
Voluta Brasiliana.
Voluta angulata.
Terebra Patagonica.

M. D'Orbigny's list also includes the following genera and species:—

Octopus tehuelchus.
Columbella sertularium.
Bullia globulosa.
Pleurotoma Patagonica.
Fissurellidæa megatrema.
Panopæa abbreviata.
Periploma compressa.
Lyonsia Patagonica.
Solecurtus Platensis.
Æolis.
Paludestrina.
Scalaria.
Natica.
Chiton.
Solen.
Lutraria.
Donacilla.
Nucula.
Leda.
Cytherea.
Petricola.
Corbula.
Pinna.
Mytilus.
Lithodomus.
Pecten.
Ostrea.

* The variety of *Venus flexuosa* found at Rio can be distinguished from the West Indian shell, which is the *Venus punctifera* of Gray.

XVII. Caribbean Province.

The Gulf of Mexico, the West Indian Islands, and the eastern coast of South America, as far as Rio, form the fourth great tropical region of marine life. The number of shells is estimated by Prof. C. B. Adams at not less than 1500 species. Of these 500 are described by M. D'Orbigny in Ramon de la Sagra's History of Cuba, and a small number of the Brazilian species in the same author's Travels in South America. A list of the Barbadoes shells has been given by Sir R. Schomburgk.

The coasts of the Antilles, Bermuda, and Brazil, are fringed with coral reefs, and there are considerable banks of gulf-weed at some distance from the coast of the Antilles.

West India Shells.

Argonauta.	Ommastrephes.	Cleodora.	Cheletropis.
Octopus.	Sepioteuthis.	Creseis.	Ianthina.
Philonexis.	Sepia.	Cuvieria.	Glaucus.
Loligo.	Spirula.	Atlanta.	Notarchus Plei.
Cranchia.	Hyalea.	Oxygryus.	Aplysia.
Onychoteuthis.			

Strombus gigas.	Clavatula zebra.	Hipponyx mitrula.
,, pugilis.	Marginella.	Pileopsis militaris.
Murex calcitrapa.	Erato Maugeriæ.	Calyptræa equestris.
Pisania articulata.	Cypræa mus.	Crepidula aculeata.
,, turbinella.	,, exanthema.	Patella leucopleura.
Triton pilearis.	,, spurca, &c.	Chiton squamosus.
,, cutaceus.	Trivia pediculus.	Hydatina physis.
Fusus morio.	Ovulum gibbosum.	——
Fasciolaria tulipa.	Natica caurena.	Bouchardia tulipa.
Lagena ocellata.	Pyramidella dolabrata.	Discina antillarum.
Cancellaria reticulata.	Planaxis nucleus.	——
Fulgur aruanum.	Littorina zic-zac.	Placunomia foliata.
Terebra acicularis.	,, flava.	Plicatula cristata.
Myristica melongena.	,, lineolata.	Lima scabra.
Purpura patula.	Tectaria muricata.	Mytilus exustus.
,, deltoidea.	Modulus lenticularis.	Lithodomus dactylus.
Oniscia oniscus.	Fossarus.	Arca Americana.
Cassis tuberosa.	Truncatella caribbæa.	Yoldia tellinoides.
,, flammea.	Torinia cylindracea.	Chama arcinella.
,, Madagascariensis.	Turritella exoleta.	,, macrophylla.
Columbella mercatoria.	,, imbricata.	Cardium lævigatum.
,, nitida, &c.	Trochus pica.	Lucina tigrina.
Voluta vespertilio.	Imperator tuber.	,, Pennsylvanica.
,, musica.	,, calcar.	,, Jamaicensis.
Oliva brasiliensis.	Fissurella Listeri.	Corbis fimbriata.
,, angulata.	,, nodosa.	Coralliophaga.
,, jaspidea.	,, Barbadensis.	Crassatella.
,, oryza, &c.	Nerita.	Gouldia parva.
Ancillaria glabrata.	Neritina.	Venus paphia.
Conus varius, &c.	Hemitoma 8 radiata.	,, dysera.

Venus crenulata.	Artemis concentrica.	Strigilla carnaria.
„ cancellata.	„ lucinalis.	Semele reticulata.
„ violacea.	Cyclina saccata.	„ variegata.
Cytherea dione.	Trigona mactroides.	Cumingia.
„ circinata.	Petricola lapicida.	Iphigenia Brasiliensis.
„ maculata.	Capsula coccinea.	Lutraria lineata.
„ gigantea.	Tellina Braziliana.	Periploma inæquivalvis.
„ flexuosa.	„ bimaculata.	Pholadomya candida.

XVIII. Trans-Atlantic Province.

The Atlantic coast of the United States was supposed by Prof. E. Forbes to consist of two provinces: (1) the *Virginian*, from C. Cod to C. Hatteras, and (2) the *Carolinian*, extending to Florida; but no data were supplied for such a division. The total number of mollusca is only 230, and 60 of these range farther north, 15 being moreover common to Europe. These two regions are sometimes treated of together as the Pennsylvanian province.

Dr. Gould describes 110 shells from the coast of Massachusetts south of Cape Cod, of which 50 are not found to the northward, but form the commencement of the proper American type. The shells of New York and the southern Atlantic States are described by De Kay, in the State Natural History of New York; this list supplies 120 additional species, of which at least a few are stragglers from the Caribbean province; e.g. *Chama arcinella*, *Iphigenia lævigata*, *Capsula deflorata*.*

M. Massachusetts. Y. New York. SC. South Carolina. F. Florida.

Conus mus. F.	Cerithium ferrugineum. F.
Fusus cinereus. M. SC.	„ 4 sp. M.
Nassa obsoleta. M. F. (Mex.)	Triforis nigro-cinctus. M.
„ trivittata. M. SC.	Odostomia, 6 sp. M. Y.
„ vibex. M. F. (Mexico).	Turritella interrupta. M. Y.
Purpura Floridana. (Mex.)	„ concava. SC.
Terebra dislocata. Y. SC.	(Vermetus lumbricalis. M. ?)
Pyrula ? papyracea. F.	Calyptræa striata. Y.
Fulgur carica. M. SC.	Crepidula convexa. M. Y.
„ canaliculatum. M. SC.	„ fornicata. M. F. (Mex).
Oliva literata. SC.	Littorina irrorata. Y.
Marginella carnea. F.	Fissurella alternata. (Say) ?
Fasciolaria distans. SC. (Mex.)	Chiton apiculatus. M. SC.
Columbella avara. M. Y.	Tornatella puncto-striata. M. Y.
Ranella caudata. M. Y.	Bulla insculpta. M. Y.
Natica duplicata. Y. SC.	——
Sigaretus perspectivus. Q. SC.	Ostrea equestris. SC. F.
Scalaria lineata. M. SC.	Pecten irradians (*scallop*).
„ multistriata. M. Y.	Avicula Atlantica. F.
„ turbinata. NC.	Mytilus leucophantus. SC.

* The sea-shells of the United States have also been collected and described by Say, Le Sueur, Conrad, and Couthouy.

Modiola Carolinensis.
„ plicatula. M. Y.
Pinna muricata. SC.
Arca ponderosa. SC.
„ pexata. M.F.
„ incongrua. SC.
„ transversa. M. Y.
Solemya velum. M. Y.
„ borealis. M.
Cardium ventricosum. SC.
„ Mortoni. M. Y.
Lucina contracta. Y.
Astarte Mortoni. Y.
„ bilunulata. F.
Cardita incrassata. F.
Venus mercenaria. M. SC.
„ Mortoni. SC. F.
„ gemma. M. Y.
Artemis discus. SC.
Petricola dactylus. M. SC.
„ pholadiformis. Y.
Mactra similis. SC. M.
„ solidissima. M. Y.
„ lateralis. M. Y.
Lutraria lineata. F.
„ canaliculata. Y. F.
Mesodesma arctata. M. Y.
Tellina tenta. M. SC.
„ 8 sp. SC. F.
Semele æqualis. SC.
Cumingia tellinoides. M.
Donax fossar. Y.
„ variabilis. G. F.
Solecurtus fragilis. M. SC.
„ caribbæus. M. F.
Corbula contracta. M. F.
Periploma Leana. M. Y.
„ papyracea. M. Y.
Lyonsia hyalina. Y.
Pandora trilineata. M. F.
Pholas costata. SC. F.
„ semicostata. SC.

LAND REGIONS.

Distribution of Land and Fresh-water Shells.

The boundaries of the Natural-history land-regions are more distinctly marked, and have been more fully investigated, than their counterparts in the sea. Almost every large island has its own fauna and flora; almost every river system its peculiar fresh-water fish and shells; and mountain-chains like the Andes appear to present impassable barriers to the "nations" of animals and plants of either side. Exceptions, however, occur which show that beyond this first generalisation there exists a higher law. The British Channel is not a barrier between two provinces, nor is the Mediterranean; and the desert of Sahara separates only two portions of the same zoological region. In these and other similar instances the "barrier" is of later date than the surrounding fauna and flora.

It has been often remarked that the northern part of the map of the world presents the appearance of vastly-extended, continental plains, much of which is, geologically speaking, new land. In the southern hemisphere the continents taper off into promontories and peninsulas, or have long since broken up into islands. Connected with this is the remarkable fact that only around the shores of the Arctic Sea are the same animals and plants found through every meridian; and that in passing southward, along the three principal lines of land, specific identities give way to mere identity of genera; these are replaced by family resemblances, and at last even the families of animals and plants become in great measure distinct, not only on the great continents, but on the islands, till every little rock in the ocean has its peculiar inhabitants—the survivors, seemingly, of tribes which the sea has swallowed up. (Waterhouse.)

The two largest genera, or principal types of the land and fresh-water shells, *Helix* and *Unio*, have an almost universal range, but admit of many geographical subdivisions.* Amongst the land-snails are several species to which a nearly world-wide range has been assigned, sometimes erroneously, as when *Helix cicatricosa* is attributed to Senegal and China, or *Helix similaris* Fér. to Brazil and India; and often correctly, but only because they have been carried to distant localities by human agency. Land-snails are in favour with Portuguese sailors, as "live sea stock;" and they have naturalised the common garden-snail of Europe (*Helix aspersa*) in Algeria, the Azores, and Brazil; and *Helix lactea* at Teneriffe and Mte. Video. *Achatina fulica* has been taken from Africa to the Mauritius, and thence to Calcutta, where it has been established by a living naturalist; and *Helix hortensis* has been carried from the old country to America, and naturalised on the coast of New England and the banks of the St. Lawrence. *Bulimus Goodalli*, indigenous to the West Indies and S. America, has been introduced into English pineries and to Mauritius. *Helix pulchella*, one of the small species found in moss and decayed leaves, inhabits Europe, the Caucasus, Madeira, the Cape (introduced), and N. America as far as the Missouri. *Helix cellaria* inhabits Europe and the Northern States of America, and has been carried abroad with the roots of plants, or attached to water-casks, and naturalised at the Cape and New Zealand. *Testacella maugei* has been transported from the Canary Islands to England.

The fresh-water *Pulmonifera*—*Limnæa*, *Physa*, *Planorbis*, *Ancylus*—and the amphibious *Succinea*, have a nearly world-wide range; and like aquatic plants and insects, often re-appear, even at the antipodes, under familiar forms. The range of the gill-breathing fresh-water shells is more restricted.

The Old World and America may be regarded as provinces of paramount importance, having no species in common (except a

* In cataloguing *Unionidæ*, the river and country of each species should be stated. American authors are too often contented with recording such localities as "Nashville" and "Smithville," which are quite unintelligible. Almost as uncertain in their meaning are S. Vincent, S. Cruz, S. Thomas, Prince's Id.; whilst the latinised names of places often defy all attempts at re-translation.

few in the extreme north), and each possessing many characteristic genera.

America.	*Old World.*	*America.*	*Old World.*
Anastoma.	Zonites.	Choanopoma.	Pomatias.
Tridopsis.	Nanina.	Chondropoma.	Otopoma.
Sagda.	Vitrina.	Cistula.	Craspedopoma.
Stenopus.	Helicolimax.	Trochatella.	Diplommatina.
Proserpina.	Daudebardia.	Alcadia.	Aulopoma.
Bulimus.	Achatina.	Stoastoma.	Pupina.
Odontostomus.	Achatinella.	Geomelania.	Acicula.
Liguus.	Clausilia.	—	—
Glandina.	Paxillus.	Hemisinus.	Vibex.
Cylindrella.	Pupa.	Melafusus.	Pirena.
Megaspira.	—	Ceriphasia.	Melanopsis.
Simpulopsis.	Testacella.	Anculotus.	Paludomus.
Amphibulima.	Parmacella.	Melatoma.	Lithoglyphus.
Omalonyx.	Limax.	Amnicola.	Navicella.
—	Arion.	—	—
Philomycus.	Phosphorax.	Mülleria.	Ætheria.
Peltella.	Incilaria.	Mycetopus.	Iridina.
—	Oncidium.	Castalia.	Galatea.
Chilinia.	—	Monocondylæa.	Cyrenoïdes.
Gundlachia.	Latia.	Gnathodon.	Glaucomya.

The Land Provinces represented on the map are the principal Botanical Regions of Prof. Schouw, as given in the Physical Atlas of Berghaus; and it is proposed to inquire how far these divisions are confirmed by the land and fresh-water shells, more especially by the land-snails (*Helicidæ*, *Limacidæ*, and *Cyclostomidæ*), which have been so elaborately catalogued by Dr. L. Pfeiffer.*

The first Botanical region—that of Saxifrages and Mosses—has not been numbered on the map, although its boundary is given by the line of northern limit of trees. This line nearly coincides with the Isotherm of 32°, or permanent ground-frost; but in Siberia the pine-forests extend 15° farther, owing to the absence of winter rains and the bright clear air.

In this region shells are very rare; Dr. Middendorff found *Physa hypnorum* in Arctic Siberia, and *Limnœa geisericola* (Beck) inhabits the warm springs of Iceland. The few species discovered by Müller in Greenland are supposed to be peculiar:—

Helix Fabricii.	Succinea Grœnlandica.	Limnæa Holböllii.
Pupa Hoppii.	Limnæa Vahlii.	Planorbis arcticus.
Vitrina angelicæ.	„ Pingelii.	Cyclas Steenbuchii.

* The distribution of the *Cycladidæ* is taken from the British Museum Catalogue, by M. Deshayes.

1. Germanic Region.

The whole of Northern Europe and Asia bounded by the Pyrenees, Alps, Carpathians, Caucasus, and Altai, constitutes but one province, with a fauna by no means proportioned in richness to its extent.*

The land-snails amount to more than 200, but nearly all (or at least five-sixths) are common to the Lusitanian region.†

Helix	90	Pupa	44	Cyclostoma	1
Bulimulus	10	Clausilia	52	Acicula	1
Zua, Azeca, Cionella	5	Vitrina	5	Limax	9
		Succinea	5	Arion	4
		Balea	1	Carychium	1

The fresh-water shells belong to these genera and sub genera:—

Limnæa	20	Velletia	1	Unio, sp. and vars.	20
Amphipeplea	2	Neritina, vars.	3	Anodon, vars.	20
Physa	5	Paludina and Bithynia	23	Alasmodon	3
Aplexa	1	Valvata	5	Cyclas	6
Planorbis	16	Conovulus (Alexia)	3	Pisidium	11
Ancylus	7	Driessena	1		

According to Reeve, there are 199 British molluscs, of which 176 dwell on the land and 23 in the water. Of the species formerly thought peculiar, *Pupa anglica* and *Helix fusca* have been found in France, and *Helix lamellata* in Holstein. *Helix excavata* (Bean) is still unknown upon the Continent; and *Geomalacus maculosus* and *Limnæa involuta* have only been met with in the south-west of Ireland, but are possibly Lusitanian species. *Dreisena polymorpha* has been permanently naturalised in canals (p. 424), and *Testacella Maugei* and *haliotidea* in gardens; *Bulimus decollatus* and *Goodalli* have been often established in greenhouses. Some species are now very scarce in England that were formerly abundant, as:—

Clausilia plicatula.	Vertigo Venetzii.	Succinea oblonga.
Vertigo minutissima.	Helix lamellata	Acicula fusca.

Others, which occur in the newer tertiary deposits, have become quite extinct in England, such as:—

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* The mean temperature of the winter and summer months averages 36°—57°; in Western Europe autumn rains prevail, and summer rains in Eastern Europe and Siberia.

† It was the opinion of Professor E. Forbes that *all* the species of the Post-pliocene land of Northern Europe and Asia had *originated* beyond the bounds of that region.

Helix fruticum,	living in	France and Sweden.
„ ruderata		Germany.
„ labyrinthica (Eocene)		New England.
Paludina marginata		France.
Corbicula consobrina		Egypt and India.
Unio littoralis		France and Spain.

On the other hand, some of the commonest living species have not been found fossil; e.g. *Helix aspersa*, *pomatia*, and *cantiana*. Several genera only occur fossil in the older tertiaries, viz. :—

Glandina.	Cyclotus.	Nematura.
Proserpina.	Megalomastoma.	Melania.
Cylindrella.	Craspedopoma.	Melanopsis.

The following estimates have been made of the number of air-breathing molluscs inhabiting the various countries of Europe :—

France,	202	(176 land,	26 fresh-water),	*Moquin Tandon.*
Dalmatia,	202	(197 „	5 „),	*Bellotti.*
Denmark,	95	(72 „	23 „),	*Mörch.*
Norway,	52	(36 „	16 „),	*Martens* and *Friele.*
Finland,	41	(23 „	26 „),	*Nylander* and *Nordenskjöld.*
Lapland,	16	(10 „	6 „),	*Wallenberg.*

This table seems to show that the Pulmonifera are most numerous in the warmest parts of Europe, and that their numbers decline, as far as species are concerned, as we approach the Polar regions. Thus, in the Mediterranean area there are 800 species, in Germany 200, in Norway 50, in Lapland 16. Hitherto, only 23 species have been obtained from European countries north of the Arctic circle. The most northerly species are *Limnœa palustris*, *Physa fontinalis*, *Physa hypnorum*, and *Succinea putris*.

Dr. Middendorff gives the following list of Siberian shells in his *Sibirische Reise* (Band II. th. 1. Petersb. 1851) :—

Helix carthusiana, Irkutsk.
„ Schrenkii, M. Tunguska, 58°.
„ hispida, Beresov. Bernaul.
„ ruderata, Stanowoj Mtn.
„ pura, „
„ sub-personata, „ ; Ochotsk.
Pupa muscorum, Bernaul.
Zua lubrica, „
Succinea putris, „ ; Irkutsk.
Limnæa Gebleri, M. Bernaul.
„ auricularia, Nertschinsk.
„ ovata, Bernaul.
„ Kamtschatica, Mid.
„ peregra, Bernaul, Beresov.
Limnæa stagnalis, Bernaul, Irkutsk.
„ palustris, „ „
„ truncatula, „ Tomsk.
„ leucostoma, Irkutsk.
Physa hypnorum, Bernaul; Taimyrlande
Planorbis corneus, Bernaul; Beresov; Kirgisensteppe, Altai.
Planorbis complanatus, Altai.
„ albus, Bernaul, „
„ contortus, „
„ vortex, „
„ leucostoma, „
„ nitidus, Irkutsk.
Bithynia tentaculata, Bernaul.

Bithynia Kickxii, R. Ami, Altai.
Valvata cristata, var. Sibirica, Bernaul, Beresov; Kamtschatka.
" piscinalis, R. Ami.
Unio complanatus Kamtschatka.
" Dahusicus, Mid. Schilka.
" Mongolicus, M. Gorbitza, Dauria.
Anodon herculeus, M. Scharanai.
Anodon anatinus, Tunguska.
" cellensis var. Beringiana, Kamtschatka.
Cyclas calyculata, Bernaul, R. Lena, R. Ami, S. Kamts.
Pisidium fontinale, Beresov.
" obliquum, Bernaul, Tomsk.

2. Lusitanian Region.

The countries bordering the Mediterranean, with Switzerland, Austria, and Hungary, the Crimea (*Taurida*), and Caucasus, form a great province (or rather cluster of provinces) to which Professor E. Forbes applied the term *Lusitanian*. The Canaries, Azores, and Madeira are outlying fragments of the same region.*

In Southern Europe about 600 land-snails are found, of which above 100 are also spread over the Germanic region and Siberia; and 20 or 30 are common to Northern Africa. Besides these 60 others are found in Algeria and Egypt, 100 in Asia Minor and Syria, and 135 in the Atlantic Islands, making a total of nearly 900 species of *Helicidæ*.†

Of the 12 species of *Zonites* (proper) 10 are peculiar to Lusitania.

The species of *Bulimus*, *Achatina*, and *Pupa* are small and minute, belonging to the sub-genera *Bulimulus*, *Cionella*, *Zua*, *Azeca*, *Vertigo*, &c.; 4 (of which 2 are Algerian) have been referred to *Glandina*.

In this region are also found 22 species of *Cyclostomidæ* and 44 *Limacidæ*:—

Helix	392	Vitrina	11	Cryptella	1
Bulimus	80	Daudebardia	3	Cyclostoma	5
Succinea	8	Helicolimax	3	Craspedopoma	3
Achatina	25	Limax	28	Pomatias	10
Tornatellina	3	Arion	7	Acicula	4
Balea	4	Phosphorax	1	——	
Pupa	120	Testacella	2	Carychium	3
Clausilia ‡	247	Parmacella	5		

The fresh-water are shells of the same genera as in the Germanic province, and the numbers about the same; with the addition of several species of *Melania*, *Melanopsis*, *Lithoglyphus*, and *Cyrena*. *Melanopsis buccinoides* is found in Spain, Algeria, and

* In the South of Europe rain seldom falls in summer, but is frequent at other seasons, especially in winter. The mean temperature is 54°—72°.

† The writer is greatly indebted to W. H. Benson, Esq., for information respecting the land-shells of the Lusitanian province, Africa, and the remote islands.

‡ Many of these cannot be considered *species*, in the sense here understood, but only as *races*, or geographical varieties.

Syria, having become extinct in the intervening countries. Two species of *Lithoglyphus* inhabit the Danube; *Cyrena* (*Corbicula*) *Panormitana* is found in Sicily, two others in the Euphrates, and *C. consobrina* in the Alexandrian Canal.

The Lusitanian province includes numerous minor regions, the islands and mountain tracts especially being centres or *foci* where a number of peculiar species are associated with those living around. Thus, of species not as yet recorded from other localities, Switzerland has 28, the Austrian Alps 46, Carpathians 28, North Italy and Dalmatia 100, Roumelia 20, Greece and its Archipelago 90, Anatolia 50, Caucasia 20, Syria 30, Lower Egypt and Algeria 60, Spain 26, and Portugal 15 *Helicidæ* and 9 *Limacidæ*.

Mediterranean Islands.

Corfu, Cyprus, Rhodes, Syra, Candia, and Crete, have each a few peculiar land-snails, amounting to 40 species altogether.

Balearic Isles.—Helix Graellsiana, hispanica (var. balerica), nyellii, minoricensis; and Cyclostoma ferrugineum, common to Spain and Algeria.

Corsica.—Helix Raspaili, tristis, Clausilia 4 sp.

Sardinia.—Helix Sardiensis, meda, tenui-costata, Pupa 2, Clausilia 1.

Malta has 2 peculiar species of Helix, and a Clausilia (*scalaris*).

Sicily has 40 peculiar species of Helices and 3 Limaces. This island is connected with North Africa by a winding shoal with deep water on each side.

Madeira Group.

These ancient volcanic islands, 660 miles south-west of Portugal, consist of Madeira, with Fora and three other islets called Dezértas, and Porto Santo, 26 miles to the north-east, with the rocky islets Ferro, Baxo, and Cima.* The land-snails have been described by the Rev. R. T. Lowe,† and form the subject of a monograph by Dr. Albers.‡ The investigations of Mr. Vernon Wollaston have nearly doubled the number of known species, which now amount to 134. The *Vitrinæ* belong

* These islands, and also the Canaries and Azores, contain marine formations (volcanic grits and tufas) with Miocene Tertiary shells. The islet of Baxo is quarried for lime.

† Primitiæ et novitiæ Faunæ et Floræ Maderæ et Portus Sancti. 12mo. Lond., 1851. Descriptive list of all the species, by same author, Zool. Proc. for 1854, p. 161. The statements and numbers given above are taken from this last monograph, corrected by Mr. Wollaston.

‡ Malacographia Maderensis, 4to. Berlin, 1854, with figures of all the species.

to the section *Helico-limax*, the Cyclostomas to the sub-genus *Craspedopoma*, and half the Pupas to *Vertigo*.

Arion	1	Bulimus	2	Cionella	3	Limnæa	1
Limax	4	Glandina	4	Pupa	23	Ancylus	1
Testacella	2	Azeca	3	Balea	1	Conovulus	3
Vitrina	3	Tornatellina	1	Clausilia	3	Pedipes (afra.)	1
Helix	76	Zua	2	Cyclostoma	2		

Of the 92 found in Madeira or the Dezertas, 70 are peculiar; 54, of which 39 are peculiar, inhabit Porto Santo and its islets; 11 others, of which 4 are widely diffused, are common to Madeira and Porto Santo. One species is peculiar to the Dezerta Grande; 1 species and 1 variety to the southern Dezerta (Bugio); 1 to the northern (Cho); 1 variety to Ferro. Seven species are common to the Dezertas; 1 to the great and northern Dezertas; 5 to Madeira and Dezerta Grande; and 3 to Madeira, Porto Santo, and the Dezertas. Of those species which inhabit more than one island, the specimens from each locality are recognisable as distinct *races* or geographichal varieties. *Helix subplicata* and *papilio* are found on the Ilheo Baxo; *H. turricula* on Cima. Of the total number (134) 112 species are peculiar to the Madeira group; 5 are common to the Canaries; 4 to the Azores, and one to the Guinea coast; 11 are common to Southern Europe, besides 2 *Limnæids* and 7 slugs, which may have been recently introduced, viz. :—

Arion empiricorum.	Helix cellaria.	Zua lubrica, var.
Limax variegatus.	,, crystallina.	,, folliculus.
,, antiquorum.	,, pisana.	Bulimus decollatus.
,, agrestis.	,, pulchella.	,, ventrosus, Fer.
,, gagates.	,, lenticula.	Balea perversa (p. 293).
Testacella Maugei.	(,, lapicida, *fossil*).	Limnæa truncatula.
,, haliotidea.	Cionella acicula.	Ancylus fluviatilis.

Great quantities of *dead shells* of the land-snails are found in ancient sand-dunes near Caniçal, at the eastern extremity of Madeira, and in Porto Santo, including 64 of the living species and 13 which have not been found alive. As the fossil examples of several species are larger than their living descendants, it is possible that some of those reputed to be extinct have only degenerated. It is a remarkable fact that some of the commonest living species are not found fossil, whilst others, now extremely scarce, occur abundantly as fossils.*

* *Helix tiarella*, W. and B., was supposed to be extinct, but in 1855 Mr. Wollaston detected it alive in two almost inaccessible spots on the north coast of Madeira: it is not a native of the Canaries.

Extinct Land-snails of Madeira.

Helix delphinula, Lowe. M.
,, arcinella, Lowe. P.
,, coronula, Lowe. S. Deserta.
vermetiformis, Lowe. P.
Lowei, Fer. (porto-sanctana, var.?). P.
fluctuosa, Lowe (= chrysomela, Lowe). P.
,, psammophora, Lowe (phlebophora var.?). P.
,, Bowdichiana, Fer. (punctulata, major?), M. P.
Glandina cylichna, Lowe. P. Santo.
Cionella eulima, Lowe. P.
Pupa linearis, Lowe. M. (= minutissima, Hartm?).
,, abbreviata, Lowe. M.

The problem of the colonisation of these islands receives additional light from the circumstances noticed at other oceanic islands, especially the Canaries and St. Helena. There is evidence that this mountain group has not arisen newly from the sea, and great probability that it has become insulated by the subsidence of the surrounding land.* The character and arrangement of its fauna is probably nearly the same now as when it formed part of a continent, and the diminution of its land-shells in variety and size may be the result of a modern change of physical conditions brought about by human agency, as at St. Helena. The annual fall of rain is now 29·82 inches, whereas it was remarked by Columbus, three hundred and fifty years ago, "that, formerly, the quantity of rain was as great in Madeira, the Canaries, and the Azores, *as in Jamaica*, but since the trees which shaded the ground had been cut down, *rain had become much more rare.*†

The *Azores* are a group of 9 volcanic islands, 800 miles west of Lisbon, the loftiest being Pico, 7,613 feet. The number of land-shells have been recently increased to 68 by Morelet and others,—including *Limax* 4, *Arion* 3, *Testacella* 1, *Vitrina* 7, *Helix* 30, *Bulimus* 10, *Zua* 1, *Pupa* 8, *Balea* 1, *Auricula* 3. Of these 28 are found in Europe, 7 in Madeira, 4 in the Canary Islands, and the remaining 29 are peculiar.

The *Canary Islands* are sixty miles west of Africa, with a temperature of 60°—66° in the coolest half year, and 78°—87° in the hottest. The land-snails are about 80 in number, including *Helix* 50, *Nanina* 1, *Vitrina* 3, *Bulimus* 16, *Achatina* 3, *Pupa* 5, *Limax* 1, *Phosphorax* 1, *Testacella* 2, *Cryptella* 1, and

* See the observations of Mr. James Smith, and of Sir C. Lyell and Mr. Hartung (Geol. Jour. 1854).

† Cosmos, ii. 660, Bohn ed. It seems likely that Jamaica itself has since undergone a similar change; the fall of rain is stated to be 49·12, whilst in the neighbouring islands it exceeds 100 inches.

4 *Cyclostomidæ*. Of these, 60 are peculiar, 12 are common to Southern Europe, and 4 to the West Indies? 1 to Morocco, 1 to Algeria (also European), and 1 to Egypt. The fresh-water shells are *Physa* 2, *Ancylus* 1.

Helix ustulata and *McAndrei* are peculiar to the rocky islets known as the "Salvages," north of the Canaries.

The absence of Western African land-shells, and the presence of West Indian species may be explained by the currents which come from the Antilles, as shown on the map.* Some of the European species may have been introduced (*e.g.*, *Helix lactea*, *pisana*, *cellaria*); but the presence of 20 Lusitanian species, in a total of 80, is too remarkable to be accidental.

The *Cape de Verde Islands*, although much farther to the south, are also much farther from the continent, being 320 miles west of Cape de Verde; the mean temperature is 65°—70°, and the vegetation, as Dr. Christian Smith remarked, is more like that of the Mediterranean coast than West Africa. Of the 12 land-shells, two are common to the Canaries and Azores.

Lusitanian Species of Wide Distribution.

Helix amanda, Sicily—Palma.
,, planata, Morocco—Canaries.
,, lenticula, S. Europe—Madeira—Canaries.
,, rozeti, Sicily, Morea—Algeria—C. de Verde—Canaries.
,, lanuginosa, Majorca—Algeria—Palma.
,, simulata, Syria—Egypt—Lancerotte.
,, Michaudi, summit of Porto Santo—Teneriffe?
,, cyclodon, Azores—Canaries—C. de Verdes.
,, advena, (= *erubescens* Lowe), Madeira—Azores—St. Vincent.
,, plicaria and planorbella, Canaries—Porto Rico?
Bulimus subdiaphanus, Canaries—Azores—C. de Verdes.
,, bœticatus and badiosus, Canaries—St. Thomas?

Ascension.—This barren volcanic island, in the midst of the Atlantic Ocean, is not known to possess any terrestrial *Pulmonifera* beside a slug, the *Limax Ascensionis*. Mr. Benson thinks that some *Helicidæ* might possibly be found on the Green Mountain, 2,840 feet high, where the garrison have their gardens. Mr. Darwin remarks "we may feel sure that at some former epoch, the climate and productions of Ascension were very different from what they now are."

St. Helena (No. 28 of Map).

The island of St. Helena is 800 miles S.E. of Ascension, and 1200 from the nearest African coast of Benguela. It is entirely

* Long before the discovery of America it was observed that the westerly gales washed ashore stems of bamboos, trunks of pines, and even *living men in canoes*.—Humboldt, ii. p. 462.

volcanic. The indigenous plants are all peculiar, and not more related to those of Western Africa than to Brazil.* The land shells are also peculiar; 13 species have been described, viz.:—*Helix*, ? sp, *Bulimus* 5, *Achatina* 2, *Pupa* 1, *Succinea* (*Helisiga*) 2. As many more have been met with only in the condition of dead shells, rarely retaining their colour and translucency. They are found beneath the surface-soil in the sides of ravines worn by the heavy rains, at a height of 1,200 to 1,700 feet. "Their extinction has probably been caused by the entire destruction of the woods, and the consequent loss of food and shelter, which occurred during the early part of last century." (Darwin's Journal, p. 488.) A living *Bulimus*, related to the extinct *B. Blofieldi*, is found feeding on the cabbage-trees, only on the highest points of the island.

Extinct Land-shells of St. Helena.†

Bulimus auris vulpinus.	Bulimus relegatus.
„ Darwini.	Helix bilamellata.
„ Blofieldi.	„ polyodon.
„ Sealei.	„ spurca.
„ subplicatus.	„ biplicata.
„ terebellum.	„ Alexandri.
„ fossilis.	Succinea Bensoni.

The large *Bulimus*, (fig. 123, p. 291), has no living analogue in Africa, but is a member of a group characteristic of tropical America (to which the names *Plecochilus*, *Pachyotis* and *Caprella* have been given), including *B. signatus*, *B. bilabiatus*, *B. goniostomus*, and especially *B. sulcatus* (Chilonopsis, Fischer) of St. Iago.‡ The four next species belong to the same type, but are smaller and slenderer. "The marine mollusks of the coast of St. Helena would lead us to infer the very ancient isolation of that island, whilst at the same time a pre-existing closer geographical relationship between the African and the American

* "It might perhaps have been expected that the examination of the vicinity of the Congo would have thrown some light on the origin, if I may so express myself, of the Flora of *St. Helena*. This, however, has not proved to be the case; for neither has a single indigenous species, nor have any of the principal genera characterising the vegetation of that island, been found either on the banks of the Congo, or on any other part of this coast of Africa."—R. Brown, Appendix to Captain Tuckey's Narrative of the Congo Expedition (p. 476). 1818.

† G. Sowerby in Darwin's "Volcanic Islands," p. 73. Forbes, Journ. Geol. Soc. 1852, p. 197.—Benson, An. Nat. Hist. 1851, vii. 263.

‡ As Dr. Pfeiffer includes this (with a sign of doubt) amongst the synonyms of *B. auris-vulpinus*, he must have suspected that the specimens came from St. Helena and not from St. Iago. The only other group of Bulimi resembling the St. Helena shells occurs in the Pacific Islands:—*Bulimus Caledonicus* at Mulgrave I., *B. auris bovinæ* at the Solomons, and *B. shongi* in New Zealand.

continents than now maintains is dimly indicated. The information we have obtained respecting the extinct and existing terrestrial mollusks would seem to point in the same direction, and assuredly to indicate a closer geographical alliance between St. Helena and the east coast of S. America than now holds." (Forbes.)

Tristan d'Acunha (No. 29 of Map).

Two peculiar species of *Balea* (Tristensis and ventricosus) are found on this remote and lofty island, which attains an elevation of 8,236 feet.

3. African Region.

Tropical western Africa, with its hot swampy coasts and river valleys is the region of the great *Achatinæ* and Achatina-like *Bulimi*, the largest of all living land-snails. In 1863 the numbers known were—*Vitrina* 4 sp., *Streptaxis* 7, *Helix* 30, *Pupa* 5, *Bulimus* 50, *Achatina* 54, *Succinea* 3, and *Perideris* 18. *Streptaxis Recluziana* inhabits the Guinea Islands. *Helix Folini*, *Bulimus numidicus* and *fastigiatus*, *Pupa crystallum* and *sorghum*, *Achatina columna*, *striatella*, and *lotophaga* are found on Princes Island; *Pupa putilla* on Goree Island; *Bulimus* (*Pseudachatina*) *Downesi*, *Achatina iostoma* and *Glandina cerea* at Fernando Po. The reversed river-snail (*Lanistes*) is generally diffused in the fresh waters of Africa; several species of *Potamides* and *Vibex* are found in the embouchures of the western rivers and *Pedipes* on the sea-shore. The fresh-water bivalves of Senegal are similar to those of the Nile:—

Pisidium parasiticum,	Egypt.	Iridina exotica,	Senegal.	
Cyrenoides Duponti,	Senegal.	„ rubens	„	
Corbicula, 4 sp.	Egypt.	Pleiodon ovatus	„	
Iridina nilotica	„	Ætheria semilunata	„	Nile.
„ aegyptiaca	„	Galatea radiata	„	

4. Cape Region.

Dr. Krauss describes 41 species of land-snail from South Africa, and Mr. Benson has furnished a list containing 22 others; these are all peculiar, except a *Succinea*, which appears to be only a variety of the European *S. putris*, and two European Helices (H. *cellaria* and *pulchella*) probably imported to the environs of the Cape. In 1863 they had raised the number to about 90. There are also 3 slugs, 9 freshwater Pulmonifera, 7 marine Pulmonifera, 5 freshwater bivalves, and 5 univalves.

The species found at the Cape, Algoa Bay, Natal, &c., are for the most part different—*Potamides decollatus*, *Clionella sinuata*, and an *Assiminea* inhabit brackish waters.

Limax	4	—		—	
Arion	1	Limnæa	1	Paludina	3
—		Physa	4	Neritina	1
Vitrina	4	Physopsis	1	—	
Helix	35	Ancylus	1	Corbicula	1
Succinea	4	Planorbis	3	Cyclas	1
Bulimus	13	—		Pisidium	1
Pupa	6	Vaginulus	1	Unio	1
Achatina	7	Oncidium	1	Iridina	1
Cyclostoma	6	Auricula	6		

5. Yemen—Madagascar.

The S. W. Highlands of Arabia (Yemen) form a distinct Botanical province isolated by rainless deserts to the north. The land snails consist of a few species of *Helix* and *Bulimus*, *Cyclostoma lithidion*, and 3 species of the section *Otopoma*, a group also found in Madagascar. Two species are common to the island of *Socotra* (No. 30), which also has a species (of *Pupa*) common to Madagascar. *Bulimus guillaini*, *Cyclostoma gratum*, *modestum* and *Souleyeti* are found on the island of Abd-el-Gouri.

Very few land shells have been collected on the mainland of Eastern Africa, although it is a rainy region, and well wooded in the southern part; 5 species only are recorded from Mogadoxa and Ibu, belonging to the genera *Helix*, *Bulimulus*, *Achatina*, *Pupa*, and *Otopoma*. On the Island of Zanzibar are found *Achatina Rodatzi* and *allisa*, *Cyclostoma Creplini* and *Zanguebarica*; *Pupa cerea* is common to Zanzibar and Madagascar.

Madagascar itself is rich in land shells; Dr. Pfeiffer enumerates—*Helix* 28 *sp.*, *Bulimus* 6, *Succinea* 14, *Pupa* 1, *Achatina* 4 (one of which, *eximia*, is allied to *A. Columna*, of W. Africa), and 32 *Cyclostomidæ*, chiefly of the section with spiral ridges (*Tropidophora*), 3 of the division *Otopoma*. *Cyclostoma cariniferum* and *Cuvieri* are found on the Island of Nosse Be; *Helix guillaini* on S. Maria I. Amongst the fresh-water shells are *Melania amarula*, *Melanatria fluminea*, and *Neritina corona*.

The land shells of the *Mascarene Islands* are nearly all peculiar; we are indebted to Mr. W. H. Benson for most of the information existing in respect to them.

Comoro Islands.

Helix russeola and *Achatina simpularia* are found in Mayotte; *Cyclostoma pyrostoma* in Mayotte and Madagascar.

Seychelles (No. 31 of Map).

Parmacella Dussumieri.
Helix unidentata.
„ Studeri.
„ Souleyeti.
„ Tranquebarica.
Streptaxis Souleyeti.
Bulimus ornatus.
„ fulvicans.
Cyclostoma insulare.
„ pulchrum.
Cyclotus conoideus.

Mauritius (32).

Parmacella perlucida.
„ Rangii.
„ mauritii.
Helix philyrina.
„ inversicolor.
„ stylodon.
„ mauritiana.
„ mauritianella.
„ rawsoni.
„ semicerina.
„ mucronata.
„ nitella.
„ rufa.
„ similaris.
„ suffulta.
„ albidens.
Helix Barclayi.
„ odontina.
Vitrina angularis.
Tornatellina cernica.
Gibbus Antoni.
„ Lyonneti.
Succinea sp.
Bulimus clavulinus.
„ Mauritianus.
Pupa pagoda.
„ fusus.
„ sulcata.
„ clavulata.
„ modiolus.
„ funicula.
„ versipolis.
Pupa Largillierti.
Cyclostoma Barclayi.
„ Michaudi.
„ carinatum.
„ undulatum.
„ insulare ?
Cyclotus conoideus ?
Otopoma Listeri.
„ hæmastoma.
Realia rubens.
„ aurantiaca.
„ multilirata.
„ expansilabris.
„ globosa.
Megalomastoma croceum.

Two large species of *Achatina* (*fulica* and *panthera*) abounding in the coffee plantations, are believed to have been introduced. The annual fall of rain in Mauritius is 35·25 inches.

Bourbon (No. 33).

Helix cælatura.
„ detecta.
„ delibata ?
Helix tortula.
„ Brandiana.
Pupa Largillierti—Mauritius.

Rodriguez.

Cyclostoma articulatum, Madagascar ?
Streptaxis—pyriformis.

No. 34. *Kerguelen's Land.* Helix Hookeri was collected at this island when visited by the Antarctic Expedition.

6. Indian Region.

Proceeding eastward, in Asia, the species of *Achatina*, *Pupa*, *Clausilia*, *Physa*, *Limax*, and *Cyclostoma* rapidly diminish or quite disappear. Helices of the section *Nanina* become plentiful, amounting to 150 species, and *Bulimulus* and *Cyclophorus* attain their maximum. *Leptopoma*, and *Pupina* are peculiar to the Asiatic Islands.

Our catalogue of Indian land shells must be very imperfect, including only about 180 *Helicidæ* and 50 *Cyclostomidæ*. A very few of the Indian species are common to China and the Asiatic Islands, or even to Ceylon. The shells of northern India resemble those of the Lusitanian region; in the south they approximate more to the large and vividly coloured species of the Asiatic Islands. In the Himalaya land shells are numerous, and ascend as high as the region of Junipers and Rhododendrons, 4,000—10,000 feet above the sea.

Helix	83	Pupa	7	Cyclophorus	26
Nanina	46	Clausilia	7	Leptopoma	1
Ariophanta	8	Vitrina	9	Pterocyclus	10
Streptaxis	3	Succinea	7	Cyclotus	3
Bulimus	45	Parmacella	2	Megalomastoma	4
Achatina	16	Cyclostoma	3	Diplommatina	3

Parmacella and *Vaginulus* are found in India, and the typical fresh-water species of *Oncidium*. Ordinary forms of *Limnæa* and *Planorbis* are abundant, and there is one species of *Ancylus*. *Physa* occurs only in a fossil state, or is represented by the singular *Camptoceras* of Benson. *Hypostoma Boysii*, *Auricula Judæ*, and *Polydonta scarabæus* are also Indian forms.

The gill-breathing fresh-water shells of India are very numerous, especially the Melanias and Melanatrias, and species of *Pirena*, *Paludomus*, *Hemimitra* (retusa), *Ampullaria*, *Paludina*, *Bithynia*, *Nematura* (deltæ), *Assiminea* (fasciata), *Neritina* (particularly crepidularia and Smithii) and *Navicella* (tessellata).

The brackish-water species of *Cerithidium*, *Terebralia*, and *Pyrazus* are mostly common to India and North Australia.

The fresh-water bivalves are a few ordinary forms of *Unio*, 3 species of *Cyrena*, a *Corbicula* (of which 6 species have been made), *Cyclas Indica*, *Arca scaphula*, *Glaucomya cerea*, and *Novaculina gangetica*.

Ceylon. The land-shells of Ceylon have been investigated by Mr. Benson; they most resemble those of the Neilgherry hills, but are nearly all specifically distinct, and even some of the genera are peculiar. It seems entitled to rank as a province. *Helix Waltoni* and *Skinneri*, are examples of the most characteristic form of Helices; the Vitrini-form type (*Nanina*) is also common. *H. hæmastoma*, one of the most conspicuous species, found on trees at P. Galle, is common to the Nicobar Islands. The Achatinas belong to a distinct section (*Leptinaria*, Beck), also represented on the Continent. Some of the *Bulimi* approach the Philippine forms.

Helix	46	Succinea	1	Pterocyclus	5
Nanina	9	Pupa	3	Aulopoma	4
Vitrina	3	Achatina	8	Leptopoma	5
Streptaxis	2	Cyclophorus	12	Cataulus	10
Bulimus	13				

The fresh-water shells belong to the genera Limnæa, Physa, 2 species (not found on the Continent); Planorbis, Melania, Tanalia 10 (peculiar), Paludomus, Bithynia, Ampullaria, Neritina, Navicella, Unio, and Cyrena.

At the Nicobar Islands are found—Cataulus tortuosus, Helicina Nicobarica and Pupina Nicobarica. *Helix castanea* is from Sumatra. (Beck.)

7. China and Japan.

The few land-snails known from China are of Indian and Lusitanian types; viz.—Helix 20, Nanina 10, Streptaxis 1, (Cochin-China), Bulimus 5, Achatina 2, Pupa 1, *Clausilia* 11, Succinea 1, *Helicarion* 6, Cyclophorus 1, Cyclotus 1, Otopoma 1. In the Island of Chusan Dr. Cantor discovered the genera *Lampania* and *Incilaria.* The most characteristic bivalves are *Glaucomya Sinensis*, and *Symphynota plicata;* 3 species (or varieties) of Cyrena and 9 Corbiculas are described by Deshayes, and a *Planorbis* by Dunker.

In the Japanese and Loo-choo Islands only 9 species of Helix, 2 of Nanina, 2 of Clausilia, and 2 of Helicarion have been hitherto obtained.

8. Philippine Islands.

The extraordinary richness of these islands has been developed mainly by the researches of Mr. Cuming. The *Helicidæ* (above 300) are inferior in number only to those of Lusitania and the Antilles, and vastly superior in size and beauty of colouring. The *Cyclostomidæ* (55) are not much fewer than in India. Nearly all the species are confined to particular islands, and the repetition of forms makes it probable that many of them are geographical varieties. The climate is equable, with a temperature like that of South China (66°—84°), woods are prevalent and the rains heavy—all circumstances favourable to the *individual* abundance of land-snails.

Helix	160	Clausilia	1	Cyclotus	6
Nanina	40	Vitrina	18	Megalomastoma	1
Helicarion ?	3	Cyclophorus	15	Pupina	9
Bulimus	105	Leptopoma	16	Helicina	7

The Helices belong in great part to the section *Callicochlias* (Ag.) and *Helicostyla* (mirabilis) Fér. Some with sharply-keeled whorls have been called *Geotrochi* (Iberus of Albers). The Bulimi are chiefly of the section *Orthostylus* (Beck), large and highly coloured, with a *hydrophanous* epidermis, the bands becoming translucent when wetted; others, like the well-known *B. perversus*, represent the typical Brazilian forms. To these islands belong most of the helicina-shaped *Cyclophori* (*Leptopoma*.)

The fresh-water shells are numerous; above 100 were obtained by Mr. Cuming, including many species of *Melania* (54 ?), *Navicella lineata*, and *suborbicularis*, 5 species of *Glaucomya*, *Unio verecundus*, a *Corbicula*, and 11 sp. (?) of *Cyrena*.

Celebes and *Moluccas*. From these islands we have on record, at present, 16 species of Helix, Nanina 19, Bulimus 3, Vitrina 2 (viridis and flammulata, Quoy), Cyclophorus 1. In the fresh-water ponds and rivulets Mr. A. Adams found species of Melania, Assiminea, Ampullaria, and Navicella; Auricula subulata and Conovulus leucodon. Neritina sulcata was found on the foliage of trees several hundred yards from the water.

9. Java.

The Java group, including Floris and Timor, have been partially explored from the head-quarters of the Dutch settlement at Batavia. The land and fresh-water shells are nearly all peculiar, a few only being common to the Philippines and North Australia; they have been described and figured by M. Albert Mousson (8vo. Zurich, 1849, 22 plates).

Helix	15	Platycloster ?	3	Navicella	2
Nanina	8	Meghimatium	2	——	
Ariophanta	1	——		Unio and Symphynota	4
Bulimus	10	Limnæa	1	Alasmodon	2
Clausilia	6	Auricula	2	Anodon	1
Cyclophorus	4	——		Cyrena	7
Cyclotus	2	Melania	5	Corbicula	4
Leptopoma	1	Ampullaria	1		
Parmacella	3	Neritina	2		

10. Borneo.

The land shells of this great island are almost unknown, and the only reason for mentioning it separately is the doubt whether it should be considered part of the Javanese Province, or associated with the Moluccas and Philippines.

Helix	12	Paxillus	1	Leptopoma	3
Nanina	8	Succinea	2	Cyclotus	1
Bulimus	1	Cyclophorus	2	Pterocyclus	2

The fresh-water bivalves are Glaucomya rostralis, Corbicula tumida, and Cyrena triangularis. *Pholas rivicola* was found burrowing in floating logs used as landing places, 12 miles from the sea, up the Pantai river. The mangrove swamps abound with Cerithidium, Terebralia Telescopium, Potamides palustris, and Quoyia; Auricula Midae and Polydonta scarabæus inhabit the damp woods.

11. Papua and New Ireland.

The land shells of New Guinea are nearly all distinct from those of the Philippines and Moluccas, and include some related to the Polynesian types. The Louisiade Islands to the south-east and New Ireland on the north of New Guinea are included with it.

Helix	30	Partula	3	Leptopoma	1
Nanina	7	Pupina	3	Cyclotus	1
Bulimus	2	Otopoma	1	Helicina	2

Cyrenæ are numerous in this region. *Cyclostoma australe* is common to the Australian Islands and New Ireland; *C. Massenæ* to Australia and New Guinea, and *C. Vitreum* to New Ireland, New Guinea, the Philippines, and India.

12. Australian Region.

Both fauna and flora of Tropical Australia are distinct from those of New South Wales and Tasmania, the principal barrier being the desert character of the interior; but the localities of the land shells have not been defined with sufficient accuracy to show whether they are equally distinct. The most complete list is given by Prof. E. Forbes, in the Appendix to McGillivray's Narrative of the Voyage of H.M.S. Rattlesnake (1846-50); it specifies 48 Helices (of which *H. pomum* is the most conspicuous), 10 Bulimi, an Achatina, 6 Vitrinas (*Helicarion*) belonging to the mainland, and one from the Lizard Islands, and a dextral *Balea* (australis). Pupa and Helicina (*Gouldiana*) are only found on the islets off the north-east coast, and Pupina (*bilinguis*) at Cape York and the adjacent islets; a portion of the province which is densely wooded, and lies within the *rain region* of the Asiatic Islands. *Cyclostoma bilabre* of Menke's Catalogue is probably West Indian. The fresh-water shells of Australia are *Planorbis Gilberti*, *Iridinae?* (Victoria R.), *Unio auratus*, *cucumoides*, *superbus* (*Hyridella*), *australis*, *Corbicula* 4 species, *Cyrena* 3, *Cyclas egregia* (Hunter R.), *Pisidium semen* and *australe*, the last common to Timor.

More recently Cox has described 178 species, belonging principally to East Australia. He notices, Helix 133, Vitrina 17, Succinea, 12, Bulimus 17, Pupa 6, Balea 1, and others belonging to genera Triboniophorus, Limax, and Planorbis.

13. South Australia and Tasmania.

From extra-tropical Australia we have the following:— Helix 9, Helicarion 2, Bulimus 2, Succinea 1 (common to Swan River and Tasmania), Limax olivaceus, and one Ancylus. Two of the largest land snails, *Helix Cunninghami* and *Falconeri*, are found in New South Wales. The coasts of this region are thinly wooded, but much of it is rendered desert by want of rain; in New South Wales droughts recur at intervals of twelve years, and sometimes last three years, during which time scarcely any rain falls.

14. New Zealand.

The moist and equable climate of these islands (which have a mean temperature of 61°—63°) is favourable to the existence of numerous land-snails. Nearly 100 species of land and fresh-water shells are already determined, and are all peculiar; the genus *Helix* musters 60 species, some of which, including the great *H. Busbyi*, resemble in shape the European *Helicellae*; Bulimus 3, Balea (peregrina), Vitrina 2 of peculiar form, Tornatellina 1, Cyclophorus cytora, and Omphalotropis egea. There are two slugs, Limax antipodarum and Janella bitentaculata; two fresh-water *pulmonifera*, Physa variabilis and Latia neritoides; several marine air-breathers,—Oncidium (*Peronia*) 2, Siphonaria 3, Amphibola 1 (*avellana*). The other fresh-water shells are Melanopsis trifasciatus (a Lusitanian type), Assiminea antipodarum and Zelandiæ, Amnicola? corolla, Cyclas Zelandiæ, and Unio Menziesii and Aucklandicus.

Vitrina zebra is found at the Auckland Islands.

15. Polynesian Region.

The Pacific Islands are partly the volcanic summits of submerged mountain ranges, usually fringed or surrounded with coral reefs; and partly *atolls* or lagoon islands, scarcely rising above the sea, and presenting no vestige of the rock on which they are based. The low coral islands form a long stream of archipelagos, commencing in the west with the Pelews, Carolines, Radack, Gilbert, and Ellice groups, then scattered over a wider space, and ending eastwards in the Low Archipelago:

they are chiefly, perhaps entirely, colonised by drift from the other islands.

The volcanic groups are the Ladrones, Sandwich Islands, and Marquesas, to the north of the low coral zone; and to the south of it, the Salomons, New Hebrides, New Caledonia, and Feejees —the Friendly Islands, Navigator's and Cook's Islands—Society and Austral Islands, ending with Pitcairn's and Elizabeth Island. Many of these are very lofty. Their molluscan fauna is entirely peculiar, but it has most affinity with those of New Zealand and the Asiatic Islands, and great analogy with those of St. Helena, Brazil, and the West Indies.

Salomons—New Hebrides—New Caledonia—Feejees.

The most remarkable land-shells of these islands are the great auriculoid, *Bulimi* (e.g. *B. auris-bovinæ* and *B. miltochlius* of the Salomons). *Acicula striata* and 2 sp. of *Cyrena* are found at Vanicoro; and *Physa sinuata*, *Peronia acinosa* and *corpulenta*, and several Neritinas and coronated Melanias, have been obtained at the Feejees.*

Helix	18	Bulimus	10	Cyclophorus	2
Nanina	2	Partula	6	Omphalotropis	1
Vitrina	6	Acicula	1	Helicina	6

Friendly Islands—Navigator's—Society Islands.

The principal lofty and rocky islands of the southern Pacific, at which land shells have been obtained, are Tonga, Samoa, Upolu, and Manua; Tahiti, Oheteroa, and Opara; Pitcairn's Island and Elizabeth Island. Each appears to have some peculiar species and some common to other islands; the little raised coral islet Aurora (*Metia*), north-east of Tahiti, 250 feet in elevation, has four land-snails which have been found nowhere else—*Helix pertenuis*, *dædalea*, *Partula pusilla*, *Helicina trochlea.* "Samoa and the Friendly Islands must have intimate geological relations; the same forms, and many of the same species of land shells, occur on both groups; not a single Feejeean species was collected on either." (Gould.)

Helix	13	Tornatellina	6	Cyclophorus	5
Nanina	18	Pupa	3	Omphalotropis	6
Bulimus	1	Succinea	12	Helicina	13
Partula	15	Electrina	1		

The fluviatile shells are species of *Physa*, *Melania*, *Assiminea*

* The Feejees (*Viti*) are more nearly allied to the westward islands, such as the New Hebrides, than the Friendly Islands. *Succinea* and *Partula*, so plentiful at the latter, are not found at the Feejees. (Gould, U.S. Exploring Expedition).

(*Taheitana*) *Neritina*, and *Navicella;* the two last being often littoral, or even marine, in their habit.

Low Coral Islands.

The Atolls, or lagoon-islands, are less prolific: 2 *Helices* and 2 *Partulæ* are found at Oualan, in the Caroline Archipelago; and from Chain Island (*Annaa*), the centre of commerce in the eastern Archipelago, have been obtained—*Helix* 2 sp., *Nanina* 1, *Partula* 1, *Tornatellina* 1, *Cyclophorus* 1, and *Melampus mucronatus.*

Sandwich Islands.

The land shells of these islands exceed 200, and are all, or nearly all, peculiar: there is one *Limax;* and in the fresh waters are found *Limnæa volutatrix*, *Physa reticulata* (Gould), *Neritopsis?* *Neritina Nuttalli* and *undata*, and *Unio contradens* (Lea).

In the I. Kaui, two species of *Achatina* have been found: the Achatinellæ are elongated (*Leptachatina*, G.) and the Helices planorboid and multispiral. In Molokai the Achatinellæ are large and coloured. In Maui and Oahu the Helices are small and glabrous, or hispid, ribbed, and toothed. In Hawaii, Succineas prevail, and Achatinellae are rare. (Gould.) The large number of Achatinellae is partly due to this group having been specially studied by Judge Cooper of America.

Helix	20	Achatina	5	Pupa	2
Nanina	5	Achatinella	204	Vitrina	2
Bulimus	5	Tornatellina	3	Succinea	10
Partula	4	Balea	1	Helicina	6

The Island of Guam, Ladrones, has 3 sp. of *Partula*, 2 of *Achatinella*, and 1 *Omphalotropis*. At the Marquesas have been found 3 sp. of *Nanina*, 1 *Partula*, and 1 *Helicina.*

NEW WORLD.

16. Canadian Region.

The country drained by the Great Lakes and the river St. Lawrence possesses very few peculiar shells, and these mostly of fresh-water genera. It is chiefly remarkable for the presence of a few European species, which strengthen the evidence before alluded to (p. 60) of a land-way across the north Atlantic having remained till after the epoch of the existing animals and plants.*

* For example, the common Heather (*Calluna vulgaris*), one of the most abundant *social* plants of Europe, characteristic of the moorland zone, and seldom rising above

Helix hortensis (imported), coast of New England and banks of St. Lawrence.
„ pulchella (smooth var. only), Boston, Ohio, Missouri.
Helicella cellaria (glaphyra, Say?), N. E. and middle States.
„ pura, nitida, and fulva?
Zua lubrica, North West Territory.
Succinea amphibia (= campestris, Say?).
Limax agrestis (= tunicatus, G.), Mass.
„ flavus, New York, introduced.
Vitrina pellucida (= Americana?)
Arion hortensis, New York (Dekay.)
Limnæa palustris (= elodes, Say?).
„ truncatula (= desidiosa?).
Aplexa hypnorum (= elongata, Say?).
Auricula deticulata, Mont., New York Harbour.
Alasmodon margaritiferus (= arcuatus, Barnes).
Anodon cygneus (= fluviatilis, Lea?).

The shells proper to Canada, or derived from the adjoining States, are only 6 sp. of Helix, 2 Succineas, and 1 Pupa; 8 sp. of *Cyclas* have been obtained from the region of Lake Superior.

The following species occur in New England:—

Helix	13	Physa	2	Unio	5
Succinea	2	Planorbis	11	Alasmodon	2
Pupa	7	Paludina	1	Anodon	2
Limnæa	7	Valvata	2	Cyclas	6
Ancylus	2	Auricula	1	Pisidium	1

Carychium exiguum, Say, is found in Vermont, and *Limnæa* (Acella) *gracilis* in Lake Champlain; *Valvata tricarinata* and *Paludina decisa* are characteristic forms.

The genera *Clausilia* and *Cyclostoma* are entirely wanting in Canada and the Northern States. The *Limacidæ* are represented by *Philomycus*, of which there are 9 reputed species, ranging from Massachusetts to Kentucky and South Carolina.

17. Atlantic States.

The parallel of 36° N. lat. forms the boundary-line of two botanical regions in the United States; but the evidence of the fresh-water shells, in which they are particularly rich, seems to favour a division into two hydrographical provinces—the region of the Atlantic streams and the basin of the Mississippi. About 50 fresh-water *Pulmonifera*, 150 *pectinibranchiata*, and 250 bivalves, are reputed to be found in the States, and it is supposed that only a few species are common to both sides of the Alleghanies. *Cyclas mirabilis*, *Pisidium Virginicum*, *Cyrena*

3,000 feet on the mountains of Scotland. (Watson.) According to Pallas it abounds on the western flanks of the Ural Mountains, but disappears on their eastern side, and is not found in Siberia. In the *Pliocene period* it appears to have spread itself northward and westward to Iceland, Greenland, and Newfoundland, where it still grows, *the only heath indigenous to the New World.* (Humboldt.)

Carolinensis, and *Unio complanatus* and *radiatus*, are characteristic of the eastern rivers; *Melania depygis* is said to be the only member of that large genus found eastward of the Hudson River. Of the American land-snails, 29 sp. of Helix, 6 Succineas, and 13 Pupas are enumerated from the Atlantic States. In Florida the propinquity of the West Indian fauna is strongly indicated by the occurrence of the great *Glandina truncata*, by species of *Cylindrella*, and a *Helicina*. A Cuban species of *Chondropoma* (C. dentatum) is also said to occur in Florida, and *Ampullaria depressa* in Florida and Georgia.

The *Pulmonifera* of North America have been carefully examined by Messrs. Binney,* Bland,† and others. The following summary of North American *Pulmonifera* is given by Mr. Binney. The area is nearly co-extensive with our regions, Nos. 16 and 17.

Arion	2	Bulimus	21	Melampus	11
Limax	3	Achatina	5	Carychium	1
Philomycus	2	Pupa	12	Limnæa	34
Vitrina	2	Vertigo	4	Physa	19
Succinea	18	Cylindrella	4	Planorbis	21
Glandina	6	Veronicella	1	Ancylus	10
Helix	131				

There are also found in the fresh waters of this district *Melaniadæ* 380, *Paludinidæ* 58, *Cycladidæ* 44, *Unionidæ* 552.

18. American Region.

The mass of American land and fresh-water shells are found in the central and southern States, the country drained by the Mississippi and its tributaries. The *Helicidæ* are not more remarkable for size and colour than those of northern Europe; the most characteristic forms belong to the sub-genus *Polygyra* (or *Tridopsis*, Raf.), such as *Helix tridentata, albolabris, hirsuta,* and *septemvolvis*. The truly North American forms all belong to three genera, viz.—Helix 43, Succinea 8, Pupa 3 species. In the Southern States are also found 5 species of Bulimus, 3 Cylindrellas, 2 Glandinas, and 5 Helicinæ, genera whose metropolis is in the Antilles or in tropical America.

The fresh-water univalves include above 100 species of *Melaniadæ* belonging to the genera *Ceriphasia, Melafusus, Anculotus, Melatoma,* and *Amnicola*, 15 *Paludinæ*, some keeled, and one

* In several papers in Proc. Acad. Nat. Sci. Phil. 1857, and subsequent years.

† Remarks on the Classification of N. Am. Helices. Annals of Lyceum of Nat. Hist., New York. 1863.

muricated (*P. magnifica*); and species of *Valvata, Limnæa, Physa* (15), *Planorbis*, and *Ancylus* (5).

The fresh-water bivalves are also extremely numerous: the *Unionidæ* are unequalled for their ponderous solidity, the rich tinting of their interiors, and the variety of their external forms.* *Gnathodon cuneatus, Cyrena floridana*, 16 species of *Cyclas*, and *Pisidium altile*, belong to this region.

19. Oregon and California.

The Fauna of the region beyond the Rocky Mountains is believed to be almost entirely distinct from that of the United States. *Arion* (foliolatus) and *Limax* (Columbianus), genera not indigenous to eastern America, were found near Puget Sound. (Gould). We have no information respecting the land and fresh-water shells of Russian America, but from analogy we may expect to find a few there identical with those already mentioned as occurring in Siberia.†

The shells of Oregon and California are principally known by the researches of Nuttall, Couthouy, and Binney.

Helix	34	Physa	9	Cyrena	2
Bulimus	10	Ancylus	4	Cyclas	1
Achatina	1	Planorbis	12	Unio	1
Succinea	4	Melania	2	Alasmodon	1
Limnæa	12	Potamides	2	Anodon	3

Limnæa fragilis, a Canadian species, is said to range westward to the Pacific; and *L. jugularis* to be common to Michigan, the North-west territory, and Oregon. (De Kay.) *Limnæa umbrosa*, Say? and *Planorbis corpulentus*, Say, are found in the Columbia River.

20. Mexican Region.

The lowlands of the northern half of Tropical America constitute only one botanical region, extending from the Rio Grande del Norte to the Amazon; but on zoological grounds it may be divided into two smaller areas. The Mexican province, including Central America, itself comprises three physical regions: the comparatively rainless and treeless districts of the west; the mountains or high table-lands with their peculiar flora; and

* The private cabinet of Mr. Jay contains above 200 species of North American *Unionidæ*, and very many varieties.

† The affinity between the *Mammalia* of the Old and New Worlds is greatest in eastern Asia and north-west America, and diminishes with distance from those regions. (*Waterhouse*, in Johnston's Physical Atlas, No. 28.)

the rainy wooded region that borders the Caribbean Sea. The land snails of Central America resemble those of the Antilles in the prevalence of some characteristic genera — *Glandina*, *Cylindrella* and *Helicina*,—of which very few species are found on the northern Coast of the Gulf of Mexico. The *Bulimi* are numerous, but chiefly thin, translucent species.

Helix	33	Glandina	25	Cistula	7
Proserpina	1	Tornatellina	1	Cyclophorus	3
Bulimus	50	Pupa	1	Chondropoma	3
Succinea	6	Cylindrella	20	Megaloma	2
Achatina (Spiraxis)	35	Cyclotus	1	Helicina	22

Amongst the fresh-water shells are *Neritina picta*, *Cyclas maculata*, *Corbicula convexa*, and 7 species of *Cyrena*. From Mazatlan, Mr. Carpenter describes *Cyrena olivacea* and *Mexicana*, *Gnathodon trigonus*, *Anodon ciconia* (allied to the Brazilian *A. anserina*), *Physa aurantia* and *elata*, *Planorbis* sp. *Melampus olivaceus*. Two brackish-water species, *Cerithidium varicosum* and *Montagnei*, are common to South America.

21. Antilles.

The West Indian Islands have supplied nearly 500 species of *Helicidæ*, a larger number than any province except the Lusitanian; and above 260 *Cyclostomidæ*, or nearly three times as many as India. They are also richest in generic forms, and the climate is highly favourable to the multiplication of individuals. The mean temperature of the Antilles is 59°—78°, and the annual fall of rain exceeds 100 inches in most of the islands.

Helix	200	Pupa	26	Cyclophorus	1
Stenopus	2	Cylindrella	73	Cyclotus	14
Sagda	20	Clausilia	1	Megaloma	8
Proserpina	5	Balea	1	Helicina	43
Bulimus	53	Succinea	16	Alcadia	17
Achatina	27	Chondropoma	15	Trochatella	16
Glandina	46	Choanopoma	53	Lucidella	6
Spiraxis	9	Adamsiella	10	Stoastoma	20
Tornatellina	1	Cistula	36	Geomelania	21

Probably every island has some peculiar species, and those of the great islands like Cuba and Jamaica are nearly all distinct. To Jamaica belong the species of *Stoastoma*, *Sagda*, and *Geomelania*, the small sub-genus *Lucidella*, the *Alcadias* and the mass of beautiful Cyclostomas with a decollated spire and fringed lip (*Choanopoma*, *Adamsiella*, *Jamaica*, *Chondropoma*, part, and *Cistula*, part.)* The solitary *Clausilia* is found in Porto Rico, the *Balea* in Haiti, and the *Tornatellina* in Cuba; *Stenopus* is peculiar to St. Vincent's. Bermuda has 4 Helices, of which one is common to Texas and one to Cuba. The Chondropomas are found in Cuba and Haiti.

The West Indian *Achatinæ* belong to the sub-genera *Glandina*, *Liguus* and *Spiraxis;* the *Bulimi* are sharp-lipped and mostly small and slender (*Subulina*, *Orthalicus*). *Helix* (Sagda) *epistylium*, *H. Carocolla*, and *Succinea* (Amphibulima) *patula* are characteristic forms.

Although connected with Florida by the chain of the Bahamas, and with Trinidad by the lesser Antilles, very few species are common to the mainland of either North or South America; the relation is generic chiefly.

The *Limacidæ* are represented by *Vaginulus* (Sloanei); and in the fresh waters there are species of *Physa* (3), *Planorbis* (8), *Ancylus*, and the peculiar *Gundlachia*, *Valvata pygmæa*, *Ampullaria* (fasciata), *Paludestrina* (minute species), *Hemisinus*, and 2 species of *Pisidium*.

In the brackish waters are *Cerithidium*, *Neritina* (*e.g.* meleagris, pupa, virginea, viridis), *Melampus* (coniformis), and *Pedipes quadridens*.

22. Columbian Region.†

The tract shaded in the map comprehends several minor regions; 1, the rainy and wooded states of New Granada and Ecuador; 2, the elevated and nearly rainless province of Venezuela, with a flora like that of the higher regions of the Andes; 3, the Guianas, including the Valley of the Amazon, where the forests are most luxuriant, and rain falls almost daily (amounting to 100 or even 200 inches in the year). Most of the low lands, like those of the Mexican Province, belong to the "Cactus Region" of botanists, and have a mean temperature of 68°—84°. Land shells are abundant in the forests and underwood of the lower zone of the mountains, where the temperature is 10° less and the rains more copious. *Bulimi* are the predominant forms, especially the succinea-shaped species, (e.g. *B. succinoides*).

* A magnificent collection of Jamaica land shells has been presented to the British Museum by the Hon. E. Chittty, whose researches were conducted with the late Professor C. B. Adams.

† In 1821 the States of New Granada, Venezuela, and Ecuador united to form the "Columbian Republic," but dissolved again in 1831.

Helix	49	Pupa	7	Cistula	1
Streptaxis	3	Clausilia	4	Bourciera	1
Bulimus	200	Cylindrella	1	Cyclotus	8
Succinea	9	Vitrina	1	Adamsiella	1
Tornatellina	1	Limax	1	Helicina	6
Achatina	10	Choanopoma	2	Trochatella	1
Glandina	5	Cyclophorus	2		

The presence of several species of the old-world genera *Clausilia* and *Streptaxis*—both wanting in North America—becomes a significant fact when taken in connection with the affinities of the higher animals of South America and Africa. These imply a land-way across the Atlantic (at some *very remote* period), more direct than would be afforded by the continent which is believed to have united the boreal regions at the close of the Miocene age.*

Corbicula cuneata and 3 species of *Cyrena* are found in the Orinoco and smaller rivers; and the remarkable genus *Mülleria*, representing the African *Ætheria*, inhabits the Rio Magdalena. A species of *Ancylus* is recorded from Venezuela.

Galapagos Islands (No. 35).

The fauna and flora of these islands are peculiar, but related to tropical South America. The only known land-shells are 17 small and obscure species of *Bulimus*, of which the most remarkable is *B. achatinellinus*. Some of them are peculiar to particular islands, like the birds and reptiles, viz.:—Chatham Island 2, Charles Island 3, Jacob Island 2, James Island 1. "The Archipelago is a little world within itself, or rather a satellite attached to America, whence it has derived a few stray colonists, and has received the general character of its indigenous productions." (Darwin's Journal, p. 377.)

23. Brazilian Region.

The "region of Palms and Melastomas," extending from the Amazon to the southern tropic, is one of the richest zoological provinces. It includes Bolivia, and the largest portion of Peru, all that lies to the east of the Andes. The greater part of the region is mountainous and rainy and densely wooded, but intersected by extensive plains (*Llanos*), some grassy and fertile,

* In Lieut. Maury's physical map of the Atlantic, the contour of this former land is partly shown by the 2,000 fathom line, extending beyond the Canaries and Madeira, and sending out a promonotory to the Azores. *Clausiliæ* are found in Eocene strata; perhaps even in the coal measures (p. 295). Principal Dawson has recently described *Pupa* from the coal measures of Nova Scotia, which may be the same shell alluded to here.

others dry, rocky and rainless, especially in the south; it is watered by numerous streams—the affluents of the Amazon and Plata. The hydrographical areas of these two great rivers have been represented on the map, but the southern boundary of the Brazilian Province extends beyond the line of watershed to the tropic, including the head-waters of the Plata, in which the same remarkable fresh-water bivalves are found as in the Bolivian streams. (D'Orbigny). The mountains around the Lake Titicaca are the highest in the New World, and there M. D'Orbigny found several species of Helix up to the elevation of 14,000 feet; *Bulimus Tupaici* ranges to 9,000 feet. The large and typical species of *Bulimus* belong to this province; *B. ovatus* and *oblongus* are found near the coast (p. 291), and *B. maximus* farther inland. The auriculoid *Bulimi* (*Otostomus*, and *Pachyotis*, Beck), those with an angular mouth (*Goniostomus*, Beck), and the pupiform species, with a toothed aperture, (*Odontostomus*), are characteristic of this region, and also some of the most elongated forms (*Obeliscus*). The lamp snails (*Anastoma*) and *Megaspira*, genera inhabiting France during the Eocene period, are now peculiar to Brazil; *Simpulopsis* is also peculiar, and *Streptaxis* attains its maximum there. The *Cyclostomidæ* are few, and the other West Indian forms have almost disappeared.

Helix	47	Glandina	1	Cyclophorus	2
Streptaxis	11	Tornatellina	1	Cyclotus	1
Anastoma	7	Vitrina	5	Cistula	1
Bulimus	250	Omalonyx	1	Helicina	12
Megaspira	2	Simpulopsis	5		

The land slugs are *Peltella palliolum*, *Vaginulus solea*, and *Limax andicolus*. The fresh-waters of the interior are rich in bivalves of peculiar genera:*—

Physa	1	Ampullaria	2	Unio	4
Ancylus	1	Corbicula	2	Iridina	1
Planorbis	4	Pisidium	1	Hyria	1
Paludestrina	2	Anodon	1	Castalia	2
Marisa	1	Monocondylæa	1	Mycetopus	3
Succinea	27				

24. Peruvian Region.

The long and narrow tract between the Andes and Pacific, extending from the equator to 25° S. lat. forms a distinct, though comparatively unproductive province, including the coast of Ecuador, Peru, and Bolivia. It is warm and almost rainless;

* The American Expedition explored forty Brazilian streams, and found only one *Ampullaria*, one *Melania*, and one *Planorbis*. (Gould.)

the clouds discharge themselves on the east side of the Andes, and rain is so rare on the west coast that in some parts it only falls two or three times in a century. In Peru, during great part of the year, a vapour rises in the morning, called the "garua;" it disappears soon after midday, and is followed by heavy dews at night.

Mr. Cuming collected 46 species of land snails in Peru; and Dr. Pfeiffer enumerates 100, but perhaps half the latter were from the eastern side of the Andes, belonging to the Brazilian Province. They are mostly *Bulimi*, and are smaller and less richly coloured than those of Bolivia and Brazil; *B. Denickei*, *solutus*, and *turritus* are peculiar forms. *Cistula Delatreana* is the only operculated land snail, and *Vaginulus limayanus* the only slug.

Helix	12	Pupa	1	Ancylus	1
Bulimus	79	Balea	1	Ampullaria	1
Succinea	5	Cistula	1	Paludestrina	2
Glandina	1	Physa	1	Cyrena	3
Tornatellina	1	Planorbis	3	Anodon	1

25. Argentine Region.

The "region of arborescent Compositæ" has afforded scarcely any land snails; only 7 species of *Bulimus*, and 3 *Helices* are recorded, but some others may have been included with those of Brazil and Chili. From Bolivia this province is separated by the wide plains of the Great Desert, or northern prolongation of the Pampas; and all the eastern part has been submerged at a recent (geological) period; so that the only promising districts are Paraguay and the eastern declivities of the Chilian Andes. The fresh-water shells of the La Plata and its tributaries are more remarkable.

Chilinia	7	Cyclas	1	Byssoanodon	1
Planorbis	11	Pisidium	1	Monocondylæa	6
Ancylus	4	Corbicula	2	Mycetopus	1
Ampullaria	7	Unio	7	Castalia	1
Asolene	1	Anodon	10	Iridina	1
Paludestrina	7				

Ampullaria (Marisa) *cornu-arietis* is a characteristic shell; *Paludestrina lapidum* has a claw-like (non-spiral) operculum, and appears to belong to the *Melaniadæ*.

26. Chilian Region.

The northern part of Chili belongs to the same physical region with Peru, consisting of dry and rainless plains. Here the land snails are few and small, and only seen after the dews. At Valparaiso rain is abundant during the three winter months, and the southern coasts are luxuriantly wooded, and extremely wet. The characteristic pulmonifera are the fresh-water *Chilinias*. The genus *Buchanania* is doubtful. There are 31 species of Bulimus (including *B. Chilensis*, Plectostylus) and 22 of Helix; *Succinea Chiloensis*, *Ancylus Gayanus* (Valparaiso), *Planorbis fuscus*, *Paludestrina* sp. *Unio Chilensis*, *Pisidium Chilense* (Valdivia). *Helix Binneyana* is found on the island of Chiloë.

The Island of *Juan Fernandez* (36) has at least 20 species of land shells, all peculiar to it :—

Helix quadrata.	Omalonyx Gayana.	Tornatellina minuta.
„ arctispira.	Achatina diaphana.	„ trochiformis.
„ pusio.	„ splendida.	Succinea Cumingi.
„ tessellata.	„ bulimoides.	„ mamillata.
„ ceroides.	„ conifera.	„ fragilis.
„ marmorella.	„ acuminata?	Parmacella Cumingi.
„ helicophantoides.	Spiraxis consimilis.	

In the adjoining island, Masafuera, are found—

Tornatellina Recluzii.	Succinea semiglobosa.
Succinea rubicunda.	„ pinguis.

27. Patagonian Region.

The Pampas, or great plains of Patagonia, are dry and rainless nearly all the year; the vegetation which springs up during the light summer rains becomes converted into natural hay for the support of the wild animals. In Fuegia the mean temperature is 33°—50°, and there is rain and snow throughout the year; yet the bases of the mountains are clothed with forests of evergreen beech.* *Bulimus sporadicus* is found on the banks of the River Negro, and *B. lutescens* at the Straits of Magellan; *Helix lyrata* (costellata, D'Orbigny?) and *H. saxatilis* inhabit Fuegia. *Succinea magellanica* is also found at the Straits, and *Chilinia fluminea*, *Limnœa viatrix*, a *Paludestrina*, *Anodon puelchanus*, and *Unio Patagonicus* in the River Negro. *Peronia marginata* and *Potamides cœlatus* were discovered in Fuegia by Mr. Couthouy.

The *Falkland Islands* are 300 miles east of Patagonia, and the only recorded shells are two species of *Paludestrina*. There is

* Humming-birds are seen fluttering about delicate flowers, and parrots feeding amidst the ever-green woods. (Darwin, p. 251.)

zoological evidence that these islands were united to the mainland of South America at no very distant geological period. The flora consists of characteristic plants of Fuegia and Patagonia, mingled, and overspreading the whole surface; few species are peculiar. (J. D. Hooker.)*

* Dr. Hooker has suggested that not only the Falkland Islands, but the far distant Tristan d'Acunha (p. 97) and Kerguelen's-land (p. 99), may be mountain-tops of a continent which has been submerged since the epoch of their existing flora. "There are five detached groups of islands between Fuegia and Kerguelen's-land (a region extending 5,000 miles), all partaking of the botanical peculiarities of the southern extremity of the S. American continent. Some of these detached spots are much closer to the African and Australian continents, whose vegetation they do not assume, than to the American; and they are situated in latitudes and under circumstances eminently unfavourable to the migration of species."

"The botany of Tristan d'Acunha (which is only 1,000 miles distant from the Cape of Good Hope, but 3,000 from the Straits of Magellan) is far more intimately allied to that of Fuegia than Africa. Of twenty-eight flowering plants, seven are natives of Fuegia, or typical of S. American botany.

"The flora of Kerguelen's-land is similar to, and many of the species identical with, those of the American continent. (Its geological structure) would bespeak an antiquity for the flora of this isolated speck on the surface of our globe far beyond our power of calculation. We may regard it as the remains of some far more extended body of land." (Botany of Antarctic Voyage, i. pt. 2, 1847).

CHAPTER III.

ON THE DISTRIBUTION OF THE MOLLUSCA IN TIME.

THE historian of modern geology, Sir Charles Lyell, has taught us to regard the stratified rocks as so many monuments, recording the physical condition and living inhabitants of the earth in past ages.

Each *formation* consists of a similar and more or less complete series of limestones, sandstones, clay, coal, and other *strata*, representing the deep and shallow seas, the fresh-waters, and the terrestrial portions of the surface of the globe, at one particular period of time.*

The organic remains found in the strata exhibit no such repetitions, but are changed gradually and regularly, from the earliest to the latest formations; so that the *mass of species* in each period must have been peculiar and distinctive.

The important theory, that strata may be identified by fossils, was taught by William Smith, early in the present century, and is thus expressed in his *Stratigraphical System*:—"Organised fossils are to the naturalist as coins to the antiquary; they are the antiquities of the earth; and very distinctly show its gradual, regular formation, with the various changes of inhabitants in the watery element."—"They are chiefly submarine, and as they vary generally from the present inhabitants of the sea, so at separate periods of the earth's formation they vary as much from each other; insomuch that each layer of these fossil organised bodies must be considered as a separate creation; or how could the earth be formed, *stratum super stratum*, and each abundantly stored with a different race of animals and plants."†

The "Prodrome" of M. D'Orbigny is a catalogue of the shells (and radiate animals) of each formation, from which it appears that the mass of the living population of the globe has been changed twenty times since the close of the First or Palæozoic Age; and although the fossils of the older rocks have not been generally classified with the same minuteness, yet enough is

* The coal-measures and chalk of England cannot indeed be called *similar*, but the Cretaceous formations of the whole *world* afford *mineral* types, corresponding to, perhaps, every variety of Carboniferous rock.

† Stratigraphical System of Organised Fossils, 4to., Lond. 1817.

known to show that at least ten great changes had taken place before the Secondary epoch.

In the following Table, the first column gives the names of the Formations or Periods; the second contains those by which the principal strata are known.

I. GEOLOGICAL TABLE.

		Formations or Periods.	Names of Strata.
Palæozoic Age.	I.	1. Tremadocian	Longmynd slate. (Bangor, Wicklow.) Lingula flags = Primordial group. (Barrande.) Tremadoc slate. Potsdam sandstone.
		2. Snowdonian	Llandeilo flags, Caradoc sandstone — Bala or Coniston group.
	II.	3. Wenlock	May-hill sandstone = Clinton group. Woolhope and Dudley limestones.
		4. Ludlow	L. Ludlow, Aymestry lime., U. Ludlow.
	III.	5. Hercynian	Spirifer sandstone; Rhine. — Devonian and Old Red Sandstone.
		6. Eifelian	Plymouth limestone.
		7. Clymenian	Petherwin limestone.
	IV.	8. Bernician	Carboniferous limestone (shale and coal.)
		9. Demetian	Coal-measures. (Millstone-grit, coal, &c.)
	V.	10. Permian	Magnesian lime = Zechstein. (Perm.)
Secondary Age.	VI.	11. Conchylian	New Red sandstone = Bunter. (Muschel-kalk = Ceratite limestone).
		12. Saliferous	Red marls = Keuper. Lias bone-bed.
	VII.	13. Liassic	L. Lias = *Sinemurien* and *Liasien*.
		14. Toarcian	Marlstone, Alum-shale. (Thouars.)
		15. Bajocian	Inf. Oolite, Fuller's-earth. (Bayeux.)
		16. Bathonian	Great Oolite. (Stonesfield slate; G. Ool. Bradford cl. Forest m. Cornbrash.)
	VIII.	17. Oxfordian	Kelloway rock = *Callovien*, D'Orb. Oxford clay. (White Jura.)
		18. Corallian	Coral-rag and Calcareous grit.
		19. Kimmeridgian	Kimmeridge clay. (Dorsetshire.)
		20. Portlandian	Portland stone and Purbeck beds.
	IX.	21. Wealden	Hastings sand and Weald clay.
		22. Neocomian	Speeton clay? (Neuchatel). Lower Green-sand, and *Aptien*, D'Orb.
	X.	23. Albian	Gault. (District of the Aube, or *Albe*.)
		24. Cenomanian	Upper Green-sand. (Mans, *Cenomanum*.)
		25. Hippuritic	Chalk-marl and L. Chalk = *Turonien*.
		26. Senonian	Chalk with flints = Baculite limestone. Maestricht chalk = *Danien*, D'Orb.
Tertiary.	XI.	27. Londinian	Thanet sands, Plastic clay, London clay.
		28. Nummulitic	Bracklesham; Barton; I. Wight; = *Parisien*. Hempstead; Fontainbleau; = *Tongrien*.
	XII.	29. Falunian	Faluns of Touraine; Bordeaux, Vienna.
	XIII.	30. Icenian	Crag of E. Co. = *Sub-apennin*, D'Orb.

It must be observed that the number and magnitude of the "Formations" was determined by accident in the first instance, and afterwards modified to suit the requirements of theory, and to make them more nearly equal in value.*

* The names of formations are in great measure provisional, and open to criticism. Some of them were given by Brongniart and O. D'Halloy; others have been more

According to MM. Agassiz and D'Orbigny, all, or nearly all the fossils of each formation are peculiar; very few species being supposed to have survived from one period to another. Sudden and entire changes of this kind only take place when the nature of the deposit is completely altered—as when sands or clays rest upon chalk—and in these instances there is usually evidence (in the form of beds of shingle, or a change of dip) that an interval must have elapsed between the completion of the lower stratum and the commencement of the upper.

Professor Ramsay* has discussed this subject at considerable length. He endeavours to prove that where we have a complete succession of rocks the species die out and appear gradually and almost imperceptiby; that where there is any sudden change in the fauna, it is always accompanied by an unconformity in the rocks—that is, the rocks do not lie evenly on one another, but the lower one shows an eroded surface, or its stratifications are not parallel with those of the upper rock. A break in the current of animal life is believed to be always accompanied by a break in the succession of rocks. Each break marks a lapse of time during which no deposition of mud, &c., took place on the area marked by the break. As it is assumed that the change of specific forms has proceeded at a uniform rate throughout geological time, it is argued that the greater the difference in the fauna, the longer was the time indicated by the break. "I cannot resist the general inference that in cases of superposition, in proportion as the species are more or less continuous—that is to say, as the break of life is partial or complete, first in the species, but more importantly in the loss of old and the appearance of new allied or unallied genera—so was the interval of time shorter or longer that elapsed between the close of the lower and the commencement of the upper formation; and so it often happens that strata a few yards in thickness, or,

recently applied by D'Orbigny, Sedgwick, Murchison, and Barrande; and some are adopted from popular usage. *Geographical* names, and those derived from characteristic fossils have been found the best, but no complete scheme of *zoological* nomenclature has been framed.

The epithet "Turonien" (25) is rejected, because it conveys the same meaning with "Falunian" (29), or Middle Tertiary, the type of which was taken from Touraine.

The term *Icenian* is proposed for the Pliocene strata because their order of succession was first determined by Mr. Charlesworth, in the eastern counties of England, the country of the ICENI. We have left the table as it stood in the first edition of this work; but we should mention here that one formation should be placed at the head, viz., the Laurentian, and the beds deposited during and since the glacial epoch at the foot.

* Anniversary Addresses, Q. J. Geol. Soc., vols. xix. and xx. 1863 and 1864.

more notably still, the absence of these strata, may serve to indicate a period of time as great as the vast accumulations of the whole Silurian series." The lapse of time is in most cases further marked by extensive denudations of strata. During the Palæozoic age ten physical breaks are known, six of which occur before we reach the Devonian formation. In every case but one (and in that the rocks are almost entirely devoid of animal remains), there is an entire change in the species and a considerable change in the genera. The breaks in the Secondary period are less marked and less numerous, amounting to about four; and they are still less marked in the Tertiary period.

We have seen that distinct faunas may be separated by narrow barriers in existing seas; and differences almost as great may occur on the same coast-line without the interposition of any barrier, merely in passing from a sea-bed of rock and weed to one of sand or mud, or to a zone of different depth. It would be unreasonable to expect the same fossils in a limestone as in a sandstone; and even in comparing similar strata we must consider the probability of their having been formed at different depths, or in distinct zoological provinces.

The most careful observations hitherto made, under the most favourable circumstances, tend to show that all sudden alterations have been *local*, and that the law of change over the whole globe and through all time has been gradual and uniform. The hypothesis of Sir C. Lyell, that species have been created, and have died out, *one by one*, agrees far better with facts, than the doctrine of periodic and general extinctions and creations.

As regards the zoological value of the "formations," we shall be within the truth if we assume that those already established correspond in importance with geographical provinces; for at least half the species are peculiar, the remainder being common to the previous or succeeding strata. This will give to each Geological period a length equal to three times the average duration of the species of marine shells.*

The Distribution of the Species in the Strata (or in Time) is like their distribution in *space*. Each is most abundant in one horizon, and becomes gradually less frequent in the beds above

* The exact value of these *periods* cannot be ascertained, but some notion of their length may be obtained by considering that the deposits in the valley of the Mississippi, estimated to represent 100,000 years, have been accumulated since the era of many existing shells. The same may be said of the elevation of Mont Blanc, the formation of the Mediterranean Sea, and other grand physical events. The great cities of antiquity—Rome, Corinth, and Egyptian Thebes—stand upon raised sea-beds, or alluvial deposits, containing recent shells.

and below; the locality of the newest rock in which it occurs being often far removed from that of the oldest.*

That species should be created at a single spot, and gradually multiply and diffuse themselves, is sufficiently intelligible. That, after attaining a certain climax of development, they should decline and disappear, is a fact involved in mystery. But even if it depends on physical causes, and is not a law of all Being, its operation is equally certain, and does not appear to vary beyond moderate limits.

The deep-sea shells (such as *Rhynchonella*, *Terebratula*, and *Yoldia*) enjoy a longer range in time, as well as in space, than the littoral species; whilst the land and fresh-water shells are most remarkable for specific longevity.†

In each stratum there are some fossils which characterise small subdivisions of rock, just as there are living species of very limited range.

When species once die out they never reappear; one evidence of their having become extinct consisting in their replacement by other species, which fulfilled their functions, and are found in deposits formed under similar conditions. (Forbes.)

The total number of species is greater in the newest formations than in those of older date; but the ratio of increase has not been ascertained.‡

Distribution of Genera in Time.—The doctrine of the Identification of strata by fossils derives its chief value from the fact that the development and distribution of genera is as much subject to law as the distribution of species; and, so far as we know, follows a similar law.

Groups of strata, like the zoological provinces, may be of various magnitudes; and whilst the smaller divisions are characterised by peculiar *species*, the larger groups have distinct sub-genera, genera, and families, according to their size and importance.

William Smith himself observed that "three principal families of organised fossils occupy nearly three equal parts of Britain."

* M. Agassiz and Professor E. Forbes have represented, diagrammatically, the distribution of genera in time, by making the horizontal lines (such as in p. 124) swell out in proportion to the development of the genera. Those whose commencement, climax, and end are ascertained may be represented by a line of this kind 
Genera which attain their *maxima* in the present seas are thus expressed 

† Land and fresh-water shells of existing species are found with the fossil bones of the *Mastodon* and *Megalonyx*, in N. America. (Lyell.)

‡ The number in each formation depends on the extent to which it has been investigated, and on the opinions entertained as to the strata referable to it. Professor Phillips has discussed this subject in his work on Devonian fossils (p. 165), and in the "Guide to Geology."

"*Echini* are most common in the superior strata;
"*Ammonites* to those beneath;
"*Producti*, with numerous *Encrini*, to the lowest."

This kind of generalisation has justly been considered by Professor E. Forbes of higher importance than the identification of strata by *species*—a method only applicable to moderate areas, and becoming less available with distance. Indeed it might be assumed that strata geographically distant, yet containing some identical species, must differ in age by the time required for the migration of those species from one locality to the other.

A table of the characteristic *species* of the English strata is of little use in America or India, except to show how few and doubtful are the identical fossils. Whereas the characteristic genera and order of succession of the larger groups are the same at the most distant localities; and whatever value there may be in the assumption that particular systems of rocks contain most workable coal, lead, or rock-salt, is not lessened by the circumstance that the species of fossils in those rocks are not everywhere the same, since the genera alone are sufficient to identify them.

Genera, like species, have a commencement, a climax, and a period of decline; the smallest usually range through several formations, and many of the typical genera equal the families in duration.

Groups of formations are called Systems, and these again are combined in three principal series :—Palæozoic, Secondary, and Tertiary.

Thirteen geological systems, each having a number of peculiar genera, are shown in the accompanying table. (No. II.) Some of the genera cited have a wider range, like *Belemnites*, but are mentioned because of their abundance in one particular system. The names *in italics* are existing genera.*

The third table contains the names of some of the larger genera, arranged according to the order of their appearance. This diagram conveys the impression that the series of fossiliferous strata is not completely known; or that the beginning of many groups of fossils has been obliterated in the universal metamorphism of the oldest stratified rocks.†

* The *Pliocene strata* contain no extinct genera, and represent only the commencement of the present order of things. All the deposits now taking place will not constitute an additional "Formation," much less a "Quaternary System."

† It was on this account that Professor Sedgwick proposed the term "Palæozoic," rather than "Protozoic," for the oldest fossiliferous rocks.

II. TABLE OF CHARACTERISTIC GENERA.

Systems.	Genera and Sub-genera.
1. Cambrian, or Lower Silurian	Camaroceras, Endoceras, Gonioceras, Pterotheca. Maclurea, Raphistoma, Holopea, Platyceras. Orthisina, Platystrophia, Porambonites, Pseudo-crania. Ambonychia, Modiolopsis, Lyrodesma.
2. Silurian	Actinoceras, Phragmoceras, Trochoceras, Ascoceras. Theca, Holopella, Murchisonia, Atrypa, Retzia. Cardiola, Clidophorus, Goniophorus, Grammysia.
3. Devonian	Bactrites, Gyroceras, Clymenia, Apioceras, Serpularia. Spirifera, Uncites, Merista, Davidsonia, Calceola. Stringocephalus, Megalodon, Orthonota, Pterinea.
4. Carboniferous...	Nautiloceras, Discites, Goniatites, Porcellia. Naticopsis, Platyschisma, Metoptoma, Productus. Aviculo-pecten, Anthracosia, Conocardium, Sedgwickia.
5. Permian	Camarophoria, Aulosteges, Strophalosia. Myalina, Bakewellia, Axinus, Edmondia.
6. Trias	Ceratites, Naticella, Platystoma, Koninckia, Cyrtia. Monotis, Myophoria, Pleurophorus, Opis.
7. L. Jurassic	Belemnites, Beloteuthis, Geoteuthis, Ammonites. Alaria, Trochotoma, Rimula, Pileolus, Cylindrites. Waldheimia, *Thecidium*, Spiriferina, Ceromya. Gryphæa, Hippopodium, Cardinia, Myoconcha.
8. U. Jurassic	Coccoteuthis, Leptoteuthis, Nautilus. Spinigera, Purpurina, Nerinæa, Neritoma. Pteroperna, Trichites, Hypotrema, Diceras. Trigonia, Pachyrisma, Sowerbia, Tancredia.
9. L. Cretaceous ...	Crioceras, Toxoceras, Hamulina, Baculina. Requienia, Caprinella, Sphæra, Thetis.
10. U. Cretaceous ...	Belemnitella, Conoteuthis, Turrilites, Ptychoceras. Hamites, Scaphites, Pterodonta, Cinulia, Tylostoma. Acteonella, Globiconcha, Trigonosemus, Magas, Lyra. Neithea, Inoceramus, Hippurites, Caprina, Caprotina.
11. Eocene	Beloptera, Lychnus, *Megaspira*, *Glandina*, *Typhis*. *Volutilithes*, *Clavella*, *Pseudoliva*, *Seraphs*, *Rimella*. Conorbis, Strepsidura, Globulus, *Phorus*, Velates. Chilostoma, Volvaria, Lithocardium, Teredina.
12. Miocene	Spirulirostra, Aturia, Vaginella, Ferussina. Halia, Proto, Deshayesia, *Niso*, *Cassidaria*, Carolia. Grateloupia, *Artemis*, *Tapes*, *Jouannetia*.
13. Pliocene	*Argonauta*, *Strombus*, *Purpura*, *Trophon*. *Yoldia*, *Tridacna*, *Circe*, *Verticordia*.

III. RANGE OF GENERA IN TIME.

Genera, arranged in their Order of Appearance.	Cambrian.	Silurian.	Devonian.	Carbonif.	Permian.	Trias.	L. Jura.	U. Jura.	L. Cret.	U. Cret.	Eocene.	Miocene.	Pliocene.
Lituites, Raphistoma, Obolus	—	—											
Camaroceras, Atrypa, Pterinea	—	—	—										
Gomphoceras, Bellerophon, Pentamerus	—	—	—	—									
Orthis, Conularia, Murchisonia	—	—	—	—	—								
Spirifera, Athyris, Posidonomya	—	—	—	—	—	—	—						
Isoarca	—	—	—	—	—	—	—	—	—	—			
Conocardium, Megalodon, Chonetes		—	—	—									
Cardiomorpha		—	—	—	—								
Orthoceras, Loxonema, Cyrtia		—	—	—	—	—							
Pleurotomaria, Porcellia		—	—	—	—	—	—	—	—	—	—		
Productus, Macrochilus, Streptorhynchus			—	—	—								
Goniatites, Pleurophorus			—	—	—	—							
Edmondia, Myalina				—	—								
Acteonina				—	—	—	—	—					
Terebratula, Pinna, Cyprina				—	—	—	—	—	—	—	—	—	—
Lima					—	—	—	—	—	—	—	—	—
Gervillia, Myoconcha					—	—	—	—	—	—			
Ammonites, Naticella, Opis						—	—	—	—	—			
Trigonia, Isocardia, Thecidium						—	—	—	—	—	—	—	—
Cerithium, Plicatula, Cardita						—	—	—	—	—	—	—	—
Trochotoma, Tancredia, Gryphæa							—	—					
Ancyloceras, Inoceramus, Unicardium							—	—	—	—			
Astarte, Pholadomya, Corbis							—	—	—	—	—	—	—
Nerinæa, Goniomya, Exogyra								—	—	—			
Terebratella, Limopsis, Neæra, Argiope								—	—	—	—	—	—
Baculites, Cinulia, Radiolites									—	—			
Physa, Paludina, Unio, Cyrena									—	—	—	—	—
Aporrhais, Tornatella, Pyrula									—	—	—	—	—
Pectunculus, Thetis, Crassatella									—	—	—	—	—
Crenella, Chama										—	—	—	—
Voluta, Conus, Mitra, Haliotis, &c.										—	—	—	—
Aturia											—	—	
Helix, Auricula, Cyclostoma											—	—	—
Pseudoliva, Rostellaria, Seraphs											—	—	—
Purpura, Strombus												—	—
Argonauta, Tridacna													—

The genera of the *older rocks* are believed to be nearly all extinct; for although the names of many recent forms appear in the catalogues of Palæozoic fossils, it must be understood that they are only employed in default of more exact information. *Buccinum*, *Melania*, and *Mya* have been long since expunged; and *Modiola*, *Nucula*, and *Natica*, are only retained until the characters which distinguish them are better understood.

IV. RANGE OF FAMILIES IN TIME.

Systems of Strata.	Cambrian.	Silurian.	Devonian.	Carbonif.	Permian.	Trias.	L. Jura.	U. Jura.	L. Cret.	U. Cret.	Eocene.	Miocene.	Pliocene.	Recent.
Argonautidæ													—	—
Teuthidæ—Sepiadæ							—	—	—	—	—	—	—	—
Belemnitidæ							—	—	—	—				
Nautilidæ		—	—	—	—	—	—	—	—	—	—	—	—	—
Ammonitidæ			—	—	—	—	—	—	—	—				
Orthoceratidæ	—	—	—	—	—	—								
Atlantidæ—Hyaleidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Strombidæ—Buccinidæ										—	—	—	—	—
Conidæ—Volutidæ										—	—	—	—	—
Naticidæ—Calyptræidæ			—	—	—	—	—	—	—	—	—	—	—	—
Pyramidellidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cerithiadæ—Littorinidæ						—	—	—	—	—	—	—	—	—
Turbinidæ—Ianthinidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fissurellidæ—Tornatellidæ				—	—	—	—	—	—	—	—	—	—	—
Neritidæ—Patellidæ							—	—	—	—	—	—	—	—
Dentaliadæ			—	—	—	—	—	—	—	—	—	—	—	—
Chitonidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bullidæ							—	—	—	—	—	—	—	—
Helicidæ—Limacidæ											—	—	—	—
Limnæidæ—Melaniadæ								—	—	—	—	—	—	—
Auriculidæ—Cyclostomidæ										—	—	—	—	—
Terebratulidæ			—	—	—	—	—	—	—	—	—	—	—	—
Rhynchonellidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spiriferidæ—Orthidæ	—	—	—	—	—	—	—							
Productidæ	—	—	—	—	—									
Craniadæ—Lingulidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pectinidæ				—	—	—	—	—	—	—	—	—	—	—
Aviculidæ—Mytilidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Arcadæ—Trigoniadæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unionidæ									—	—	—	—	—	—
Chamidæ—Myadæ								—	—	—	—	—	—	—
Hippuritidæ									—	—				
Tridacnidæ													—	—
Cardiadæ—Lucinidæ		—	—	—	—	—	—	—	—	—	—	—	—	—
Cycladidæ								—	—	—	—	—	—	—
Cyprinidæ—Anatinidæ	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Astartidæ						—	—	—	—	—	—	—	—	—
Veneridæ—Tellinidæ								—	—	—	—	—	—	—
Mactridæ										—	—	—	—	—
Solenidæ				—	—	—	—	—	—	—	—	—	—	—
Gastrochænidæ—Pholadidæ							—	—	—	—	—	—	—	—

Distribution of Families of Shells in Time.—Employing the term "families" for natural groups of genera, and adopting the smallest possible number of them, we find that sixteen, or nearly one-fifth, range through all the geological systems. Only seven have become extinct, viz. :—

Belemnitidæ.	Spiriferidæ.	Hippuritidæ.
Ammonitidæ.	Orithidæ.	
Orthoceratidæ.	Productidæ.	

Three others are nearly extinct:—

Nautilidæ. Rhynchonellidæ. Trigoniadæ.

And several have passed their maximum, and become less varied and abundant than formerly, *e.g.*—

Tornatellidæ. Cyprinidæ. Anatinidæ.

The extinct families and genera appear to have attained their *maxima* more rapidly than their *minima;* continuing to exist, under obscure forms, and in remote localities, long after the period in which they flourished.

The introduction of new forms, also, is more rapid than the process of extinction. If four Palæozoic families disappear, twenty-six others replace them in the Secondary series; and three of the latter are succeeded by fifteen shell-bearing families in the Tertiary and existing seas.

In consequence of this circumstance, the number of types is three times greater in the newer Tertiary than it was at the Silurian period; and since there is no evidence or indication that the earth was ever destitute of life, either wholly or in part, it follows almost as a matter of necessity that the early types must have been more widely distributed and individually developed, than those of the present day.

From the following Table it will be seen that the number of genera and families increases with an amount of regularity which cannot be accidental. Moreover, the relation of these numbers is not liable to be much altered by the progress of discovery or the caprice of opinion. The *discovery* of new types is not likely to be frequent; the imposition of new names, in place of the old, will not increase the number of Palæozoic genera; and the establishment of fresh and arbitrary distinctions will affect all the groups in due proportion.

If the number of groups called "Systems" were reduced to seven (viz., three Palæozoic, three Secondary, and one Tertiary, as shown in the following Table), then the *average* duration of a genus of shells would be equal to a System of Formations.

The duration of the smallest well-defined Families of shells is about equal to one of the three great Geological Divisions, or Ages.

DEVELOPMENT OF FAMILIES, GENERA, AND SPECIES, IN TIME.

		Geological Systems.	Total of Genera.	Cephalopoda.	Gasteropoda.	Brachiopoda.	Conchifera.	Total Number of Species (D'Orbigny).	Families.	
Palæozoic.	1	Cambrian	49	12	11	15	11	362	18	32
	1	Silurian	53	13	11	16	13	317	20	
	2	Devonian	77	14	20	23	20	1035	24	
	3	Carboniferous	79	11	26	19	23	835	30	
	3	Permian*	66	6	24	16	20	74	30	
Secondary.	4	Trias	81	9	25	16	31	713	35	57
	5	L. Jurassic	107	12	35	12	48	1502	42	
	5	U. Jurassic	108	13	36	9	50	1266	49	
	6	L. Cretaceous	123	20	41	9	53	784	52	
	6	U. Cretaceous	148	16	59	14	59	2147	56	
Tertiary.	7	Eocene	172	4	85	11	72	2636	60	78
	7	Miocene	178	3	97	11	76	2242	60	
	7	Pliocene	192	1	100	12	79	437	62	
		Recent	400	21	251	13	115	16,000	78	
		Recent & Fossil	520	56	280	34	150	30,000	85	

Order of Appearance of the Groups of Shells.—The first and most important point shown in the preceding Tables, is the co-existence of the four principal classes of *testacea* from the earliest period. The highest and the lowest groups were most abundant in the palæozoic age; the ordinary bivalves and univalves attain their climax in existing seas. If there be any meaning in this order of appearance it is connected with the general scheme of creation, and cannot be inquired into separately; but it may be observed that the last-developed groups are also the most typical, or *characteristic of their class* (p. 49).

The *Cephalopoda* exhibit amongst themselves unmistakable evidence of order in their appearance and succession. The tetrabranchiate group comes earliest, and culminates about the period of the first appearance of the more highly-organised cuttle-fishes.† The families of each division which are least unlike

* Those genera are estimated as belonging to each system which occur in the strata *both above and below*, as well as those actually found in it. We have left this table as it stood in the first edition, as we are unable to correct all the figures. This, however, is not of much importance, since the main points, such as the gradual increase in the number of families, would not be affected.

† The *Palæoteuthis* of Bronn (not D'Orb.) appears to be a *fish-bone*, from the equivalent of the Old Red sandstone in the Eifel.

(*Orthoceratidæ and Belemnitidæ*) were respectively the first developed.

Amongst the *Brachiopoda* the hingeless genera attained their maximum in the palæozoic age, and only three now survive (*Lingula*, *Discina*, *Crania*,)—the representatives of as many distinct families. Of the genera with articulated valves, those provided with spiral arms appeared first and attained their maximum while the *Terebratulidæ* were still few in number. The subdivision with calcareous spires disappeared with the Liassic period, whereas the genus Rhynchonella still exists. Lastly, the typical group, *Terebratulidæ*, attained its maximum in the chalk period, and is scarcely yet on the decline. The number of sub-genera (as well as genera) in each system is stated in the preceding table, because this group shows a tendency to "polarity," or excessive development at the ends of the series.*

The genera of ordinary bivalves (*Conchifera*) are seven times more numerous in the newer tertiary than in the oldest geological system. The palæozoic formations contain numerous genera of all the families with an *open mantle; Cyprinidæ*, *Anatinidæ*, and the anomalous genus *Conocardium*. The mass of siphonated bivalves do not appear till the middle of the secondary age, and are only now at their maximum.

The *Gasteropoda* are represented in the palæozoic strata by several genera closely allied to the diminutive *Atlanta* and *Scissurella*, and by others perhaps related to *Ianthina*. The *Naticidæ* and *Calyptræidæ* are plentiful, and there are several genera of elongated spiral shells referred to the *Pyramidellidæ*. In the secondary strata, *holostomatous* shells become plentiful; and in a few peculiar localities (especially Southern India) the genera of siphonated univalves make their appearance in strata of Cretaceous age. Fresh-water *Pulmonifera* of the recent genus *Physa* occur in the Purbeck strata, but the marine air-breathers and land-snails have not certainly been found in strata older than the Eocene tertiary.

Order of Succession of Groups of Shells.—It has been already pointed out that animals which are closely allied in structure

* See the anniversary address of Professor E. Forbes to the Geological Society of London, Feb., 1854, p. 63. The hypothesis seems to have arisen out of an exclusive regard to the poverty of the Permian and Triassic strata in England, where they separate, like a desert, the palæozoic from the "neozoic" formations. The "Permian" should never have been esteemed more than a division of the carboniferous system, and is poor in *species*, rather than in *types*. The Trias must be studied in Germany, or in the collection of Dr. Klipstein (in the British Museum) to be properly appreciated.

and habit rarely live together, but occupy distinct *areas*, and are termed "representative species." The same thing has been observed in the distribution of fossils; the species of successive strata are mostly representative.

At wider intervals of time and space, the representation is only generic, and the relative proportions of the larger groups are also changed.

The succession of forms is often so regular as to mislead a superficial observer; whilst it affords, if properly investigated, a valuable clue to the affinities of problematic fossils.

It is now generally admitted that the earlier forms of life, strange as many of them seem to us, were really less metamorphosed—or departed less widely from their ideal archetypes—than those of later periods and of the present day.* The types first developed are most like the embryonic forms of their respective groups, and the progression observed is from these general types to forms more highly specialised. (Owen.)

Migration of Species and diffusion of Genera in Former Times.—Having adopted the doctrine of the continuity of specific and generic areas, it remains to be shown that such groups as are now widely scattered *can* have been diffused from common centres, and that the barriers which now divide them have not always existed.

In the first place it will be noticed that the mass of the stratified rocks are of *marine origin*, a circumstance not to be wondered at, since the area of the sea is twice as great as the land, and probably has always been so; for the average depth of the sea is much greater than the general elevation of the land.†

The mineral changes in the strata may sometimes be accounted for by changes in the depth of the sea, or an altered direction of the currents. But in many instances the sea-bed has been elevated so as to become dry land, in the interval between the formation of two distinct marine strata; and these alterations are believed to occur (at least) *once in each formation.*

If every part of what is now dry land has (on the average)

* Mr. Darwin has pointed out that the *sessile* Cirripedes, which are more highly metamorphosed than the *Lepadidæ*, were the last to appear. The fossil mammalia afford, however, the most remarkable examples of this law. At the present day such an animal as the three-toed horse (*Hippotherium*) of the Miocene Tertiary would be deemed a *lusus naturæ*, but in truth the ordinary horse is far more wonderful. Unfortunately, a new "vulgar error" has arisen from the terms in which extinct animals have sometimes been described, as if they had been constructed upon *several distinct* types, and combined the character of several classes.

† The enormous thickness of the older rocks *in all parts of the world* has been held to indicate the prevalence of deep water in the primæval seas.

been thirty times submerged, and has formed part of the sea-bed during two-thirds of all the past geological time,—there will be no difficulty in accounting for the migration of sea-shells, or the diffusion of marine genera.

On the other hand, it may be inferred that every part of the present sea has been dry land many different times; on an average not less than thirty times,—amounting to one-third of the whole interval since the Cambrian epoch.

The average duration of the marine species has been assumed at only one-third the length of a geological period, and this harmonises with the fact that so few (either living or extinct) have a world-wide distribution.

The life of the land-snails and of the fresh-water shells has been of longer average extent, enabling them to acquire a wide range, notwithstanding their tardy migrations.

But when we compare the estimated rate of change in physical geography with the duration of *genera* and *families* of shells, we not only find ample time for their diffusion by land or sea over large portions of the world, but we may perceive that such transferences of the scene of creation must have become inevitable.

Method of Geological Investigation.—In whatever way geological history is written, its original investigators have only one method of proceeding—from the known to the unknown—or backwards in the course of time.

The newest and most superficial deposits contain the remains of man and his works, and the animals he has introduced.

Those of pre-historic date, but still very modern, contain shells, &c., of recent species, but in proportions different from those which now prevail (pp. 89, 90, 93). Some of the species may be extinct in the immediate neighbourhood of the deposits, but still living at a distance.

In the harbour of New Bedford are colonies of dead shells of the *Pholas costata*, a species living on the coast of the Southern States. At Bracklesham, Sussex, there is a raised sea-bed containing 35 species of sea-shells living on the same coast, and 2 no longer living there, viz.—*Pecten polymorphus*, a Mediterranean shell; and *Lutraria rugosa*, still found on the coasts of Portugal and Mogador.

Tertiary Age.—If any distinction is to be made between "Tertiary" and "Post-tertiary" strata, the former term should be restricted to those deposits which contain some *extinct* species. And the newest of these, in Britain, contain an assemblage of Northern shells. Professor Forbes has published a list of 124 species of shells from these "Glacial beds," nearly all of which are now existing in British seas.*

In most of the localities for glacial shells, the species are all recent; but at Bridlington, Yorkshire, and in the Norwich *Crag*, a few extinct species are found (e.g. *Nucula Cobboldiæ*, Pl. 17, f. 18). At Chillesford, Suffolk, *Yoldia arctica* and *myalis* occur of large size and in excellent preservation, with numerous specimens of *Mya truncata*, erect as they lived, in the muddy sea-bed. *Trophon scalariforme*, *Admete viridula*, *Scalaria grœnlandica*, and *Natica grœnlandica*, also occur in the Norwich Crag; and *Astarte borealis*, with several arctic forms of *Tellina*, are amongst the commonest shells, and frequently occur in pairs, or with their *ligament* preserved; the deposit is extensively quarried for shell-sand.

Raised sea-beds with Arctic shells at Uddevalla, in Sweden, have been repeatedly noticed ever since the time of Linnæus. Captain Bayfield discovered similar beds near Quebec, 50—200 feet above the River St. Lawrence, containing an assemblage of shells entirely Arctic in character; whereas in the present gulf he obtained an admixture of the American representatives of Lusitanian types, *Mesodesma*, *Periploma*, *Petricola*, *Crepidula*.

The glacial deposits of the northern hemisphere extend about 15° south of the line of "northern limit of trees;" but this comparatively recent extension of the Arctic ocean does not appear to have much influenced, if it ever invaded, the inland basin of the Aralo-Caspian, which contains only one species common to the White Sea, *Cardium edule*, var. *rusticum*.†

The older pliocene period is represented in England by the *Coralline Crag*, a deposit containing 340 species of shells. Of these 73 are living British species, but (with two or three exceptions) they are such as range south of Britain. (Forbes.) The remainder are extinct, or living only to the south, especially in the Lusitanian province: e.g. *Fossarus sulcatus*, *Lucinopsis Lajonkairii*, *Chama gryphoides*, and species of *Cassidaria*, *Cleodora*, *Sigaretus*, *Terebra*, *Columbella*, and *Pyramidella*. It also contains a few forms belonging to an earlier age—a *Pholadomya*, a true *Pyrula*, a *Lingula*, and a large *Voluta*, resembling the Magellanic species.

* The species which have retired farther north are marked (**) in the preceding Arctic List, pp. 57, 58.

† Mr. Wm. Hopkins, of Cambridge, has investigated the causes which may have produced a temporary extension of the Arctic phenomena in Europe; and considers the most efficient and probable cause would be a diversion of the Gulf-stream, which he supposes to have flowed up what is now the valley of the Mississippi. (*Geological Journal*).

The shells of the newer tertiaries are always identical, at least *generically*, with those of the nearest coasts. Thus, in Patagonia are found species of *Trophon*, *Crepidula*, *Monoceros*, *Pseudoliva*, *Voluta*, *Oliva*, *Crassatella*, and *Solenella*. The tertiaries of the United States contain species of *Fulgur*, *Mercenaria*, and *Gnathodon*. The miocene shells of St. Domingo appear at first sight to be all of recent species, but on comparison prove to be mostly distinct.

The proportion of extinct species in the *Pliocene* tertiary varies from 1—50 per cent. If a deposit contains more than 50 per cent. of extinct species it is referred to the *Miocene* period; and this test is particularly valuable since the modern deposits are often isolated, and frequently no assistance can be derived from superposition, or even from identity of species.

In the *Eocene* tertiaries we perceive the "dawn" of the present order of things. All, or very nearly all, the species are different, but a large proportion of the genera are still existing, though not always in the seas nearest to the localities where they occur fossil.

Thus in the London clay are found—*Rostellaria*, *Oliva*, *Ancillaria*, and *Vulsella*, genera still living in the Red Sea; and many species of *Nautilus*, *Rimella*, *Seraphs*, *Conus*, *Mitra*, *Pyrula*, *Phorus*, *Liotia*, *Cardilia*—genera characteristic of the Indian Ocean; *Cyprovula*, *Typhis*, and *Volutilithes*, now living at the Cape; *Clavella*, at the Marquesas, and *Pseudoliva*, *Trochita*, and species of *Murex*, whose recent analogues are found on the western shores of South America.

The freshwater shells of this period are Old World forms: *Melanopsis*, *Potamides*, *Lampania*, *Melanatria*, and *Nematura*; whilst the land-shells form a group quite American in character —large species of *Glandina* and *Bulimus* (with reflected lip) *Megalomastoma* (*mumia*), a *Cyclotus* (with its operculum) like *C. Jamaicensis*, and the little *Helix labyrinthicus*.

Secondary Age.—In none of the older strata do we find indications of a warmer climate having prevailed, in the latitude of England, than that which marks the period of the London clay. And this is not more than can be accounted for by such a cause as the flow of an equatorial current from the direction of the Red Sea, until arrested by a continent to the south-west, as supposed by Mr. Prestwich, in the region of the Azores.

Some indications exist of a more moderate climate having obtained in the north polar regions; for remains of the *Ichthyosaurus* were found at Exmouth Island, the farthest point reached by Sir E. Belcher's expedition.

The peculiar physical conditions of the *Chalk period* are represented at the present day, not so much by the Coral Sea, as by the Ægean, where calcareous mud, derived from the waste of the *scaglia* regions, is being rapidly deposited in deep water. (*Forbes.*)

The *Wealden period* was styled the "Age of Reptiles" by Dr. Mantell, who compared the state of England at that time with the present condition of the Galapagos Islands.

The *Oolitic period* finds its parallel in Australia, as long since pointed out by Professor Phillips, and the comparison holds good to some extent, both for the Marine and Terrestrial Faunas.

The *Trias*, with its foot-prints of gigantic wingless birds, has been compared with the state of the Mascarene Islands only a few centuries ago, and with the New Zealand Fauna, where birds are still the highest aboriginal inhabitants.*

Palæozoic Age.—It has lately been shown by Professor Ramsay that signs of glacial action may be traced in some of the trappean conglomerates of the *Permian* and of the Devonian or Old Red Sandstone period in England; and Mr. Page has endeavoured to apply the same interpretation to phenomena of a similar character in the Old Red sandstone of Scotland.† Geologists generally have abandoned the notion, once very prevalent, of a universal high temperature in the earliest periods; a notion which they had derived from the occurrence of certain fossil plants, corals, and shells in high latitudes.

The absence of remains of mammalia in the palæozoic formations, is at present a remarkable fact, but it is completely paralleled in the great modern zoological province of the Pacific Islands.

Baron Humboldt has speculated on the possibility of some land being yet discovered, where gigantic lichens and arborescent mosses may be the princes of the vegetable kingdom.‡ If such exist, to shadow the Palæozoic age, its appropriate inhabitants would be like the cavern-haunting *Proteus*, and the *Silures* which find an asylum even in the craters of the Andes.

What, then, is it which has chiefly determined the character of the present zoological provinces? What law, more powerful than climate, more influential than soil, and food, and shelter;

* In a paper read before the British Association, on the subject of the great extinct wingless birds of New Zealand, Professor Owen suggested the notion of land having been propagated like a wave throughout the vast interval between Connecticut and New Zealand, since the Triassic period.

† See also the Rev. J. G. Cumming's "Isle of Man" (1849), p. 89.

‡ Views of Nature, p. 221. Bohn's ed.

nay, often seemingly producing results opposed to *à priori* probability, and at variance with the suitableness of conditions?*

The answer is, that each fauna bears, above all things, the impress of the age to which it belongs. Each has undergone a series of vicissitudes up to the time when its barriers became fixed, and after its isolation it has known no further change, but decline.

The number of living and fossil species of each genus of mollusca will be stated in the following pages, so far as they can be ascertained. With some modifications, these numbers give the following totals, by which the relative numerical development of the orders and families will be seen.

	Recent.	Fossil.
CEPHALOPODA. *Dibranchiata.*		
Argonautidæ	4	2
Octopodidæ	63	—
Teuthidæ	104	31
Belemnitidæ	—	140
Sepiadæ	30	16
Spirulidæ	3	—
	204	189
Tetrabranchiata.		
Nautilidæ	6 }	593
Orthoceratidæ	— }	
Ammonitidæ	—	1600
	6	2193
GASTEROPODA. *Prosobranchiata.*		
Strombidæ†	87	393
Muricidæ	993	703
Buccinidæ	1,144	352
Conidæ	856	462
Volutidæ	686	210
Cypraeidæ	227	97
Naticidæ	268	340
Pyramidellidæ	216	394
Cerithiadæ	192	610
Melaniadæ	424	50
Turritellidæ‡	329	290
Littorinidæ	410	220
Paludinidæ	217	110
Calyptræidæ	160	101
Turbinidæ	855	906
Haliotidæ	104	136
Fissurellidæ	201	76

	Recent.	Fossil.
Neritidæ	428	103
Patellidæ	368	104
Dentaliadæ	50	125
Chitonidæ	250	37
	8,465	5,819
Pulmonifera.		
Helicidæ	4750	316
Limacidæ	93	4
Limnæidæ	332	185
(Marine)	193	37
(Ditto, shell-less)	36	—
	5,404	542
Operculated Pulmonifera.		
Cyclostomidæ	903	45
Aciculidæ	28	1
	931	46
Tecti-branchiata.		
Tornatellidæ	62	166
Bullidæ	168	88
Aplysiadæ	84	4
Pleurobranchidæ	28	5
Phyllidiadæ	14	—
	356	263
Nudibranchiata.		
Doridæ	160	—
Tritoniadæ	38	—
Æolidæ	101	—
Phyllirhoidæ	6	—
Elysiadæ	13	—
	318	

* Burchell, in Darwin's Journal, p. 87.

† Including *Aporrhais*

‡ With *Scalaria*.

	Recent.	Fossil.
Nucleobranchiata.		
Firolidæ	33	1
Atlantidæ	22	159
	55	160
PTEROPODA.		
Hyaleidæ	52	95
Limacinidæ	19	—
Clionidæ	14	—
	85	95
BRACHIOPODA.		
Terebratulidæ	67	340
Spiriferidæ	—	380
Rhynchonellidæ	4	422
Orthidæ	—	328
Productidæ	—	146
Craniadæ	5	37
Discinidæ	10	90
Lingulidæ	16	99
	102	1,842

	Recent.	Fossil.
CONCHIFERA.		
Ostreidæ	426	1,362
Aviculidæ	94	638
Mytilidæ	217	331
Arcadæ	360	1,142
Trigoniadæ	3	139
Unionidæ	549	58
Chamidæ	50	62
Hippuritidæ	—	103
Tridacnidæ	8	3
Cardiadæ	200	369
Lucinidæ	178	446
Cycladidæ	176	144
Cyprindæ	176	956
Veneridæ	600	329
Mactridæ	147	58
Tellinidæ	560	388
Solenidæ	63	81
Myacidæ	121	334
Anatinidæ	246	400
Gastrochænidæ	40	35
Pholadidæ	81	50
	4,295	7,419

GENERAL SUMMARY.

	Recent.	Fossil.
Dibranchiata	204	189
Tetrabranchiata	6	2,193
Prosobranchiata	8,465	5,819
Inoperculated Pulmonifera	5,404	542
Operculated Pulmonifera	931	46
Tectibranchiata	356	263
Nudibranchiata	318	—

	Recent.	Fossil.
Nucleobranchiata	55	160
Pteropoda	85	95
Brachiopoda	102	1842
Conchifera	4,295	7,419
	20,502	18,568

CHAPTER IV.

ON COLLECTING SHELLS.

The circumstances under which shells are found is a subject so intimately connected with the methods of collecting them, as to make it undesirable to treat of them separately.

Naturalists distinguish between the *habitats*, or geographical localities of species, and the stations or circumstances in which they are found: to the latter subject only slight allusion has been hitherto made (p. 7).

Land-shells are most abundant on calcareous soils (p. 29), and in warm and moist climates. The British species are collected with advantage in autumn, when full-grown, and showing themselves freely in the dews of morning and evening. Some species, like *Bulimus acutus*, are found only near the sea; *Bulimus Lackhamensis* ascends beech trees on the Chalk downs and Cotswolds; *Pupa Juniperi* and *Helix umbilicata* occur chiefly on rocks and stone walls. The moss-frequenting *Clausiliæ* may be obtained even in mild winter weather at the roots of trees; the small species of *Pupa* (or *Vertigo*) are sometimes taken abundantly when sweeping wet grass with an insect net; *Acicula fusca* lives at the roots of grass; *Cionella acicula* is found in old bones (such as occur in Danish burial-grounds!), and occasionally in moving garden-bulbs; *Helix aculeata* has been met with on the under sides of leaves (*e.g.* the sycamore), a few feet from the earth.

In tropical countries a large number of the land snails are *arboreal* in their habits. The West Indian palms (such as *Oreodoxa regia*) are the chosen abode of many species of Helicidæ. M. Couthouy found *Bulimus auris leporis* on the orange and myrtle-trees near Rio, and *Partulæ* and *Helicinæ*, on the Dracænas and Bananas of the Polynesian Islands; and the sailors of H.M.S. *Rattlesnake*, in Captain Owen Stanley's expedition, became expert in collecting *Geotrochi* in the trees of the Australian islands.

The great tropical *Bulimi* and *Achatinæ* will sometimes lay their eggs in captivity.*

* Such giants require to be collected in a basket, while the small land-shells of open and rocky countries may be put in a cotton bag, hung on a coat button.

The following are examples of the elevations at which land-snails have been found. (pp. 289, 294.)

Helix pomatia, 5,000 feet—Alps. (Jeffreys.)
„ rupestris, 1,200—5,000 ft.
„ bursatella, Gould, 2,000—5,000 ft. Taheiti.
Bulimus vibex, 7,000 ft. India. (Benson.)
„ nivicola and ornatus, 14,000 ft. „
„ Lamarckianus, 8,000 ft. New Granada.
Achatina latebricola, 4—7,000 ft. Landour.
Pupa Halleriana, 1,200—2,500 ft. Alps.
„ tantilla, 2,000 ft. Taheiti.
Clausilia Idæa, 5,500 ft. Mt. Ida.
Vitrina glacialis, Forbes, 8,000 ft. Monte Rosa.
„ annularis, 2,000—3,000 ft. Burgos. (M'Andrew.)
„ Teneriffæ, 2,000 – 6,210 ft. Madeira.
Helicina occidentalis, Guilding, 2,000 ft. St. Vincent's.
(Limnæa Hookeri, 18,000 ft. Thibet.)

The land-snails of warm and dry regions remain dormant for long periods (p. 14), and require no attention for many months after being collected.*

Freshwater shells are collected with an insect net or "landing net" of strength suited to the work of raising masses of weed. The strongly rooted flags and rushes may be pulled up with a boat-hook; and *Cyclades*, as well as univalves, may be obtained by shaking aquatic plants over the net. For getting up the pearl mussels, the most efficient instrument is a tin bowl, perforated like a sieve, and fitted on the end of a staff, or jointed rod. (Pickering.)

In some situations the fresh-water shells are all much eroded (p. 33,), or coated with a ferruginous deposit. It may be desirable to find out the localities where the specimens are in best condition before collecting extensively. The *opercula* should always be preserved with the shells to which they belong; those of the *Cyclostomidæ* and *Melaniadæ* are particularly interesting.

The *Auriculidæ* are especially met with in damp places by the sea; in mangrove-swamps, and creeks and river-banks where the water becomes brackish. *Amphibola* and *Assiminea* are found in salt-marshes, *Siphonaria* and *Peronia* on the shore, between tide-marks.

Collecting Sea-shells.—The following remarks are from the pen

* Land and fresh-water snails may be killed instantaneously with boiling water, if a few are done at a time; and cooled by removal to cold water. Every collector finds expedients for removing the animals more or less completely from their shells; those which, like *Clausilia*, retire beyond the reach of a bent pin may be drowned in tepid water.

of an experienced conchologist, Mr. W. J. Broderip:—"When the tide is at the lowest, the collector should wade among the rocks and pools near the shore, and search under overhanging ledges of rock as far as his arms can reach. An iron rake, with long close-set teeth, will be a useful implement on such occasions. He should turn over all loose stones and growing sea-weeds, taking care to protect his hands with gloves, and his feet with shoes and stockings, against the sharp spines of *Echini*, the back-fins of sting-fishes, and the stings of *Medusæ*. In detaching chitons and limpets, which are all to be sought for on rocky coasts, the *spatula* or case-knife will prove a valuable assistant. Those who have paid particular attention to preserving chitons have found it necessary to suffer them to die under pressure between two boards. Ormers (*Haliotides*) may be removed from the rocks to which they adhere by throwing a little warm water over them, and then giving them a sharp push with the foot sideways, when mere violence would be of no avail without injuring the shell. Rolled madrepores and loose fragments of rock should be turned over; cowries and other shell-fish frequently harbour under them. Numbers of shell-fish are generally to be found about coral-reefs." In coral regions the services of *natives* should be obtained, as they may render much assistance by diving or wading.

Advantage may be taken of *spring-tides*, especially at the equinoxes, to examine lower tracts of sea-shore than are ordinarily accessible. Many *bivalves* bury in sand and mud at extreme low-water, and may be obtained alive by digging with a spade or fork; others may be found boring in piles and rocks, and require the hammer and chisel for their extraction.*

Mr. Joshua Alder remarks that "in collecting among rocks the principal thing is to look close, particularly in crevices and under stones. Minute species inhabiting sea-weed are best obtained by gathering the weed and immersing it for some time in a basin of sea-water, when the little mollusks will generally creep out. If the shells only are wanted, the surer and more ready way is to plunge the weed into freshwater, when the animals immediately fall to the bottom."

The *floating mollusca* of the open sea, especially in tropical latitudes, are comparatively little known. Good drawings, and descriptions made from the life, are most valuable. "Of the animal of the *Spirula*, entire specimens are greatly wanted. If

* *Bivalves* may be boiled, and their soft parts removed when the shells gape. Care should be taken not to injure the ligament, or hinge, especially in the genera (like the *Anatinid*) provided with an *ossicle*.

captured alive, its movements should be watched in a vessel of sea-water, to see whether it has the power of rising and sinking at will; its mode of swimming, and position during these movements, and when at rest. The chambered shell should be opened under water, to ascertain if it contain a gas, the nature of which should, if possible, be made out. The pearly nautilus requires the same observations, which would be attended with more precision and facility from its larger size." (Owen.)*

The *towing-net* used by Mr. McGillivray "consisted of a bag of *bunting* (used for flags) 2 feet deep, the mouth of which was sewn round a wooden hoop 14 inches in diameter; three pieces of cord, 1½ foot long, were secured to the hoop at equal intervals and had their ends tied together. When in use, the net was towed astern, clear of the ship's wake, by a stout cord secured to one of the quarter-boats, or held in the hand. The scope of the line required was regulated by the speed of the vessel at the time, and the amount of strain caused by the partially submerged net." †

Trawling.—Mr. John W. Woodall, of Scarbro', has kindly fur-

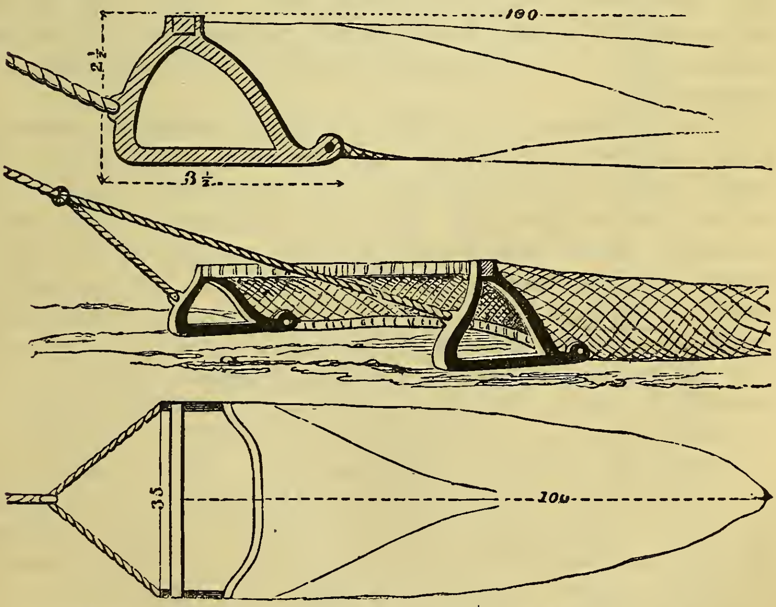


Fig. 32. A Trawl-net. A. Side view; B. Net in op ration; C. Plan.

nished the following sketches and particulars:—"B, Fig. 32, is intended to represent a *trawl-net* at work on the bottom of the sea.

* Admiralty Manual of Scientific Inquiry. 8vo. Lond. 1849.

† Voyage of H.M.S. *Rattlesnake*, vol i. p. 27.

The side frames are of iron, the upper beam of wood, and the lower edge of the net is kept down to the ground by means of a chain, which is wolded or wrapped round with old rope. The beam is generally from 40 to 50 feet in length, and about 8 inches square. The net is about 30 yards in depth, and has a couple of pockets inside. The end is untied when the net is hauled on board for the purpose of taking the fish out. These nets can only be worked where the bottom of the sea is free from rocks. They are used by boats of 35 to 60 tons, manned by crews of from four to six men and two to three or four boys. In the vicinity of Scarbro' they fish between the shore-reefs and the off rock, which is 4 to 10 miles from land; the bottom is sand or clay, with 4 to 15 fathom water on the land side, and 17 to 25 fathoms on the off side." Immense quantities of crustacea and shell-fish are taken with the trawl, as well as ground-fish.

Kettle-nets.—On the flat, sandy coast of Kent and Sussex, the mackerel-fishery is pursued by setting up stakes 10 or 15 feet high, at distances of 10 feet apart, in lines running outwards from the shore at high-water, to low-water neap tides, where they are turned in the direction of the tide. To these stakes nets are attached, and leaded, which remain as long as the fish are on the coast. Cuttle-fish are frequently taken in these nets.

Deep-sea Fishery.—In North Britain an extensive ground-fishery is conducted by means of long lines—often a mile in length—with hooks and baits every few yards. These lines are laid out at night near the coast, and taken up the next morning. When used out at sea, the boats lay by for a few hours, and then take up the lines. The carnivorous whelks adhere to the baits (which have not been seized by fishes), and sometimes a bushel of them are taken in this way from a single line. *Rhynchonella psittacea*, *Panopæa Norvegica*, *Velutinæ*, and some of the scarce *Fusi*, have been obtained from these lines, the bivalves having been entangled accidentally by the hooks.

For trapping whelks on rocky ground a net may be made such as is used for crabs and lobsters, by attaching a loose bag to an iron ring of a yard across. This is fastened to a rope by three equal strings, baited with dead fish, and let down from a vessel at anchor, or, still better, from a buoy. It is put down over-night, and hauled up gently in the morning.

Mr. D'Urban informs us that *Natica Alderi* and *monilifera* are frequently found in the lobster-pots at Bognor, Sussex, which they enter to feed upon the bait.

Dredging.—The dredges used in the oyster and whelk-fisheries are so rudely made as to injure the more delicate marine animals, and suffer all the minute things to escape. It is therefore necessary to have instruments specially adapted for the naturalist's work.

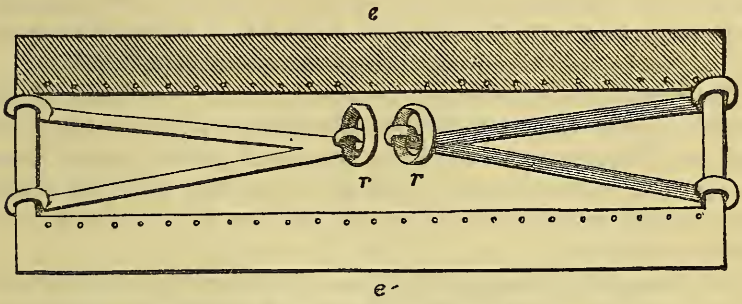


Fig. 33. Plan of the Framework of a Dredge, reduced to ⅛.

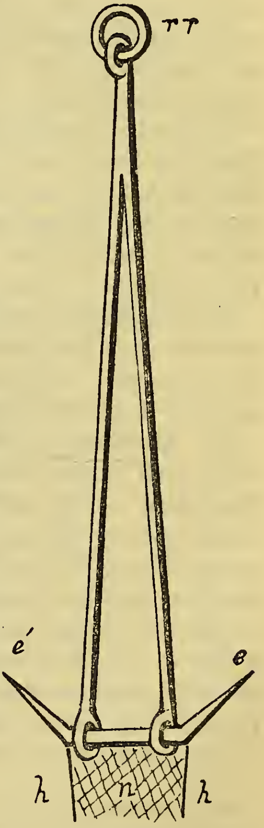


Fig. 34.

Fig. 33 is a plan, and Fig. 34 a side-view, of a small dredge, belonging to Mr. J. S. Bowerbank, and suited for such work as a private collector might do on the English coast. It is made of wrought iron, with movable joints, so as to fold up and carry in the hand. The bag attached to the dredge is formed of two pieces of raw hide (*h*, *h*), connected at the ends and bottom by net (*n*) made of cod-line, to allow the water to escape; and is fastened to the frame with copper wire, through the eyelet-holes. The towing-rope is attached to the rings (*r*, *r*), and when thrown overboard it scrapes with one or other of the cutting edges (*e*, *e′*). The opening is made narrow, to prevent the admission of large and heavy stones.

Dredging should not be attempted in a *rowing-boat*, unless near the shore, in smooth water, and with a depth not exceeding 5 or 10 fathoms. It may be managed in a light boat by two persons; one rowing, the other holding the rope of the dredge which is passed overboard near the stern.

The whelk and oyster-dredgers employ a decked sailing-vessel, and work several dredges simultaneously, each requiring a person to manage it.

The dredges are put overboard on the weather-side, and the ropes made fast to a bulwark or thwart; each dredger holds the rope in his hand, after giving it a single turn round a thwart or "belaying pin," to regulate the strain by means of the spare line. When a sufficient distance has been traversed, or the ropes strain with the weight of mud and stones, the vessel is brought to, and the dredges hauled up and emptied.*

The *length of line* required is about *double* the depth of the water. If the line is too short, the dredge will only skim the bottom; if too long, it will be in danger of getting fast. When the bottom is loose sand or soft mud, the line must be shortened, or the vessel have more way, or else the dredge will be apt to get buried.

The *strength of the line* ought to be sufficient to anchor the vessel in smooth water,—though not, of course, when there is much way on her,—so that if the dredge gets foul it is necessary to let out the spare line and relieve the strain while the vessel is brought round. The dredge will then usually capsize, and may be hauled up.

If the bottom is at all rocky, a small strong dredge is best. The line must be shortened, and some additional precautions may be taken, such as fastening the rope to one ring of the dredge, and tying the other with spun yarn, which will break under a sudden and dangerous strain, and release one end of the dredge.

In dredging on coral-ground, Mr. Cuming employed a 3-inch hawser, and had a patent buoy attached to the dredge by a $1\frac{1}{4}$-inch rope. More than once the hawser parted, and the dredge was left down all night, but recovered the next day.

Mr. McAndrew's researches on the coast of Norway were conducted in the *Naiad*, a yacht of 70 tons, and extended from the shore to 250 fathom water. The dredge employed was at least twice as strong and heavy as the one we have represented, and all forged in one piece, instead of folding up. The bag was fastened on the frame with thongs cut from the hide. Before using, it requires to be towed astern for a couple of hours, to soften it. In three months' work only two cow-hides were used, and one of those was torn by accident on sharp rocks. Several spare dredges were on board, in case of emergency, but not used.

Dredging in deep water (50 to 300 fathoms) can only be done

* The collector may go out with the fishermen and superintend his own dredge almost any time of the year, although oyster catching is illegal in the summer. The scallop-banks off Brighton are in 15 fms. water, and nearly out of sight of land. It is not always possible to work over them and return the same night.

in calm weather, with a light breeze. The yacht is brought to the wind (by putting up the helm), the foresheet hauled to windward, mainsail hauled up, and mizen taken in; the gaff topsail also hauled up; she then drifts to leeward, and the dredge is thrown overboard to windward, with the line made fast amidships; the spare line being coiled up so as to be given out readily. When the dredge is to be hauled in, the rope is passed through a movable block, fixed to the shrouds, and the whole strength of the crew (fifteen hands) called into requisition, if necessary. When the depth does not exceed 50 fathoms, the boat, with three men and the two dredgers, is used.

If the dredge gets fouled, the rope is passed into the boat, brought over the dredge, and hauled up. In very deep water (150 fathoms) the line is carried forward and made fast to the bows, and the yacht itself hauled up till right over the dredge, which is then recovered without difficulty.

The contents of the dredge are washed, and sifted with two sieves, one "¼-inch," the other very fine. They are made of *copper wire*, and one fits into the other. The dredge is emptied into the coarse sieve and washed in the sea from the boat, or if in the yacht, they are placed in an iron frame, over the side of the vessel, and buckets of water poured on. The sediment retained in the fine sieve may be dried and examined at leisure, for minute shells.

The following "dredging-papers," kept on the plan recommended by Professor E. Forbes, have been selected by Mr. Barrett, to illustrate the kind of shells found at various zones of depth.

The shell-fish obtained by dredging should be at once boiled, and the animals removed, unless wanted for examination (p. 153). The bivalves gape, and require to be tied with cotton; the *opercula* of the univalves should be secured in their apertures with wool. The small univalves may be put up in spirit, or *glycerine*, to save time. In warm climates the flies and ants assist in removing any remains of the animals left in spiral shells, and *chloride of lime* may be necessary to deodorise them.

M. Petit de la Saussaye has given very full instructions for collecting and preserving shells, in the *Journal de Conchyliologie* for 1850, p. 215, and 1851, pp. 102, 226.

It is stated that both the form and colour of molluscous animals may be preserved in a saturated solution of *hydrochlorate of ammonia* (10 parts) and corrosive sublimate (1 part —first dissolved in alcohol), but the preparation is expensive and dangerous.

DREDGING PAPERS, AND RECORDS OF RESEARCHES ON THE COAST OF NORWAY.

By R. McAndrew, Esq., and Lucas Barrett, Esq., F.G.S.

I.

Date ... ... July 1st, 1855.
Locality ... ... Tromsoë (Nordland).
Depth ... ... Between tide marks.
Ground .. .. Rock and sand.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Mya truncata	6	Many.	In sand.
Tellina incarnata	Many.	Many.	In sand.
Astarte compressa	1	0	On sand.
,, borealis	3	Many.' *	On sand.
Cardium edule	Many.	Many.	In sand.
Crenella discors	Many.	0	Covering the under sides of stones.
Acmæa testudinalis	Many.	0	On rock.
Margarita undulata	6	0	On weed.
,, helicina	8	0	On weed.
Littorina littorea	Many.	0	On rock.
,, rudis	Many.	0	On rock.
Lacuna vincta...	2	0	On weed.
Natica pusilla	2	0	On sand.
,, clausa	Many.	0	On rock.
Purpura lapillus	Many.	Many.	On rock.
Buccinum undatum	Many.	0	On rock and sand.
,, cyaneum	Many.	0	On rock.
Bela turricula	10	0	On rock.
Doris Johnstoni	8	0	

(Note.) No specimens of *Trochus* or *Patella vulgata* occurred.

II.

Date ... ... July 5th, 1855.
Locality ... ... Near Hammerfest (Finmarken).
Depth ... ... 7 to 20 fathoms.
Distance from shore ... Close to shore.
Ground... ... ... Nullipore and sand.

Saxicava arctica	4	0	Young.
Mya truncata	4	3	Young.
Thracia convexa	4	0	In sand.
Tellina proxima	0	4'	
Mactra elliptica	1	0	
Venus ovata	3	0	
,, striatula	Many.	0	
Cyprina Islandica	Many.	Many.'	
Astarte compressa...	Many.	0	
Cardium fasciatum	6	0	
Modiola modiolus	1	4'	
,, phaseolina	3	0	

* The accented numbers in the column of "dead specimens" refer to disunited valves of *Conchifera* and *Brachiopoda*.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Leda caudata	2	1	
Pecten Islandicus	0	2'	
Chiton asellus...	2	0	
,, marmoreus...	2	0	
Acmæa virginea	3	2	
,, testudinaria	0	1	
Patella pellucida	6	0	
Dentalium entale	4	2	
Trochus tumidus	Many.	Many.	
,, cinerarius...	1	0	
Margarita helicina...	12	0	
,, undulata	Many.	Many.	
,, cinerea	6	2	
Velutina lævigata	0	1	
Buccinum undatum	0	3	
Trophon clathratus	1	0	
,, Gunneri	1	0	
Bela rufa	1	0	
,, turricula...	0	4	
Mangelia nana	2	0	

III.

Date ... ... July 3rd, 1855.
Locality ... ... Island of Arnöe (Finmarken).
Depth ... ... 7 to 22 fathoms.
Distance from shore ... Half a mile.
Ground ... ... Laminaria and red weed.

Saxicava arctica	3	Many.'	
Thracia convexa	1	0	
Venus ovata	1	3'	
Cyprina Islandica	2	Many.'	
Astarte crebricostata	Many.	Many.	
,, elliptica	12	Many.	
,, compressa	Many.	Many.	
Cardium fasciatum	Many.	Many.	
Cryptodon flexuosus	1	6'	
Modiola modiolus	1	Many.'	
Crenella decussata...	Many.	Many.	
Leda pernula	Many.	Many.	
Pecten Islandicus	3	Fragments.	Young.
Anomia Ephippium	Many.	0	
,, aculeata	Many.	0	
Chiton marmoreus...	4	0	
Dentalium entale	4	Many.	
Trochus tumidus	Many.	Many.	
,, cinerarius	Many.	Many.	
Margarita cinerea	Many.	Many.	
,, undulata	Many.	Many.	
,, helicina...	Many.	Many.	
Lacuna vincta...	Many.	Many.	
Littorina littoralis	3	0	
Rissoa parva	Many.	0	
Natica clausa	4	0	
,, pusilla	0	1	
Velutina lævigata	3	0	
,, flexilis	1	0	

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Trichotropis borealis	3	0	
Nassa incrassata	1	0	
Mangelia nana	8	0	
Bela turricula	Many.	0	
Trophon Gunneri	12	0	
„ clathratus	3	0	

IV.

Date ... ... July. 1855.
Locality ... ... Vigten Island (N. Drontheim).
Distance from shore ... Quarter of a mile.
Depth ... ... 30 fathoms.
Ground ... ... Coral-bank.

Arca nodulosa	3	5	
Leda caudata	2	0	
Yoldia lucida	3	0	
Astarte succata	3	4′	
Pecten Islandicus	0	2′	
Lima excavata	0	1′	
Lucina Sarsii	0	1	
Cryptodon flexuosus	2	0	
Modiola phaseolina	10	0	
Anomia ephippium	Many.	0	
Venus ovata	0	2	
Terebratulina caput-serpentis ...	20	Many.	
Chiton asellus	4	0	
Puncturella noachina	2	0	
Emarginula fissura	1	2	
„ crassa	0	1	
Margarita cinerea	1	0	
„ alabastrum	1	0	
Trophon barvicensis	1	0	

V.

Date ... ... June 23rd, 1855.
Locality ... ... Omnaesöe (Nordland).
Depth ... ... 30 to 50 fathoms.
Distance from shore ... Half a mile.
Ground ... ... Stones and sand.
No. of hauls ... ... Four.

Saxicava arctica	6	2	
Tellina proxima	0	1	
Venus ovata	2	0	Small.
Cyprina Islandica	2	Many.	
Astarte elliptica	4	0	
„ compressa	6	0	
Cardium fasciatum	2	0	
„ suecicum	5	4′	
Modiola phaseolina	200	Many.	Large.
Crenella nigra	0	1	Large.
Nucula nucleus	0	5	
„ tenuis	4	Many.	
Leda caudata	2	0	
Arca pectunculoides	12	10′	Large.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Pecten striatus	2	0	
„ tigrinus	3	6	
„ similis	1	0	
„ Islandicus	0	1'	Large and Recent.
Terebratula cranium	80	10	
Terebratulina caput-serpentis ...	1	0	
Crania anomala	12	0	Many stones had on them the attached valve.
Chiton Hanleyi	3	0	
Lepeta cœca	4	0	
Acmæa virginea	10	6	
Pilidium fulvum	Many.	4	
Puncturella noachina	2	1	
Trochus millegranus	2	0	
Eulima polita...	1	0	
Natica nitida	3	2	
„ helicoides	0	1	
„ pusilla	0	1	
Velutina lævigata	1	0	
Trichotropis borealis	6	3	Large.
Nassa incrassata	1	0	
Fusus antiquus	0	2	Carinated Var.
Trophon clathratus...	0	1	
Mangelia turricula...	1	0	
Tornatella fasciata	0	2	
Buccinum undatum	6	0	Young.
Pleurotoma nivalis...	10	15	

VI.

Date	July 20th, 1855.
Locality	North of Rolphsoe (Finmarken).
Depth	130 to 180 fathoms.
Distance from shore ..	Half a mile.
Ground...	Sand.
No. of Hauls	Two.

Cyprina Islandica	0	3	
Neæra cuspidata	0	2'	
Leda caudata	0	3'	
Yoldia lucida	1	2'	
Pecten Islandicus	0	Many.	Small.
„ similis...	0	1	
Arca pectunculoides	1	0	
Syndosmya prismatica...	0	1	
Cryptodon flexuosus	0	1	
Mactra elliptica	0	2''6'	
Cardium fasciatum	0	2	
„ suecicum...	0	3	
Astarte sulcata	1	0	
Anomia ephippium	Many.	0	
Crenella decussata...	2	Many.	
„ nigra...	0	2'	
Terebratula cranium	3	0	
Rhynchonella psittacea...	1	2	
Dentalium entale	Many.	Many.	
Puncturella noachina	Many.	0	
Lepeta cœca	2	0	
Pleurotoma nivalis	1	2	

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Fusus? sp.	0	Fry.	
Buccinum Humphreysianum ...	0	1	
Bela turricula	2	0	
Margarita cinerea	3	4	
„ undulata	0	2	
„ alabastrum	0	1	

VII.

Date ... ... July 25th, 1855.
Locality ... ... Off the Island of Arnöe (Finmarken).
Depth ... ... 200 fathoms.
Distance from shore ... Four miles.
Ground... ... ... Mud.

Pecten similis...	0	2'	
Cryptodon flexuosus	4	0	
Neæra cuspidata	0	1	
Arca pectunculoides	1	3	
Nucula tenuis	2	0	
Yoldia lucida	4	6	
Modiola phaseolina	2	0	
Cardium suecicum...	2	0	
Crenella decussata...	1	0	
Astarte crebricostata	0	4'.	
Terebratula cranium	0	2	
Dentalium entale	1	2	
„ sp....	1	8	
„ quinquangulare (Forbes)	1	0	
Eulima bilineata	2	2	
Eulimella Scillæ	0	3	
Mangelia trevelliana	0	1	
Bela rufa	0	1	
Philine quadrata	0	1	

DREDGING PAPERS, OR RECORDS OF RESEARCHES IN THE ÆGEAN SEA.

By Professor E. Forbes.

I.

Date ... ... May 29th, 1841.
Locality ... ... Nousa Bay, Paros.
Distance from shore ... Within the Bay.
Depth ... ... 5 to 6 fathoms.
Ground... ... ... Mud and sandy mud.

Pinna squamosa	0	1	
Modiola tulipa...	1	0	In sandy mud.
Pecten polymorphus	4	6'	
„ hyalinus	1	0	
Nucula margaritacea	0	40'	In dark mud.
Cytherea chione	0	1	
„ venetiana	1	3-5'	
„ apicalis	1	2-12'	

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Artemis lincta	0	1'	
Tapes virginea	0	5'	
Venus verrucosa	0	5'	
Tellina donacina	0	1-3'	
„ balaustina	0	2'	
Syndosmya alba	0	2-10'	
Lucina lactea	0	2-28'	
„ squamosa	0	3'	
„ rotundata	0	4'	
Cardium rusticum	0	1'	A strong valve.
„ exiguum	3	7'	
Cardita sulcata	0	1'	
Patella scutellaris	0	1	Washed in from shore.
Calyptræa Sinensis	0	2	
Bulla hydatis	0	1	
Turritella 3 plicata...	0	1	
Trochus canaliculatus	0	4	
Cerithium lima	0	3	
„ vulgatum	12	8	
Murex fistulosus	1	0	In dark mud.
Aplysia depilans	1	0	
Ostræa plicatula	0	10'	

II.

Date ... ... Sept. 14th, 1842
Locality ... ... Gulf of Smyrna.
Depth ... ... 26 fathoms.
Distance from shore ... Two miles and a half.
Ground... ... ... Fine brown mud.

Avicula Tarentina	3	3	Full grown, adhering to each other.
Saxicava arctica	4	0	

III.

ate ... ... August 5th, 1841.
Locality ... ... Off northern extremity of Paros.
Depth ... ... 40 fathoms.
Distance from shore ... Three miles and a half.
Ground... ... ... Weedy.

Pecten pusio	5	4'	
„ opercularis	0	1	Small.
Nucula margaritacea	0	2'	
Cytherea apicalis	0	1'	
Cardita squamosa	1	1'	
Cardium papillosum	0	2	
Fusus fasciolaroides	1	0	New.
Murex brandaris	0	3	
Vermetus gigas	0	1	
„ corneus	3	0	New.
Trochus exiguus	8	2	
Turbo rugosus...	1	0	
Pleurobranchus sordidus	1	0	New.
Doris tenerrina	2		New.
„ gracilis	2		
„ coccinea	1		
Ascidium, four species			
Aplidium, two species			

IV.

Date ... ... Sept. 16th, 1841.
Locality ... ... Off Ananas Rocks.
Depth ... ... 105 fathoms.
Ground... ... ... Nullipore.
Distance from shore ... From Rocks three miles, from Milo ten miles.

Species.	Number of living specimens.	Number of dead specimens.	Observations.
Terebratula vitrea	0	2'	Dead and worn.
Megerlia truncata	30	100-20'	Of all ages.
Argiope decollata	100	400-6'	Of all ages.
„ seminulum	18	10-8'	
Morrisia anomioides	1	0	Adhering to T. vitrea. New.
Crania ringens	0	6'	
Lima elongata	0	5'	New.
Pecten concentricus	0	1'	New.
„ fenestratus...	0	2'	New.
Spondylus Gussoni...	1	1'	
Arca lactea	1	7'	
„ scabra	0	2'	
Neæra cuspidata	0	1'	
„ attenuata	0	1'	New.
Fusus echinatus	0	2	
Pleurotoma crispata	0	2	Hitherto known only fossil.
„ maravignæ...	0	2	New.
„ abyssicola	0	4	New.
Mitra philippiana	0	4	New.
Cerithium lima	0	8	
Trochus tinei	0	6	
„ exiguus	1	9	
Turbo sanguineus	0	24	Hitherto known only fossil in the Mediterranean basin.
Rissoa reticulata	4	11	
Emarginula elongata	0	8	
Pileopsis Hungaricus	0	1	Small.
Acmæa unicolor	1	24	New.
Atlanta Peronii	0	2	Incrusted with nullipore, and thus rendered solid.
Hyalea gibbosa	0	1'	
Cleodora pyramidata	0	3	
Criseis clava	0	7	
„ spinifera	0	10	

V.

Date ... ... Nov. 25th, 1841.
Locality ... ... S. extremity of Gulf of Macri.
Depth ... ... 230 fathoms.
Distance from shore ... One mile (shore steep).
Ground... ... ... Fine yellowish mud.

Terebratula vitrea	0	2'	
Syndosmya profundissima	0	3'	
Arca imbricata	1	1'	
Dentalium quinquangulare	1	0	
Hyalea gibbosa	0	1	
Cleodora pyramidata	0	8	
Criseis spinifera	0	5	

The distribution of the Mollusca in Depth has been investigated by MM. Audouin and Milne-Edwards, M. Sars, and Professor E. Forbes. By these observers the sea-bed is divided into four principal regions :—

1. The Littoral zone, or tract between tide marks.
2. The Laminarian zone, from low water to 15 fathoms.
3. The Coralline zone, from 15 to 50 fathoms.
4. The deep-sea coral zone, 50 to 100 fathoms or more.

1. *The Littoral zone* depends for its depth on the rise and fall of the tide, and for its extent on the form of the shore. The shells of this zone are more limited in their range than those which are protected from the vicissitudes of climate by living at some depth in the sea.* In Europe the characteristic genera of *rocky* shores are *Littorina*, *Patella*, and *Purpura;* of sandy beaches, *Cardium*, *Tellina*, *Solen;* gravelly shores, *Mytilus;* and on muddy shores, *Lutraria* and *Pullastra*. On rocky coasts are also found many species of *Haliotis*, *Siphonaria*, *Fissurella*, and *Trochus*; they occur at various levels, some only at the high-water line, others in a middle zone, or at the verge of low-water. *Cypræa* and *Conus* shelter under coral-blocks, and *Cerithium*, *Terebra*, *Natica*, and *Pyramidella* bury in sand at low water, but may be found by tracing the marks of their long burrows. (Macgillivray.)

2. *Laminarian zone.*—In this region, when rocky, the tangle (*Laminaria*) and other sea-weeds form miniature forests, the resort of the vegetable feeding mollusks—*Lacuna*, *Rissoa*, *Nacella*, *Trochus*, *Aplysia*, and various *Nudibranchiata*. On soft sea-beds bivalves abound and form the prey of *Buccinum*, *Nassa*, and *Natica*. From low-water to the depth of one or two fathoms on muddy and sandy shores, there are often great *meadows* of grass-wrack (*Zostera*) which afford shelter to numerous shell-fish, and are the haunt of the cuttle-fish and calamary. In tropical seas, the reef-building corals often take the place of sea-weeds, and extend their operations to a depth of about 25 fathoms. They cover the bottom with living verdure, on which many of the carnivorous mollusks feed, while some, like *Ovulum* and *Purpura*, browse on the flexible *Gorgoniæ*. To this zone belong the oyster-banks of our seas, and the pearl-fisheries of the south; it is richer than any other in animal life, and affords the most highly coloured shells.

* Some of the littoral shells, like *Purpura lapillus* and *Littorina rudis*, have no free-swimming larval condition, but commence life as crawlers, with a well-developed shell. Their habits are sluggish, and their diffusion by ordinary means must be exceedingly slow.

3. *Coralline zone.*—In northern seas the belt of sea-weed that fringes the coast is succeeded by a zone where horny zoophytes abound, and the chief vegetable growth consists of *Nullipore*, which covers rocks and shells with its stony-looking incrustations. This zone extends from 15 or 25, to 35 or 50 fathoms, and is inhabited by many of the predacious genera—*Buccinum*, *Fusus*, *Pleurotoma*, *Natica*, *Aporrhais*, *Philine*, *Velutina;* and by vegetable feeders, such as *Fissurella*, *Emarginula*, *Pileopsis*, *Eulima*, and *Chemnitzia*. The great banks of scallops belong to the shallower part of this region, and many bivalves of the genera *Lima*, *Arca*, *Nucula*, *Astarte*, *Venus*, *Artemis*, and *Corbula*.

4. *Deep-sea Coral-zone.*—From 50 to 100 fathoms the *Nullipore* still abounds, and small branching corals to which the *Terebratula* adhere. In northern seas the largest corals (*Oculina* and *Primnoa*) are found in this zone, and shells are relatively more abundant, owing to the uniformity of temperature at these depths. These deep-water shells are mostly small and destitute of bright colours; but interesting from the circumstances under which they are found, their wide range, and high antiquity. Amongst the characteristic genera are *Crania*, *Thetis*, *Neæra*, *Cryptodon*, *Yoldia*, *Dentalium*, and *Scissurella*. In the mud brought up from deep water may be often found the shells of *Pteropoda*, and other mollusca which live at the surface of the sea. In the Ægean Sea there is deep-water within one or two miles of the coast; but in the British Channel the depth seldom amounts to more than 20—40 fathoms.

When registering the results of dredging operations, it is important to distinguish between *dead and living shells*, as in the preceding Tables; for almost every species is met with, in the condition of *dead shells*, at depths far greater than those in which it actually lives. On precipitous coasts the littoral shells fall into deep water, and are mingled with the inhabitants of other zones; currents also may transport dead shells to some distance over the bed of the sea. But the principal agents by which so many decayed and broken shells are scattered over the bed of the deep-sea, must be the mollusk-eating fishes. Of 270 species of boreal shells described by Dr. Gould (p. 60) more than half were obtained from the maws of fishes, in Boston market. Cod-fish do not swallow the large whelk-shells, but some idea of the number they consume may be derived from the fact that Mr. Warington has obtained the muscular foot and operculum of above 100 whelks, of large size, besides quantities of *crustacea*, from the maws of three cod-fish procured in the London market. Bivalve shells, like the Solens, and the rare *Panopæa Norvegica* are swallowed, and ejected again with eroded surfaces. The haddock swallows shells still more indiscriminately, and Mr. M'Andrew has found great numbers of rare Pectens in them, but generally spoiled. The cat-fish and skate break up the strongest shell-fish with their teeth—accounting for the many angular fragments met with in the dredge, and in recent deposits.

The following are examples of shells obtained from great depths :—

Norway. (M'Andrew.)

Living shells.

	Fathoms.
Cerithium metula	20—150
Margarita cinerea	10—130
Dentalium entale	200
Limea sarsii	120
Leda pygmæa	200
Yoldia limatula	120
Thetis koreni	40—100
Cryptodon flexuosus	200

Off the Cape. (Belcher.)

Buccinum ? clathratum	136
Volutilithes abyssicola	132
Pectunculus Belcheri	120

Ægean. (Forbes.)

	Living.	Dead.
Terebratula vitrea	100	250
Argiope decollata	100	110
Crania ringens	90	150

Ægean. (Forbes.)

	Living.	Dead.
Murex vaginatus		150
Fusus muricatus	80—95	150
Nassa intermedia		45—185
Cerithium lima	3—80	140
Chemnitzia fasciata		110—150
Eulima distorta		69—140
Scalaria hellenica		110
Rissoa reticulata	55	185
Trochus exasperatus	10—105	165
Scissurella plicata		70—150
Acmea unicolor	60—105	150
Dentalium quinquangulare		150—230
Bulla utriculus		40—140
Spondylus Gussonii	105	
Pecten Hoskynsii		185—200
Arca imbricata	90—230	
Neæra cuspidata	12—185	
Thetis anatinoides		40—150
Kellia abyssicola	70—180	200
Syndosmya profundissima		80—185

Preserving molluscous animals for examination.

When shell-fish are killed by sudden immersion in hot water or strong spirit, great and unequal contraction is caused, distorting the muscular parts and rupturing the membranes.

Experiments have yet to be made for the discovery of means whereby these and other marine animals may be paralysed and killed, without altering the ordinary condition of their organs.*

Glycerine is the best medium for preserving such objects as the univalve shell-fish, intended for the examination of their

* The brittle-stars (*Ophiocoma*) are killed by sudden immersion in fresh-water; and the *Actiniæ* may be stupified by adding fresh-water drop by drop until they lose the power of retracting their tentacles. But the bivalves (such as *Pholas*) may be kept in stale water till their valves fall off with incipient decomposition, and yet the muscular siphons retain their irritability, and contract slowly and completely, when placed in spirit.

lingual teeth; for if put up in strong spirit they become so hard that it is almost impossible to make good preparations from them, and in weak spirit they will not keep for any length of time.

Alcohol.—The cheapest alcohol for preserving natural history objects, at home, is sold as "methylated spirit;" it contains ten per cent. of ordinary wood spirit, and being undrinkable, is free of duty. When many specimens are put up together the spirit becomes much diluted, and should be changed. The soft tissues of bivalves, and spiral bodies of the univalves soon decompose in weak spirit. But for permanent use, in Museums, proof spirit may be diluted with an equal bulk of water. Cotton wool may be put with the specimens in spirit, especially with cuttle-fish, to preserve them from distortion by pressure.

Goadby's solution is prepared by dissolving ½ lb. of bay salt, 20 grains of arsenious acid, or white oxide of arsenic, and 2 grains of corrosive sublimate, in 1 quart of boiling rain-water.

Burnet's solution (chloride of zinc), largely diluted, is now used at the British Museum for the preservation of fishes and other objects, in glass jars. It has several advantages over spirit; being undrinkable, and not inflammable, and the concentrated solution (sold by all druggists) is much less bulky.

Muriate of Ammonia is recommended by Mr. Gaskoin, for removing any unpleasant odours which may arise from preparations when taken out of spirit for examination. (See p. 143.)

A solution of *Chloride of Calcium* has been employed by General Totten, United States Engineers, for preserving the flexibility of the epidermis in various shells. The solution of this deliquescent salt (which any one can make by saturating hydrochloric acid with marble) keeps the object which has been steeped in it permanently moist, without injuring its colour or texture; while its antiseptic properties will aid in the preservation of matters liable to decay. (Professor J. W. Bailey, in *Silliman's Journal*, July, 1854.)

PART II.

SYNOPSIS OF THE GENERA.

CHAPTER I.

CLASS I.—CEPHALOPODA.

THE *cephalopoda* are represented by the common squid, the nautilus, and the ammonite; forms with which most of us are more or less familiar. They possess a more complicated structure than any other group of the mollusca; but in this respect they are much inferior to the vertebrate animals, in whom the setting apart of particular organs for the performance of distinct functions is developed to so high a degree. We cannot trace a series of gradational forms between the highest cephalopod and the lowest vertebrate; but we can descend from the more to the less specialised forms of mollusca, which ultimately merge in one direction in such creatures as *Fasciola*, among entozoa; and in another direction, to forms like *Vorticella*, through the intermediate genera — *Pedicellina*, among the Bryozoa, and *Perophora* among the Ascidians. It is consequently much easier to define the higher than the lower boundaries of a great primary group. The points of analogy between the cephalopods and the vertebrates are the internal skeleton, the similarity in the form of the blood corpuscles, and in the capillary structure of the portion of the circulatory system situated between the arteries and veins.

The cephalopods move partly by means of a series of long muscular arms arranged round the mouth, partly by means of fins, or flaps, attached on each side of the body, and partly by the forcible expulsion of water through a tube or *siphon*.

Unlike most of the *mollusca*, they are symmetrical animals, having their right and left sides equally developed. 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; 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. In all probability they possess the faculty both of smelling and hearing. All are carnivorous, and live in the sea.

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. The cephalopoda 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* eight or ten, provided with suckers. *Body* round or elongated, usually with a pair of *fins; branchiæ* two, furnished with muscular ventricles; *ink-gland* always present; *funnel* a complete tube.

Shell internal (except in *argonauta*), horny or shelly, with or without air-chambers. The shell of the argonaut does not correspond with the ordinary shell of mollusks. (See p. 39.)

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 above-mentioned 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. There are two types of lung structure among the dibranchiates. Thus, in *Octopus* and *Sepia* the gills form a cylinder, while in *Loligo* and other genera they form a half cylinder.

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

* 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 nucleobranchs, or the nautilus with the holostomatous gasteropods, their external analogies seem to favour an opposite conclusion. There are many terms in use which are apt to mislead, such as fins, arms, &c.; they have a definite meaning when applied to the vertebrata, but not so when applied to the invertebrata.

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. 40) is tough and fibrous, with a thinsil very 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.

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 some-

* "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.

times 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 generally 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 near the shore, as well as 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 cetaceans which prey upon them.

Section A.—Octopoda.

Arms, eight; 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* 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 seldom have fins.

The males and females have a general resemblance to each other; although the form and appearance of the sexes are very distinctive. But until recently our knowledge on the subject has been confused. In all male cuttle-fishes one of the eight arms presents a peculiar appearance and undergoes a special development, fitting it for the purpose of helping forward the work of reproduction of the species. In many cases it is so altered as to be incapable of acting as a locomotive organ. According to Dr. Müller, the arm is detached, after it has been filled with semen, and is fixed on to the female. The arm, or whatever it may be that is so attached, was formerly mistaken

* *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).

for a parasitic worm; and more recently it has been regarded as the spermatophore by some, and as the entire male animal by other naturalists, under the name of *hectocotylus*. The hectocotyle of *tremoctopus* is shown in Fig. 3, Pl. I. 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 filaments 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 interior part of the body. There is an artery and vein on each side, giving branches to the branchial filaments, while a *nerve* runs down the centre. The *oval sac* encloses a small but very long convoluted tube, ending in a muscular sac containing *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 *suckers*, 45 on each side; but no *branchiæ;* the skin contains numerous changeable spots of red or violet, like that of the argonaut.‡ (Kölliker.)

It would seem strange how former observers could have overlooked so marked a feature as the metamorphosed or *hectocotylised* arm of cuttle fishes. Aristotle not only gives a clear description of the peculiarity, but even shows that he was aware of the function the arm performed. Subsequent writers appear to have misunderstood Aristotle; at any rate they refer to the colourless arm as a monstrosity, or in some cases they have used it as one of the distinctive characters of a species. There are numerous instances in which the male has formed one, and the female another species in the naturalist's catalogue. Now that the hectocotylus is known to be only a portion of the male, their relation is more clearly seen. They present an analogous phenomenon to what occurs in some species of spiders, in which

* An. Sc. Nat., 2nd series, 7, p. 173.

† Lin. Trans., vol. 20, pt. 1, p. 9; and in his own zootomical *Berichte*, where it is figured.

‡ An. Sc. Nat., 2nd series, vol. 16, p. 185.

certain parts of the palpi of the males are developed into spoon-shaped organs which perform the same office as the hectocotylus. Something similar also occurs in *Polydesma.*

Madame Power appears to have made her observations on an hectocotylus when she asserted that the young argonaut has no shell. M. Duvernoy has shown that the embryo argonaut has acquired a shell before it has been excluded from the egg.

The most important memoir on the development of Cephalopods is that by Kölliker.* "The process of yolk division is partial, and the development of the embryo takes place within a distinct germinal area, whence a distinct yolk sac is formed. This is proportionally very large in *Sepia* (Fig. 35), and *Loligo*, very small in *Argonauta* (Fig. 36), and therefore while the embryo is flattened and extended in the former genera, in the latter it more resembles the embryo of an ordinary gasteropod. Development commences by the separation of the

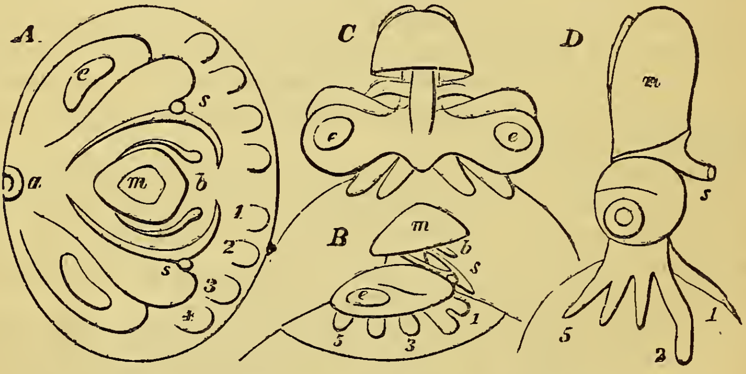


Fig. 35. Development of the Cuttle-fish. (Kölliker).

A, Embryo two lines in diameter; *m*, mantle; *b*, branchial processes; *s*, siphonal processes; *a*, mouth; *e*, eyes; 1—5, rudimentary arms.
B, Side view of the embryo, when more developed.
C, Front view, at a later period.
D, Young cuttle-fish, still attached to the yolk-sac, with the tentacular arms (2) longer than the rest.

embryo into *mantle* and *body* (foot). The part of the body in front of the mantle becomes the head; that behind it the branchio-anal surface. The latero-posterior margins of the body are produced into four or five processes on each side, which become the *arms*. On each side of the mantle, between it and the head and arms, a ridge is formed upon the body. These ridges (*s s*, Fig. 35, A), represent the *epipodium;* their

* *Entwickelungs-geschichte der Cephalopoden.* Zurich, 1844.

anterior ends are continuous and attached; the posterior ends are at first free, but eventually uniting they form the funnel D *s*. The rudimentary gills *b* appear between the *epipodium* and mantle. The alimentary canal is at first straight; (the mouth being at *a*, the vent at *b*, in Fig. 35 A). The embryo now grows faster in a vertical than in a longitudinal direction, so that it takes on the cephalopodic form. The intestine, as a consequence, becomes bent upon itself; and the and terior pair of arms grow over in front of the head, and unite, so as eventually to throw the mouth nearly into the centre of the arms." (Huxley.) At a later period of development (Fig. 35, D), the respiratory movements are performed by the alternate dilatation and contraction of the mantle; and the ink-bag is conspicuous by the colour of its contents. At the period of exclusion from the nidimental capsule, fine layers of the shell of the young cuttle-fish have been formed; but except the nucleus, which is calcified, they are horny and transparent. The lateral fins are broader than in the mature animal. The embryo of the *Argonaut*, as described by Kölliker, has simple conical arms (1—4, Fig. 36); and indications of the funnel appear as a ridge, *p*, on each side of the body; *v* is the yolk sac; *o* the position of the future mouth; *e* the eye; *b* the gill; and *m* the mantle.

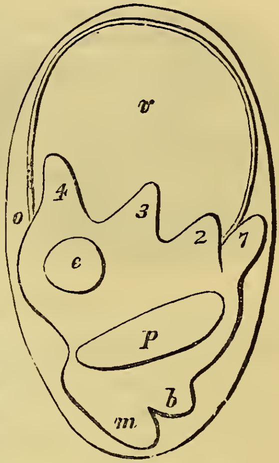


Fig. 36. *Argonaut*, embryo in the egg.

FAMILY I.—ARGONAUTIDÆ.

Dorsal arms (of the female) webbed at the extremity, secreting a symmetrical involuted shell. Third left arm in male hectocotylised; deciduous, colourless, developed in a sac. Female polyandrous. *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.

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 shell is believed to be peculiar to the female. Its special function is for protec-

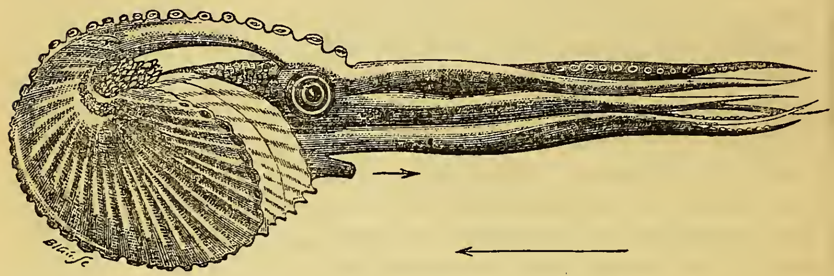


Fig. 37. *Argonauta argo* L. swimming.*

tion and incubation of the eggs. It is not homologous with the chambered or internal rudimental shells of other cephalopods, but may be compared with the cocoon of the leech, or the float of *Ianthina*. 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. 37, where, however, they are represented as partially withdrawn, in order to show the margin of the aperture. It swims by ejecting water from its funnel, and crawls in a reversed position, carrying its shell over its back like a snail. (Madame Power and M. Rang.)

The male argonauts are one inch in length, and possess no shell; their dorsal arms are pointed, not expanded. The testis is large, and like that of the *Octopus* in structure and situation; it contains spermatozoa of different degrees of development, and the excretory duct probably debouches into the Hectocotylus. The sac in which the Hectocotylus is developed is cleft by the movements of the Hectocotylus in extending itself, while the sac becomes inverted, and forms the violet coloured capsule on its back. The sac never contains more than one Hectocotylus, which is attached by its base, whilst

* 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.

the rest is free and coiled up. It has no enlargement like that of the Tremoctopus (Pl. I., Fig. 3); the filiform appendage proceeds from the smaller extremity, and sometimes remains entangled in the coloured cyst near the base of the outer side of the Hectocotylus. It has a chain of nervous ganglia in its axis.

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. It does not use its arms as sails, but it sometimes uses them as oars when it wishes to progress slowly, while floating on the surface of the sea.

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

Fossil, 2 species, Tertiary. *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.

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

Synonyms, *cistopus*. (Gray.)

Example, 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 ventral arms over its back, and seems to shadow forth the argonaut's shell.

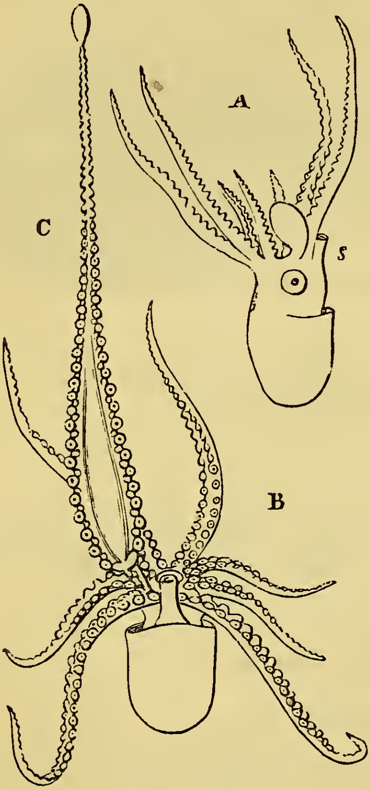


Fig. 38. *Octopus carena* ♂, Ver.

A, Side view, showing cyst in place of third arm.

B, Ventral side of an individual more developed, with the Hectocotylus C.

In the male octopus, the third right arm is more developed than the corresponding arm on the left side, and terminates in an oval-shaped plate (Fig. 38, c), marked with numerous transverse ridges, between which are pits. A muscular fold of skin passes from this plate down the dorsal margin of the arm to the web at its base; the margin is rolled up, and forms a covered passage through which the spermatophore is probably transmitted to the terminal plate. The arm is permanently attached, and is developed in a free state from a cyst, A.

Distribution: 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 more than 2 feet, according to the species.

Sub-genus. *Tremoctopus* (Chiaje), Pl. I., Fig. 3.

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

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

Arms longer than the body; the two dorsal pairs the longest, and webbed half-way up, and sometimes to the extremities. Arms not webbed in male. 4 aquiferous (?) openings, two between the eyes, and two below; sometimes there are small openings on the sides; *suckers* in two rows; third right arm hectocotylised.

Distribution, 3 species. *T. quoyanus*, *violaceus*, and *velifer*. Atlantic and Mediterranean.

PINNOCTOPUS, D'Orb. Finned octopus.

Body with lateral fins, united behind.

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

ELEDONE. (Aristotle.) Leach.

Type, E. octopodia, L.

Suckers forming a single series on each arm; length 6 to 18 inches. *E. Moschata* emits a musky smell. Third right arm hectocotylised; permanently attached; developed free.

Distribution, 2 species. Coasts of Norway, Britain, and the Mediterranean.

CIRROTEUTHIS. Eschricht. 1836.

Synonyms, Sciadephorus (Reinh and Prosch); Bostrychoteuthis (Ag.)

Etymology, *cirrus*, a filament, and *teuthis*, a cuttle-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 inches. Colour violet. The only species (*C. Mülleri*, Esch.) inhabits the coast of Greenland.

PHILONEXIS, D'Orb.

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

Type, P. atlanticus, D'Orb.

Arms free; *suckers* in two rows; *mantle* supported by two ridges on the funnel; *eyes* large and prominent. Total length, 1 to 3 inches.

Distribution, 6 species. Atlantic and Mediterranean. Gregarious in the open sea; feeding on floating *mollusca*.

SCÆURGUS. Troschel. 1857.

Body oval, without fins; wider than the head; *arms* short;

suckers in two rows; the third left arm hectocotylised at the apex.

Distribution, 2 species. Mediterranean.

BOLITÆNA. Strp. 1858.

Similar to Eledone, but more gelatinous, and with small suckers. 1 species living.

SECTION B.—DECAPODA.

Arms 8. *Tentacles* 2, elongated, cylindrical, with expanded ends. *Suckers* pedunculated, armed with a horny ring. *Mouth* surrounded by a buccal membrane, sometimes lobed and furnished with suckers. *Eyes* movable 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 aspect of the mantle.

The arms of the decapods are comparatively shorter than those of the octopods; the dorsal pair is usually shortest, the ventral longest. The tentacles originate within the circle of the arms, between the third and fourth pairs; they are usually much longer than the arms, and in *cheiroteuthis* are six times as long as the animal itself. They are completely retractile into large subocular pouches in *sepia*, *sepiola*, and *rossia;* partly retractile in *loligo* and *sepioteuthis;* non-retractile in *cheiroteuthis*. They serve to seize prey which may be beyond the reach of the ordinary arms, or to moor the animal in safety during the agitation of a stormy sea.

The *lingual dentition* of the cuttle-fishes somewhat resembles that of the *pterovoda*. The central teeth are simple in *sepia* and

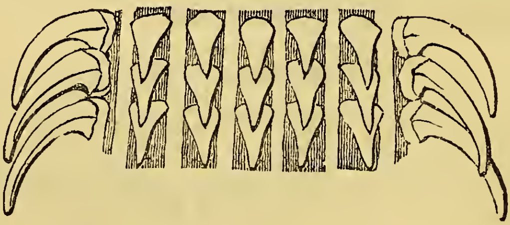


Fig. 39. Lingual teeth of *Sepia officinalis* (Cocken).

sepiola, tricuspid in *loligo*, and denticulated in *eledone*. The lateral teeth or uncini are three on each side, and mostly simple and claw-like. There were fifty rows of teeth in one specimen of *sepia*, the ribbon increasing in breadth from before to behind.

The *shell* of the living decapods is either a horny "pen" (*gladius*) or a calcareous "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 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'Orbigny.)

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'Orbigny. *Eyes* covered by the skin.

Loligo. (*Pliny*) Lamarck. Calamary.

Synonym, *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. Fourth left arm in male metamorphosed at its extremity. Steenstrup* says two species are confounded under the name of *L. vulgaris*. The variety occurring in the Atlantic, and not in the Mediterranean, is a distinct species (*L. Forbesii,* Stp.). In it the fourth left arm has twenty-three pairs of suckers well developed, five less developed, while the arm beyond the twenty-eighth pair is occupied by forty pairs of conical elongated papillæ, which correspond to forty pairs of suckers.. Steenstrup recognises only seven living species of Loligo, all the others so called being only varieties of these.

* Annals of Natural History, 1857.

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.)

Distribution, 24 species, in all seas. Norway—New Zealand.

Fossil, 1 species. Lias.

Sub-genus. Teudopsis, Deslongchamps, 1835.

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

Type, T. Bunellii, Desl.

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

Fossil, 5 species. Upper Lias, Oolite; France and Wurtemberg.

GONATUS, Gray.

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

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

SEPIOTEUTHIS, Blainville.

Synonyms, (?) Loliolus (Steenstrup); Chondrosepia (Leuckart).

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

Distribution, 13 species. West Indies, Cape, Red Sea, Java, Australia, Mediterranean.

BELOTEUTHIS, Münster.

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

Type, B. subcostata, Münster. Pl. II., fig. 8., Upper Lias, Wurtemberg.

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

Distribution, 6 species described by Münster, considered varieties of one only (differing in age and sex) by M. D'Orbigny.

GEOTEUTHIS, Münster.

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

Synonyms, belemnosepia (Agassiz), belopeltis (Voltz), loligo-sepia (Quenstedt), Coccoteuthis, Owen (part)

Type, Loligo Aalensis (Schubler).

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

Fossil, 9 species. Upper Lias, Wurtemberg; Calvados; Lyme Regis. Several undescribed species in the Oxford 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.) This genus may probably turn out to belong to the Belemnitidæ.

Leptoteuthis, Meyer.

Etymology, *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.

Synonym, Owenia, Prosch.

Type, C. scabra, Leach.

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

Pen long and narrow.

Distribution, 3 species. West Africa; in the open sea.

This genus makes the nearest approach to the octopods.

Sepiola. (Rondelet) Leach, 1817.

Example, S. atlantica (D'Orbigny). Pl. I., fig. 4.

Body short, purse-like; mantle supported by a broad cervical band, and a ridge fitting a groove in the funnel. *Fins* dorsal, rounded, contracted at the base. *Suckers* in two rows, or crowded, on the arms, in four rows on the tentacles. Length two to four inches. First left arm hectocotylised.

Pen half as long as the back. *S. Stenodactyla* (sepioloidea, D'Orbigny) has no pen.

Distribution, 7 species. Coasts of Norway, Britain, Mediterranean, Mauritius, Japan, Australia.

Sub-genus. Rossia, Owen (R. palpebrosa). *Synonym*, Heteroteuthis (Gray). *Mantle*, supported by a cervical ridge and groove. *Suckers* in two rows on the tentacles. First left arm hectocotylized throughout its length, and the corresponding right one in the middle. Length three to five inches.

Distribution, 6 species. Regent Inlet, Britain, Mediterranean, Manilla.

Sub-family B. *Oigopsidæ*, D'Orbigny.

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

LOLIGOPSIS, Lam. 1812.

Etymology, *loligo*, and *opsis*, like.

Synonyms, Leachia, Les., 1821; Perotis, Eschscholtz, 1827; Taonius, Steenstrup, 1861.

Type, L. pavo (Lesueur).

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

Pen slender, with a minute conical appendix. Length from six to twelve inches.

Distribution, pelagic, 8 species. North Sea, Atlantic, Mediterranean, India, Japan, South Sea.

CHEIROTEUTHIS, D'Orbigny.

Etymology, *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 four rows of pedunculated claws on their expanded ends.

Pen slender, slightly winged at each end. Length of the body two inches; to the tips of the arms eight inches; to the ends of the tentacles three feet.

Distribution, 2 species. Atlantic, Mediterranean; on gulf-weed in the open sea.

HISTIOTEUTHIS, D'Orbigny.

Etymology, *histion*, a veil, and *teuthis*.

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

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

Pen short and broad.

Distribution, 2 species. Mediterranean; in the open sea.

ONYCHOTEUTHIS, Lichtenstein. Uncinated calamary.

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

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

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

Pen narrow, with hollow, conical apex.

Arms with two 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 four inches to two 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.

Distribution, 8 species. Atlantic, Indian Ocean, Pacific.

ENOPLOTEUTHIS, D'Orbigny. Armed calamary.

Etymology, *enoplos*, armed, and *teuthis*.

Type, E. smithii, Leach.

Synonyms, 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 two inches to one 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. 158), 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.)

Distribution, 10 species. Mediterranean, Pacific.

Fossil, 1 species. Oolite.

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

Ommastrephes, D'Orbigny. Sagittated calamary.

Etymology, *omma*, the eyes, and *strepho*, to turn.
Synonym, Hyaloteuthis (Gray).
Type, O. sagittatus, Lam.

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

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

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.

Distribution, 14 recent species; similar *pens* (4 species) have been found fossil in the Oxford clay, Solenhofen; it may, however, be doubted whether they are generically identical. There is 1 tertiary species.

Thysanoteuthis, Troschel. 1857.

Etymology, *thysanos*, a fringe.

Arms sessile and webbed, but without hooks. *Tentacles* furnished with cups. *Fin* long. *Pen* sagittate. Two recent species, *T. rhombus*, *T. elegans*. Mediterranean.

Loliolus, Stp. 1856.

Pen horny, broad, with the shaft sharp-keeled; no muscular bands to the funnel; suckers with a raised band. Left fourth arm hectocotylised.

Distribution, 2 species. Indian Ocean.

Plesioteuthis, Wagner. 1860.

Pen slender, with a central and two side ridges. *Point* arrow-shaped. *Arms* with hooks.

Distribution, 2 species. Lias. Solenhofen slate.

DOSIDICUS, Stp. 1856.

Somewhat like Ommastrephes. Lower portion of arms with large suckers, and the extremity with numerous small suckers. Tentacles with four or five hooks.

Distribution, 1 species. Mediterranean.

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 *phragmocone* are connected by a *siphuncle*, close to the ventral side.

BELEMNITES, Lamarck. 1801.

Etymology, *belemnon*, a dart.*

Example, 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.‡ *Suckers* provided with horny hooks.

More than 100 species of belemnites have been found in a fossil state, ranging from the lias to the chalk, and distributed over all Europe. A few species have been found in the chalk

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

† Five specimens were at one time in Dr. Mantell's cabinet, and others are in the British Museum; they were obtained by William Buy in the Oxford clay of Christian Malford, Wilts. A still finer specimen, in Mr. Montefiore's collection, was recently obtained from the lias of Dorsetshire by Mr. Day. The *last chamber* of a lias belemnite in the British Museum is 6 inches long, and $2\frac{1}{2}$ 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 $7\frac{1}{2}$ 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

of Southern India, and a few more in the Jurassic formation of the Himalayas. The *phragmocone* of the belemnite, which represents the terminal appendix of the calamaries, is 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 calcareous 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. Our knowledge of this genus now extends to the form and proportions of the body, arms, the hooks, ink-bag, one type of pro-ostracum and beak. The belemnites have been divided into groups by the presence and position of furrows on 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 species. Lias—Neocomian.

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

Type, B. clavatus. 3 species. Lias.

SECTION II. GASTROCŒLI (D'Orb.), ventral groove distinct.

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

Type, B. canaliculatus. 5 species. Inferior oolite—Great oolite.

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

Type, B. hastatus. 19 species. Upper lias—Gault.

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

Type, B. dilatatus. 9 species. 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 lifetime of the animal have been frequently noticed.

Belemnitella, D'Orb.

Synonym, Actinocamax, Miller (founded on a mistake.)

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

Distribution, Europe; North America. 6 species. Upper 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.

Xiphoteuthis, Hux. (1864).

Shell with a long phragmocone enveloped in a calcareous sheath.

Fossil. 1 species. Lias. England.

Acanthoteuthis (Wagner), Münster.

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

Synonyms, Kalæno (Münster). 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 ten 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*.

Fossil. 17 species. Oolite.

Belemnoteuthis (Miller, Pearce, 1842).

Type, B. antiquus (Cunnington), Fig. 40.

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. 40).

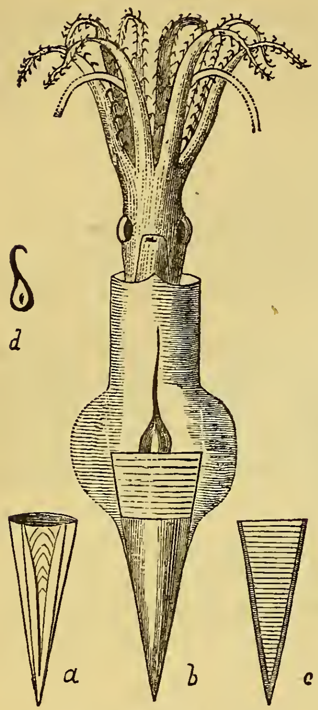


Fig. 40. *Belemnoteuthis.**

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.

Conoteuthis, D'Orb.

Type, C. Dupinianus, D'Orb. Pl. II., Fig. 9. *Neocomian*, France; Gault, England.

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*) calcareous; consisting of a broad laminated plate, terminating behind in a hollow, imper-

* Fig. 40. *Belemnoteuthis antiquus*, $\frac{1}{4}$, 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 been obtained for the British Museum; the *tentacles* are not longer than the ordinary arms, owing, perhaps, to their partial retraction; this specimen is 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.

fectly chambered apex (*mucro*). *Animal* with elongated tentacles, expanded at their ends.

SEPIA (Pliny), Linnæus.

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

Synonyms, *Belosepia*, Voltz. (B. sepioïdea, Pl. II., Fig. 3, mucro only.) Palæoteuthis, Roem.

Body oblong, with lateral fins as long as itself. *Arms* with four 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. S. 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 foot. (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'Orbigny.)

Distribution, 30 species. World-wide; 2 British.

Fossil, 10 species. Oxford clay, Solenhofen. Several species have been founded on *mucrones* from the Eocene of London and Paris. Pl. II., Fig. 3. S. ungula occurs fossil in Texas.

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.

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

Type, B. belemnitoïdes, Blainville. Pl. II., Fig. 7.

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

Fossil, 4 species. Eocene. Paris; Bracklesham.

BELEMNOSIS, Edwards.

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

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

Helicerus, Dana.

Example, *H. Fugiensis*. Only species known.

Shell like a belemnite, half-inch in diameter; *guard* thick, sub-cylindrical, fibrous; *phragmocone* slender, terminating in a fusiform spiral nucleus. In slate rock, Cape Horn.

Family VI.—Spirulidæ.

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

Spirula, Lam., 1801.

Synonym, Lituus, Gray.

Example, S. lævis (Gray). Pl. I., Fig. 9.

Body oblong, with minute terminal fins. *Mantle* supported by a cervical and two ventral ridges and grooves. *Arms* with six 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.

Distribution, 3 species. All the warmer seas.

Order II.—Tetrabranchiata.

Animal creeping; protected by an external shell.

Head retractile within the mantle. *Eyes* pedunculated. *Mandibles* calcareous. *Arms* very numerous. *Body* attached to the shell by adductor muscles, and by a continuous horny girdle. *Branchiæ* four. *Funnel* formed by the union of two lobes, which do not form a complete tube.

Shell external, camerated (polythalamous) and siphuncled; the inner layers and septa nacreous; outer layers porcellanous.*

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

It was long ago remarked by Dillwyn, 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 2,000 fossil species belonging to this order are now known by their shells; whilst their only living representatives are a few species of nautili.*

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 only is occupied by the animal. The others are

Fig. 41. Suture of an ammonite.†

probably occupied in succession. They 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 *zigzag*, as in *goniatites* (Fig. 60), or *foliaceous*, as in the ammonite (Fig. 41).

* 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. 50, is taken from a more perfect specimen, subsequently 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.

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. 61) 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. 44).

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 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. 44). In the *nautilidæ* it is usually *central* (Fig. 42), or *internal* (Fig. 43).

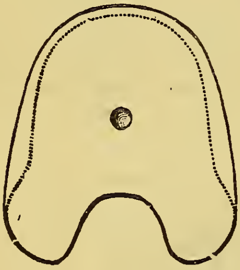


Fig. 42. Nautilus.

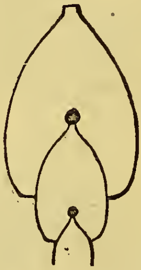


Fig. 43. Clymenia.

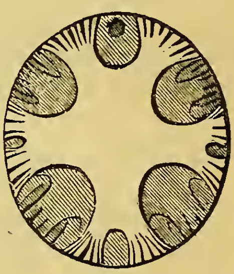


Fig. 44. Hamites.†

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. 46) it occupies a whole whorl, and has a considerable lateral extension; and in *ammonites communis* it occupies more than a whorl.

The *margin of the aperture* is quite simple in the recent nautilus,

* From their resemblance to the sutures of the skull.

† Fig. 42. *Nautilus Pompilius*, L. Fig. 43. *Clymenia striata*, Münst., see Pl. II., Fig. 16. Fig. 44. *Hamites cylindraceus*, Defr., see Fig. 65.

‡ Most of the so-called *spongaria* are 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.

and affords no clue to the many curious modifications observable in the fossil forms. In the *ammonites* we frequently find a dorsal

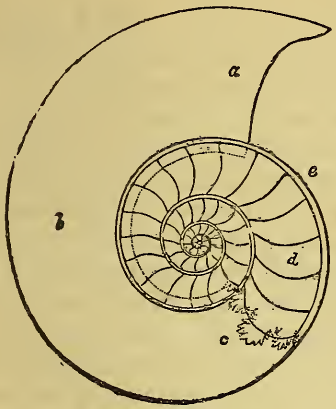


Fig. 45. Ammonites.

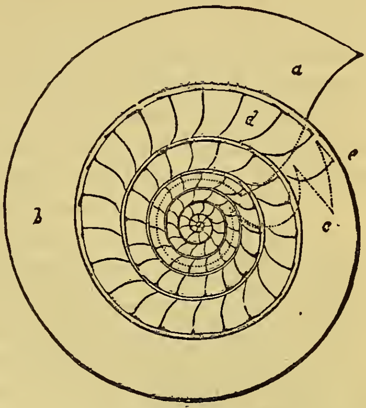


Fig. 46. Goniatites.*

process, or lateral projections, developed periodically, or only in the adult (Fig. 62, and Pl. III., Fig. 5).

In *phragmoceras* and *gomphoceras* (Figs. 47, 48) the aperture is so much contracted that it is obvious the animal could not have withdrawn its head into the shell like the nautilus.

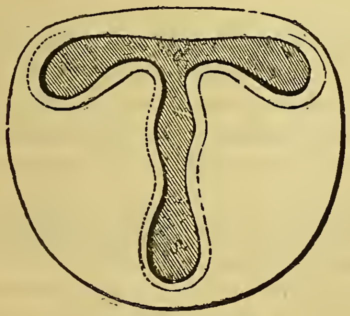


Fig. 47. Gomphoceras

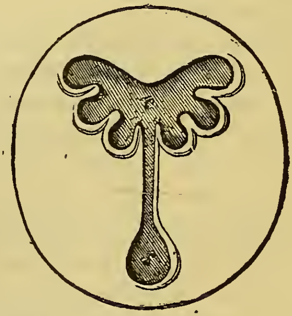


Fig. 48. Phragmoceras.†

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

* Fig. 45. Section of *Ammonites obtusus*, Sby. lias, Lyme Regis; from a very young specimen. Fig. 46. 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.

† Fig. 47. *Gomphoceras Bohemicum* (Barrande), reduced view of the aperture; *s*, the siphonal opening. Fig. 48. *Phragmoceras callistoma* (Barr.), both from the U. Silurian, Bohemia.

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. 50, *h*), formed by the union of the two dorsal arms, which correspond to the shell-secreting arms 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. 49). They were described in 1811, by Parkinson, who called them *trigonellites*, and pointed out the resemblance of their 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*.‡

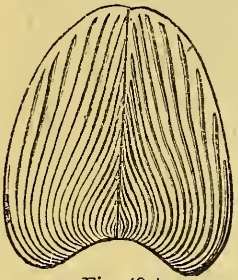


Fig. 49.†

Calcareous 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

* 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'Institut, 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.

‡ 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. Some of them have been described by Rolle (1862) as *Cyclidia* and *Scaphanidia*.

§ 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.

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."* They also occur in the belemnite beds of the middle lias of Dorsetshire; these latter are very different in form from those of nautili in the lower lias, and may probably belong to belemnites.

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 calcareous grit of Berkshire and Wiltshire the ammonites have lost their shells; but perfect casts of the chambers, formed of calcareous 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 sulphides 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 permeated by mineral water, which slowly deposits calcarecus spar, in crystals, on their walls; or by acidulous water, which removes 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; 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.

The tetrabranchs could undoubtedly swim, by their respiratory jets; but the discoidal nautili and ammonites are not well

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

† Called *spondylolites* by old writers.

‡ In he 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.

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 siphuncle (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 course 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 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 whorls 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

* A *nautilus pompilius* (in the cabinet of Mr. Morris) weighs 1lb., and when the siphuncle is secured, it floats with a ¼lb. weight in its aperture. The animal would have displaced two 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.

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*. M. D'Orbigny, noticing that there were 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. Professor Van der Hoeven has described the difference in the shells of the two sexes; † but these are trivial as compared with those presented by the animals. The most marked is that while the female has twelve retractile tentacles, the male has only eight, while the other four tentacles are coalesced together to form an organ called the *spadix*.

In 1865, M. Barrande published the plates to his second volume on the Cephalopods of Bohemia. We have not been able to see this work: but it contains 107 plates, with figures of 200 species of cephalopods, belonging to the genera *Goniatites*, *Nothoceras*, *Trochoceras*, *Hercoceras*, *Lituites*, *Phragmoceras*, *Gomphoceras*, and *Ascoceras*.

Family I.—Nautilidæ.

Shell. *Body-chamber* capacious. *Aperture* simple. *Sutures* simple. *Siphuncle* central or internal. (Figs. 50, 51.)

Nautilus, Breynius, 1732.

Shell involute or discoidal, few-whorled. *Siphuncle* central or sub-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.

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

* 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.)

† Annals of Natural History, vol. xix. 1857.

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*, twelve or thirteen in each group; they appear to answer

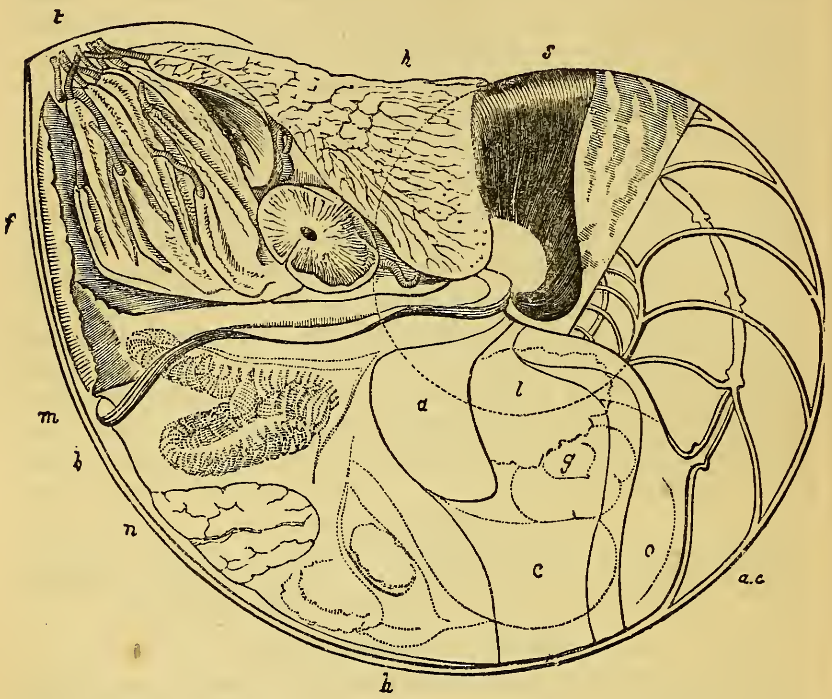


Fig. 50. *Nautilus pompilius* in its shell.*

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*, thirty-six 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 on their inner surface, and are retractile within sheaths, or "digitations," which correspond to the eight ordinary arms of the

* This woodcut and eighteen others illustrating the *tetrabranchiata*, are the property of Dr. Gray, to whom we are indebted for their use. Fig. 50 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.

cuttle-fishes; their superiority in number being indicative of a lower grade of organisation. 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. This process bears the external ears. The cavity leads to the auditory capsule, along a passage lined with a glandular membrane. 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. 50 *s*).* Inside the funnel is a valve-like fold (Fig. 51 *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 its 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 on 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 Amboyna. "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;

* The *funnel* is considered to be the homologue of the foot of the gasteropods by Lovén, a conclusion with 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. 114).

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

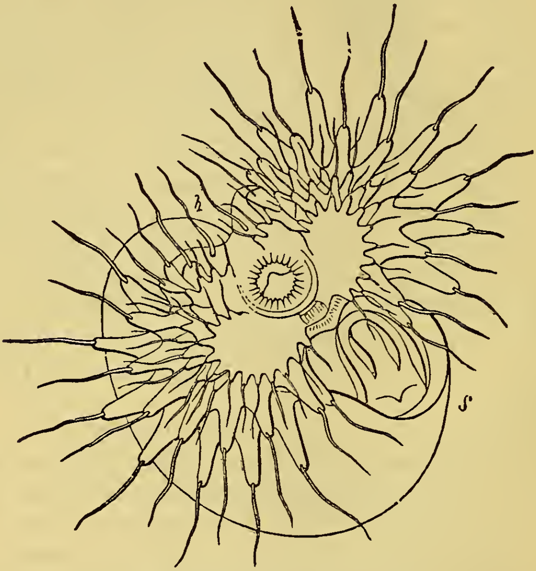


Fig. 51. Nautilus expanded.*

Distribution, 3 or 4 species. Chinese seas, Indian Ocean, Persian Gulf.

Fossil, about 188 species. In all strata, South and North America (Chili). Europe. S. India.

There are two types of ornamentation in nautili—the smooth and the longitudinally striated; the latter are almost exclusively oolitic, and at present only 1 species is known in Indian cretaceous rocks; the smooth type is almost exclusively cretaceous, and is abundantly represented in India. D'Orbigny

* 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. ii., 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.

has taken advantage of these characters for dividing the nautili into three groups, viz., 1. *Lævigati.* Nautili with smooth shells ranging from the Permian epoch to the present time; 2. *Radiati.* Shells ornamented with transverse ribs, mainly cretaceous; and 3. *Striati.* Shells ornamented with longitudinal striæ. These are confined to the oolite in Europe. In India a few species occur in the lower chalk.

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 species. Eocene; North America, Europe, India.

Sub-genus ? Discites, McCoy. *Whorls* all exposed; the last chamber sometimes produced.

Fossil, 5 species. Lower Silurian.—Carb. limestone.

Temnocheilus, McCoy. Founded on the carinated species of the carb. limestone, of which 5 are known.

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

Fossil, 16 species. Upper Silurian—Carb.

Lituites, Breynius.

Etymology, lituus, a trumpet.

Synonyms, Hortolus, Montf. (whorls separate). Trocholites, Conrad.

Example, L. convolvans, Schl. L. lituus, Hisinger.

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

Fossil, 18 species. Silurian; North America, Europe.

Trochóceras, Barrande, 1848.

Example, T. trochoides, Bar.

Shell nautiloid, spiral, depressed.

Fossil, 44 species. Upper Silurian; Bohemia.

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

Fig. 52. *Clymenia striata*, Munst.*

Fig. 53. *C. linearis*, Munst.

CLYMENIA, Munster, 1832.

Etymology, *Clymene*, a sea-nymph.

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

Example, C. striata, Pl. II., Fig. 16 (Mus. Tennant).

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

Fossil, 45 species. Upper Silurian—Mount. Limestone. North America, Europe.

FAMILY II.—ORTHOCERATIDÆ.

Shell straight, curved, or discoidal; *body chamber* small; *aperture* contracted, sometimes extremely narrow (Figs. 48, 49); 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.

ORTHOCERAS, Breyn.

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

Synonyms, Cycloceras, McCoy. Gonioceras, Hall.‡ Conoceras, Br. nn.

Example, O. Ludense (diagram of a longitudinal section) Pl. II., Fig. 14.

Shell straight; siphuncle central; aperture sometimes contracted.

Fossil, 240 species. Lower Silurian—Lias; North America, Australia, and Europe.

* Figs. 52, 53. Sutures of two species of Clymenia from Phillips' Pal. Fos., Devonshire. † Figured by D'Archiac and Verneuil, Geol. Trans.

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

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 an orthoceras, 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. 1. *Cameroceras*, Conrad (= melia and thoracoceras, Fischer ?).

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

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

27 species. Lower Silurian—Trias ? North America and Europe.

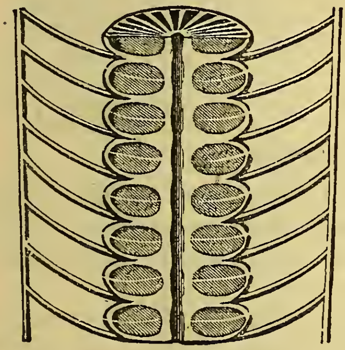


Fig. 54. *Actinoceras.**

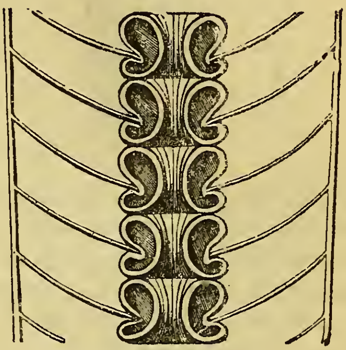


Fig. 55. *Ormoceras.*

2. *Actinoceras* (Bronn), Stokes. Siphuncle very large, inflated between the chambers, and connected with a slender central tube by radiating plates. 6 species. Lower Silurian—Carb.; North 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 species. Lower Silurian—Devon; North America. This sub-genus very much resembles, if it is not identical with, the last mentioned.

4. *Huronia*, Stokes. *Shell* extremely thin, membranous or horny ? Siphuncle very large, central, the upper part of each joint inflated, connected with a small central tube by radiating plates. 3 species. Lower Silurian. Drummond Island, Lake Huron.

Numerous examples of this curious fossil were collected by Dr. Bigsby (in 1822), and by the officers of the regiments formerly

* Fig. 54. *Actinoceras Richardsoni*, Stokes. Lake Winipeg. (Diagram reduced ½.) Fig. 55. *Ormoceras Bayfieldi*, Stokes. Drummond Island. (From Mr. Stokes' paper, Geol. Trans.)

stationed on Drummond Island. Specimens have also been brought home by the officers of many of the Arctic expeditions. But with the exception of one formerly in the possession of

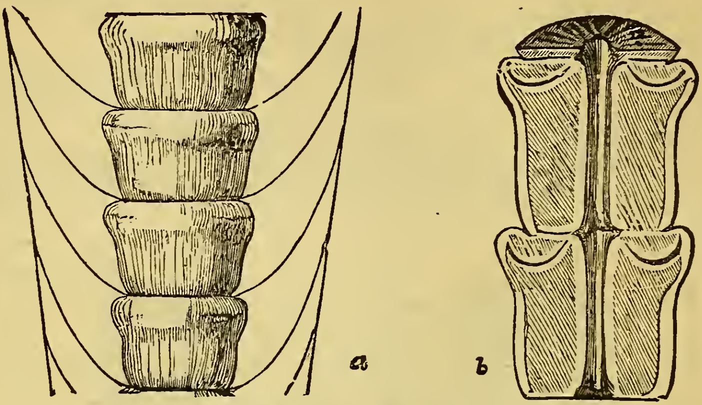


Fig. 56. *Huronia vertebralis.**

Lieutenant Gibson, 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 (Conotubularia, *Troost*). Shell extremely elongated, cylindrical. Siphuncle very large, cylindrical, lateral; thickened internally by repeated layers of shell, or partitioned off by funnel-shaped diaphragms. 12 species. Lower Silurian, New York.

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 frequently 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.

6. *Tritoceras*=*Diploceras*, Salter. The shell is supposed to

* Fig. 56. *Huronia vertebralis*, Stokes. *a* from a specimen in the British Museum 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 British Museum 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.

have resembled *Gonioceras*, and the external tube to be a simple cavity, formed by the approximation of the lateral angles.

Discosorus (*conoideus*) Hall, 1852. Pal. New York. This fossil appears to be a siphuncle similar to those figured by Dr. Bigsby in 1824 (Geol. Trs. I., Pl. 30, f. 6), and which have been correctly referred to the orthocerata by Quenstedt.

GOMPHOCERAS, J. Sby. 1839.

Etymology, *gomphos*, a club; and *ceras*, a horn.

Synonyms, Apioceras (Fischer). Poterioceras (McCoy).

Type, G. pyriforme, Sby., Fig. 58, and G. Bohemicum, Bar. Fig. 47.

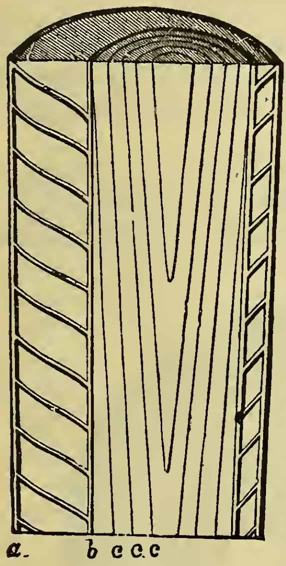


Fig. 57. *Endoceras.**

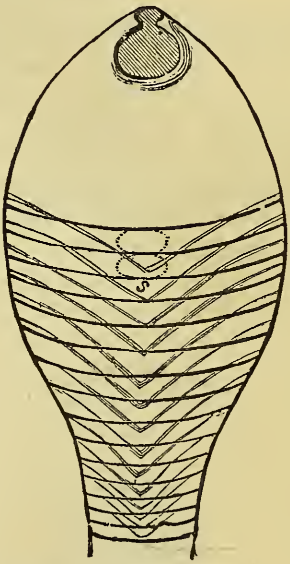


Fig. 58. *Gomphoceras.*†

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

Distribution, 27 species. Lower Silurian—Carb. North America, Europe, Brit. Barrande figures 70 species in Vol. II. of his "Système Silurien," 1865, nearly all of which are believed to be new.

ONCOCERAS, Hall.

Etymology, *oncos*, a protuberance.

Type, O. constrictum, Hall. Trenton limestone.

* Fig. 57. Diagram of an *endoceras* (after Hall). *a*, shell-wall; *b*, wall of siphuncle; *c c c*, diaphragms ("embryo-tubes" of Hall).

† Fig. 58. *Gomphoceras pyriforme*. L. Ludlow rock, Mocktree Hill, Herefordshire. (From Murchison's Silurian Syst. reduced ½.) *s*, beaded siphuncle.

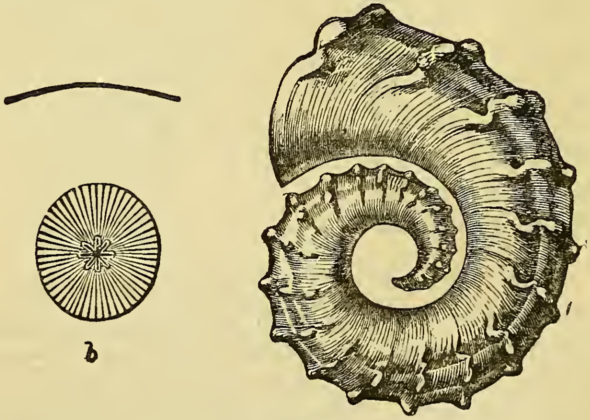
Shell, like a curved *gomphoceras ;* siphuncle external.
Distribution, 3 species. Silurian, New York.

PHRAGMOCERAS, Broderip.

Etymology, *phragmos*, a partition, and *ceras*, a horn.
Type, P. ventricosum (Steininger species), Pl. II., Fig. 15.
Shell curved, laterally compressed; *aperture* contracted in the middle; *siphuncle*, ventral, radiated. Example, P. callistoma, Bar., Fig. 48.
Distribution, 15 species. Lower Silurian—Carb.; Brit., Germany.

CYRTOCERAS, Goldf., 1832.

Etymology, *curtos*, curved, *ceras*, horn.
Synonyms, Campulites, Desh., 1832 (including gyroceras). Aploceras, D'Orbigny. Campyloceras and trigonoceras, McCoy. Gyroceras, D'Orbigny.
Example, C. hybridum, Volborthi, and Beaumonti (Barrande).
Shell curved; *siphuncle* small, internal, or sub-central.
Fossil, 84 species. Lower Silurian—Carb.; North and South America and Europe.



b

Fig. 59.*

GYROCERAS, Meyer, 1829.

Etymology, *gyros*, a circle, and *ceras*.
Synonym, Nautiloceras, D'Orbigny.
Example, G. eifeliense, D'Arch. (Pl. II., Fig. 13). Devonian; Eifel.

* Fig. 59. *Gyroceras Goldfussii.* (= ornatum Goldf.). *b*, siphuncle of *G. depressum*, Goldf. sp. Devonian. Eifel. From MM. D'Archiac and Verneuil.

Shell nautiloid; whorls separate; siphuncle excentric, radiated.
Fossil, 17 species. Upper Silurian—Trias? North America and Europe.

THORACOCERAS, Fischer, 1844.

Synonym, Melia, Fischer (not L.).
Type, T. vestitum.
Shell straight, elongated, conical, with a small lateral straight siphuncle.
Fossil, 20 species. Lower Silurian—Carb. United States and Europe.

NOTHOCERAS, Barrande, 1856.

Shell nautiloid, slightly involute; septa slightly arched, without lobes.
Fossil, 1 species. Upper Silurian.

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 as that of the nautilus. It consists of an external porcellanous* layer, formed by the *collar* 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 shows 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 whorl 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

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

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

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 *A. obtusus*, *amaltheus*, and *tuberculatus*.

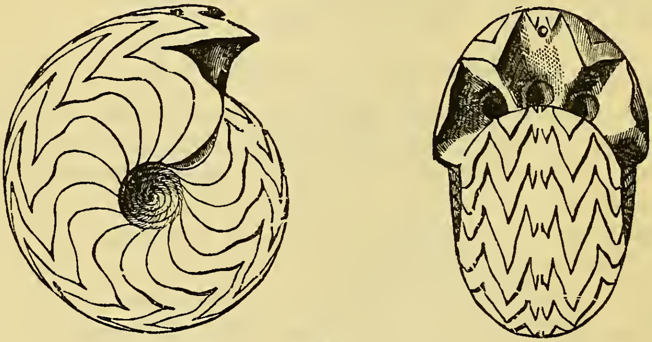


Fig. 60.†

GONIATITES, De Haan.

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

Synonym, *aganides*, D'Orbigny (not Montf=*Aturia zic-zac*).

Examples, G. Henslowi (Pl. III., Fig. 1), G. sphericus (Figs. 60 and 46).

Shell discoidal; sutures lobed; siphuncle dorsal.

Distribution, 197 species. Upper Silurian—Trias. Europe.

RHABDOCERAS, Hauer, 1860.

Shell straight, orthoceratoid, with bold sculpture. *Septa* with rounded lobes.

Distribution, 1 species. Trias. Germany.

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

† Fig. 60. *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.

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

Shell straight; sutures lobed.
Type, B. subconicus, Sbger.
Distribution, 3 species. Devonian, Germany.

Fig. 61.*

CERATITES, De Haan.

Type, C. nodosus (Pl. III., Fig. 2).
Shell discoidal; sutures lobed, the lobes crenulated (Fig. 61).
Distribution, 29 species. Devonian—Chalk. Europe, India.

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

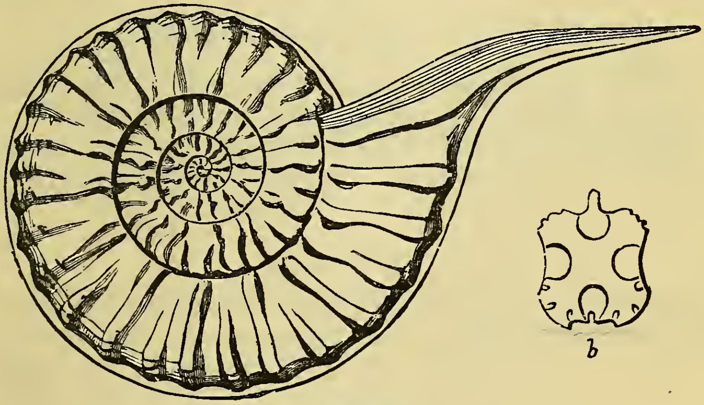


Fig. 62.†

AMMONITES, Bruguiere.

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

Synonyms, Orbulites, Lam. Planulites, Montf.

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

* Fig. 61. Suture of *ceratites nodosus* (Brug). The arrow in the dorsal lobe points towards the aperture.

† Fig. 62. *Ammonites rostratus* (Sby.) From the U. greensand of Devizes, in the cabinet of W. Cunnington, Esq. *b*, front view of one of its partitions.

Distribution, about 700 species. Trias—Chalk. Coast of Chili (D'Orbigny), Santa Fé de Bogota (Hopkins), New Jersey, Europe, South India, and New Zealand.

In this, as in almost every case, the figures represent the number of species which have been described, and which generally pass current as species. It is very probable that when all the forms have been thoroughly examined many may turn out to be nothing more than variations of the same species, due to differences of age, &c. Thus, according to Mr. Seeley, the *Ammonites splendens* from the greensand of Cambridge, comprises not only the form so-named, but fourteen others occurring in the same bed, and which have received distinctive specific names; *A. planulatus* is made up of five so-called species. Looked at from this point of view the 700 would be replaced by a much smaller number.

Captain 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. 62), varians.

B. *Back crenated.*

4. *Amalthei*,	ool.	A. amaltheus, cordatus, excavatus.
5. *Rothomagenses*,	cret.	A. rothomagensis, from *Rothomagum*, Rouen (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, spinosus (Pl. III., Fig. 5).

F. *Back round, convex.*

11. *Heterophylli*,	L. ool.	A. heterophyllus (Fig. 41).
12. *Ligati*,	cret.	A. planulatus (Pl. III., Fig. 3).

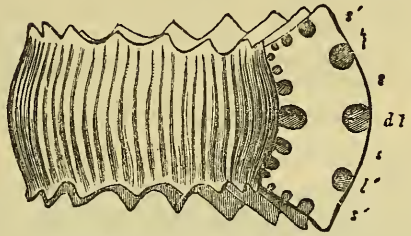


Fig. 63. *Ammonites coronatus.**

13. *Annulati*,	ool.	A. annulatus, biplex, giganteus.
14. *Coronati*,	ool.	A. coronatus (Fig. 63), sublævis.
15. *Fimbriati*,	ool.	A. fimbriatus, lineatus, hircinus.

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

Fig. 64.†

Examples, A. Maximiliani (Fig. 64), A. Metternichii.

CRIOCERAS, Leveille.

Etymology, *krios*, a ram, and *ceras*, a horn.
Synonym, Tropæum, Sby.
Example, C. cristatum, D'Orbigny (Pl. III., Fig. 8).
Shell discoidal; whorls separate.
Distribution, 13 species. Neocomian — Upper greensand. Britain, France.

* Fig. 63. 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.

† Fig. 64. *Am. Maximiliani*, Klipstein. (= *A. bicarinatus*, Münst.) Trias, Hallstadt (copied from Quenstedt). A, profile, showing the numerous lobes and saddles; B, suture of one side; *v*, dorsal saddle.

TOXOCERAS, D'Orbigny.

Etymology, *toxon*, a bow, *ceras*, a horn.
Example, T. annulare, D'Orbigny (Pl. III., Fig. 12).
Shell bow-shaped; like an ammonite uncoiled.
Distribution, 20 species. Neocomian, Between this and *crioceras* and *ancyloceras* there are numerous intermediate forms.

ANCYLOCERAS, D'Orbigny.

Etymology, *anculos*, incurved.
Synonym, Anisoceras, Pictet.
Example, A. spinigerum (Pl. III., Fig. 10).
Shell at first discoidal, with separate whorls; afterwards produced at a tangent and bent back again, like a hook or crosier.
Distribution, 38 species. Inferior oolite—chalk. South America (Chili and Bogota), Europe.

SCAPHITES, Parkinson.

Etymology, *scaphe*, a boat.
Example, S. equalis (Pl. III., Fig. 9).
Shell at first discoidal, with close whorls; last chamber detached and recurved.
Distribution, 19 species. Oolite—Chalk. Europe, India.

HELICOCERAS, D'Orbigny.

Etymology, *helix* (*helicos*), a spiral, and *ceras*, a horn.
Example, H. rotundum, Sby. species (Pl. III., Fig. 11—diagram).
Shell spiral, sinistral; whorls separate.
Distribution, 11 species. Inferior oolite ?—Chalk. Europe, India.

TURRILITES, Lam.

Etymology, *turris*, a tower, and *lithos*, a stone.
Shell spiral, sinistral; aperture often irregular.
Distribution, 37 species. Gault—Chalk. Europe.

The turrilite was perhaps *dibranchiate* 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.

HAMITES, Parkinson.

Etymology, *hamus*, a hook.

Example, H. attenuatus (Pl. III., Fig. 15).

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

Distribution, 58 species. Neocomian—Chalk. South America (Tierra del Fuego), Europe, India.

Fig. 65. Sutures of *Hamites cylindraceus*, Defr.*

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 twenty neocomian species.

PTYCHOCERAS, D'Orbigny.

Etymology, *ptyche*, a fold.

Example, P. emericianum, D'Orbigny (Pl. III., Fig. 14).

Shell bent once upon itself; the two straight portions in contact.

Distribution, 8 species. Neocomian—Chalk. Britain, France, India.

BACULITES, Lamarck.

Etymology, *baculus*, a staff.

Example, B. anceps (Pl. III., Fig. 13).

Shell straight, elongated; aperture guarded by a dorsal process.

Distribution, 17 species. Neocomian—Chalk. Europe, South America (Chili), India.

Baculina, D'Orbigny, 2 species. B. Rouyana. Neocomian. France. Sutures not foliated.

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

* Fig. 65. Space between two consecutive sutures of the right side, from a specimen in the British Museum. *a*, dorsal line; *b*, ventral. Baculite limestone, Fresville.

Chapter II.

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 organisation 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 *nucleobranchs* 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.

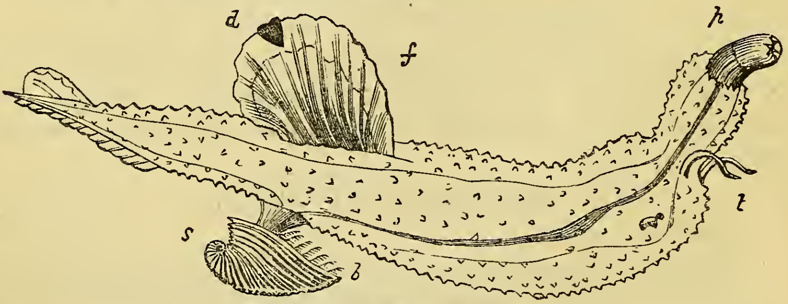


Fig. 66. A *nucleobranch*.*

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.

A few species of *cymba*, *littorina*, *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

* Fig. 66. *Carinaria cymbium*, Desh. = C. cristata, L. sp. (after Blainville), Mediterranean. *p*, proboscis; *t*, tentacles; *b*, branchiæ; *s*, shell; *f*, foot; *d*, disk.

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

(*pulmonifera*), the other water (*branchifera*). 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 *calyptrœa* and *chiton* have a greater range than the "paper-sailor," or the ever-drifting oceanic-snail.

Fig. 67.*

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. Edwards.)

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.

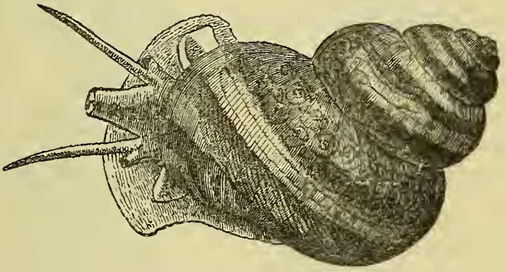


Fig. 68. *Paludina vivipara.*†

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.

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.

* Fig. 67. Fry of *Eolis* (from Alder and Hancock). *o*, the operculum; the original is not larger than the letter *o*.

† Fig. 68. *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 whorl; the gill is seen on the left; and between them the termination of the alimentary canal. Surrey Docks, June, 1850.

The development of the air-breathers goes on within the shell, and has been traced by Van Beneden, Gegenbaur, and others in Limax, Veronicella, Vitrina, Bulimus, and Helix.

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. trochiform; conical, with a flat base, like *trochus.*
  k. turbinated; conical, with a round base, like *turbo.*
  l. few-whorled; *Helix hæmastoma.* Pl. XII., Fig. 1.
  m. many-whorled; *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. 69), 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 whorls separate, or scarcely in contact, as *scalaria, cyclostoma*, and *valvata;*

* 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 whorls Rev. H. Moseley, "On geometrical Forms of Turbinated and Discoid Shells."—*Phil. Trans. Lond.* 1838. Pt. 2, p. 351.

but more commonly the inner side of the spiral tube is formed by the pre-existing whorls (Fig. 69).

The axis of the shell, around which the whorls 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 (*rima*), as in *lacuna;* or it may be filled up by a shelly deposit, as in many *naticas.* In other shells, like the *triton*, the whorls are closely coiled, leaving only a pillar of shell, or *columella*, in the centre: such shells are said to be *imperforate.*

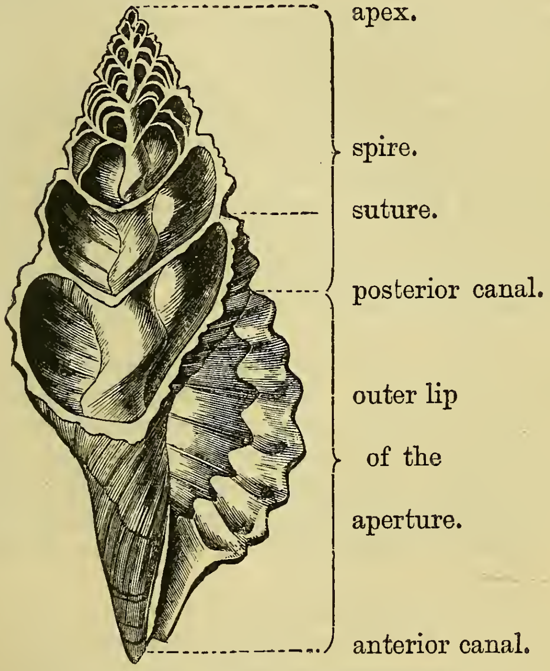


Fig. 69. Section of a spiral univalve.*

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 *nucleobranchs* 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.

* Fig. 69. 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 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 in acidulous waters (e.g. *cerithidea* and *pirena*), and specimens may be obtained from more favourable situations with the points perfect.

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

The last turn of the shell, or *body-whorl*, is usually very capacious; in the females of some species the whorls 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 (*siqhonostomata*); 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. *strombidœ* 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-whorl. 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-whorl (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 *cyprœa;* 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 whorls; but stripes of colour extending from the apex across the whorls 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 shells, 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 calcareous 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 embryo, 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. 70.

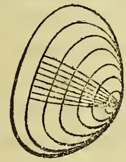


Fig. 71.


Fig. 72.

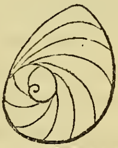


Fig. 73.


Fig. 74.

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. 71), when it grows only on one side, and the nucleus is marginal, as in *purpura*, *phorus*, and *paludomus*.

Claw-shaped, or unguiculate (Fig. 70), with the nucleus apical or in front, as in *turbinella* and *fusus*; it is claw-shaped and serrated in *strombus* (Fig. 76).

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

Paucispiral, or few-whorled (Fig. 73), as in *littorina*.

Sub-spiral, or scarcely spiral, in *melania* (Pl. VIII., Fig. 25*).

Multispiral, or many-whorled (Fig. 72), as in *trochus*, where they sometimes amount to twenty; the number of turns which the operculum makes is not determined by the number of whorls 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. 74).

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.*

The researches of Dr. Lovén* have led to many attempts being made to remodel the arrangement of the *Gasteropoda* by the aid of peculiarities in their dentition. Whatever improvements may be thus obtained, it does not appear desirable to introduce a new terminology for divisions long since well established, and already over-burdened with *classical* names.†

The patterns, or *types* of lingual dentition, are on the whole remarkably constant; but their *systematic value* is not uniform. It must be remembered that the teeth are essentially *epithelian cells*, and like other superficial organs liable to be modified in accordance with the wants and habits of the creatures. The instruments with which animals obtain their food are of all others most subject to these *adaptive* modifications, and can never form the *basis* of a philosophical system.‡

* Ofversigt af Kongl. Vetensk. Akad. Förhandl. 1847.

† The following names were proposed by Troschel (in Wiegman's *Handbuch der Zoologie*, 1848) and Gray (An. Nat. Hist.) for the principal types of lingual dentition:—

a. Tænioglossa, teeth 3. 1. 3; Littorina, Natica, Triton.

b. Toxoglossa, teeth 1. 0. 1; Conus, Terebra?

c. Hamiglossa, teeth 1. 1. 1; Murex, Buccinum.

d. Rachiglossa, teeth 0. 1. 0; Voluta, Mitra?

e. Gymnoglossa, teeth 0; Pyramidella, Cancellaria, Solarium?

f. Rhipidoglossa. teeth 00, 1. 00; Nerita, Trochus.

‡ The carnivorous opossums have teeth adapted for eating flesh, but are not on that account to be classified with the placental carnivora. The lingual teeth, like the *operculum*, usually have a structure characteristic of the genera or sub-genera. Sometimes they have a general uniform character throughout a whole family or group of families. In many cases they present minute differences which promise to be valuable aids for distinguishing closely allied species. For example, *Patella athletica* may be distinguished from the common limpet (*P. vulgata*) by its teeth.

Some of the gasteropoda can suspend themselves by glutinous threads, like *litiopa* and *Rissoa parva*, which anchor themselves to sea-weeds (Gray), and *cerithidae* (Fig. 75), 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.)

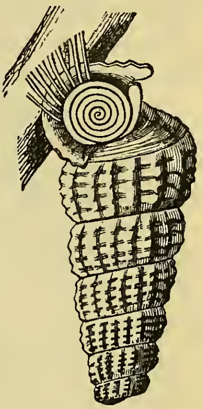


Fig. 75.

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. PROSOBRANCHIATA.

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. SIPHONOSTOMATA. 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 one or two, comb-like, placed obliquely over the back. Species all marine.

Family I.—Strombidæ. 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.

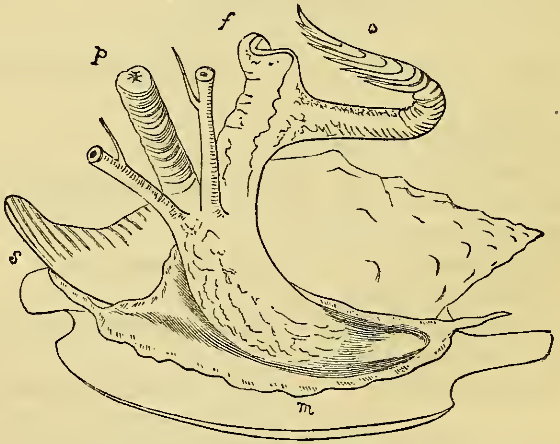


Fig. 76.*

Strombus, L. Stromb.

Etymology, *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

* Fig. 76. *Strombus auris-Dianæ*, L. (after Quoy and Gaimard), Amboyna. *p*, proboscis, between the eye-pedicels; *f*, foot, folded up; *o*, operculum; *m*, border of the mantle; *s*, respiratory siphon.

the anterior canal. Lingual teeth (*S. floridus*) 7 cusped; uncini, 1 tri-dentate, 2, 3 claw-shaped, simple (Fig. 77).*

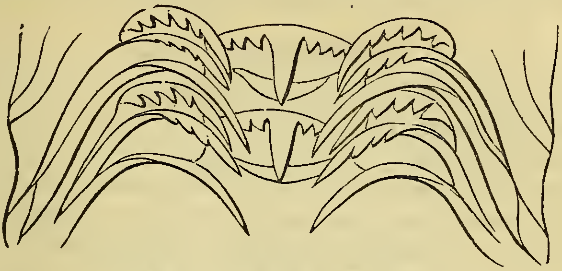


Fig. 77. *Strombus.* (Wilton).

Strombus (floridus) is described by Lovèn as having a non-retractile, produced *muzzle*, like *Aporrhais*. *S. gibberulus* is represented by Dr. Bergh with all the uncini denticulated.

Distribution, 65 species. West Indies, Mediterranean, Red Sea, India, Mauritius, China, New Zealand, Pacific, West America. On reefs, at low water, and ranging to 10 fathoms.

Fossil, 5 cretaceous species; 3 species 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 the name *Rimella* Ag., 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 year 1850. (Mr. Archer.)

PTEROCERAS, Lam. Scorpion shell.

Etymology, *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.

Distribution, 12 species. India, China.

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

Fossil, nearly 100 species 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.

Etymology, *rostellum*, a little beak.
Synonym, Fusus, Humphreys.
Example, R. curta. Pl. IV., Fig. 4.

Shell with an elongated spire; whorls 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.

Distribution, 8 species. Red Sea, India, Borneo, China. *Range*, 30 fathoms.

Fossil, 80 species. Neocomian—chalk (= aporrhaïs?). 6 species. Eocene—. Britain, France, &c.

The old 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'Orbigny. 1847. Shell like *rostellaria*; whorls keeled; keel developed into a slender spine on the outer lip, and two on each whorl, forming lateral fringes, as in *ranella*. Fossil, 5 species. Inf. oolite—chalk. Britain, France.

SERAPHS, Montfort. (Terebellum, Lam.)

Etymology, diminutive of *terebra*, an auger.

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

Distribution, 1 species. China. Philippines, 8 fathoms. (Cuming.)

Fossil, 5 species. 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, cr at their base; branchial plumes two. *Lingual ribbon* long, linear; *rachis* armed with a single series of dentated teeth; *uncini*, single. Predatory on other *mollusca*. The two species belonging to the genus *Cheletropis*, Forbes =*Sinusigera*, D'Orbigny, are now known to have no affinity with the Atlantidæ, but to be the larva form of species belonging to the Muricidæ.

Fig. 78. *Murex tenuispina.* (Wilton.)

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 sup-apical (Pl. IV., Fig. 10); lingual dentition (M. erinaceus), teeth single, three crested; uncini single, curved. For dentition of *M. tenuispina* see Fig. 78.

Distribution, 220 species. World-wide; most abundant on the West 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, 164 species. Eocene—. Britain, France, Java, &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 whorl 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. 21.) 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.

Etymology, *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.

Distribution, 9 species. Mediterranean, West Africa, Cape, India, Western America. —50 fathoms.

Fossil, 8 species. Eocene—. London, Paris.

PISANIA, Bivon, 1832.

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

Synonyms, 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*.

Distribution, about 120 species. West Indies, Africa, India, Philippines, South Seas, Western America.

Fossil, ? species. Eocene—Britain, France, &c.

RANELLA, Lam. Frog-shell.

Synonym, 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.

Distribution, 58 species. Mediterranean, Cape, India, China, Australia, Pacific, Western America. *Range*, low-water to 20 fathoms.

Fossil, 23 species. Eocene—.

TRITON, Lam.

Etymology, *Triton*, a sea-deity.

Synonym, Persona (Montfort, Gray).

Type, T. tritonis, L. species. Pl. IV., Fig. 13.

Shell with disconnected varices; canal prominent; lips denticulated.

Operculum ovate, sub-concentric.

Distribution, 100 species. West Indies, Mediterranean, Africa, India, China, Pacific, Western America. Ranging from low water to 10 or 20 fathoms; one minute species has been dredged at 50 fathoms.

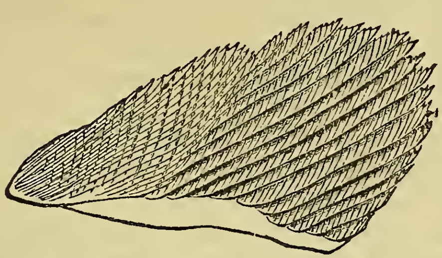


Fig. 79. One of the buccal plates of *Triton*, $\frac{40}{1}$ (Wilton.)

Fossil, 45 species. Eocene—. Britain, France, &c. Chili.

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

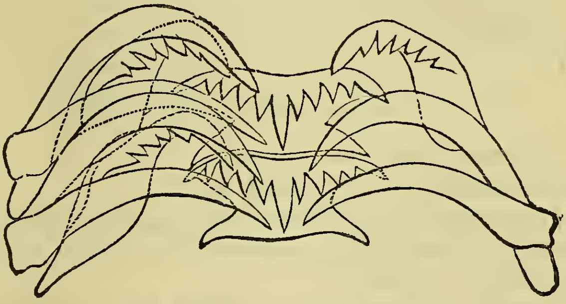


Fig. 80. Teeth of *Triton*, $\frac{240}{1}$. (Wilton.)

West Indies. The buccal plates and teeth of *Triton* are shown in Figs. 79, 80.

Fasciolaria, Lam.

Etymology, *fasciola*, a band.

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

Fig. 81. *Fasciolaria Tarentina.* (Wilton.)

Shell fusiform, elongated; whorls round or angular; canal open; columellar lip tortuous, with several oblique folds. Operculum claw-shaped. *F. gigantea* of the South Seas attains a length of nearly two feet. The teeth of *Fasciolaria* resemble those of *Fusus Islandicus*. In *Buccinum undatum*, the median tooth has five, or rarely six denticles; and Mr. Wilton has observed that *B. limbosum*, ♂ has the teeth seven cusped, while in the females they are six cusped.

Distribution, 108 species. West Indies, Mediterranean, West Africa, India, Australia, South Pacific, Western America.

Fossil, 30 species, U. chalk—. France.

Turbinella, Lam.

Etymology, 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. 70. The chank-shell (*T. pyrum*) is carved by the Cingalese, and reversed varieties of it, from which the priests administer medicine, are held sacred.

Distribution, 70 species. West Indies, South America, Africa, Ceylon, Philippines, Pacific, Western America.

Fossil, 20 species. Miocene—.

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

Latirus (Montfort), T. gilbula. Pl. V., Fig. 4.

Lagena (Schum.), T. Smaragdula, L. species. Northern Australia.

Cancellaria, Lam.

Etymology, *cancellatus*, cross-barred.

Type, C. reticulata. Pl. V., Fig. 5.

Shell cancellated; aperture chanelled in front; columella with several strong oblique folds; no operculum. The animals are vegetable feeders. (Desh.)*

Distribution, 71 species. West Indies, Mediterranean, West Africa, India, China, California.

Fossil, 60 species. Up. Chalk—. Britain, France, &c.

Admete (viridula) is a boreal form of Cancellaria, without plaits.

Dibaphus, Phi.

Synonym, conohelix edentulus. (Sw.) *Shell* subcylindrical, spire acute; aperture narrow, linear, edentulous, excised at the base; lip thickened, rectilinear, rounded and abbreviated below.

Trichotropis, Broderip, 1829.

Etymology, *Thrix* (trichos), hair, and *tropis*, keel.

Type, T. borealis, Pl. VI., Fig. 8. (= ? *Admete*, Phil., no operculum).

* *Cancellaria* and *trichotropis* form a small natural family connected with *cerithiadæ* and *strombidæ*.

Shell thin, umbilicated; spirally furrowed; the ridges with epidermal fringes; columella obliquely truncated; operculum lamellar, nucleus external.

Animal with a short broad head; tentacles distant, with eyes on the middle; proboscis long, retractile.

Lingual dentition similar to *velutina; teeth* single, hamate, denticulated; *uncini* 3: 1 denticulate, 2 and 3 simple (Fig. 82).

Fig. 82. *Trichotropis borealis.* (Warrington).

Lovén places *Trichotropis* in the same family with *Velutina;* Cancellaria is very closely allied, though it wants both teeth and operculum. Mr. Couthouy describes *Trichotropis cancellata* as having a muzzle like Littorina.

Distribution, 14 species. Northern seas. United States, Greenland, Melville Island, Behring's Straits, North Britain. 15—80 fathoms. 1 species from Japanese seas (A. Adams).

Fossil, 1 species. Miocene—. Britain.

PYRULA, Lam. Fig-shell.

Etymology, diminutive of *pyrus*, a pear.

Synonyms, 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.

Distribution, 39 species. West Indies, Ceylon, Australia, China, Western America.

Fossil, 32 species. Neocomian—. Europe, India, Chili, Java.

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 fathoms water. (Adams.)

Sub-genera, *Fulgur*, Montfort P. perversa. (= *Pyrella*, Sw. P. spirillus.)

Rapana, Schum. P. bezoar, shell perforated. Operculum lamellar, nucleus external. This appears to be a Purpura.

Myristica. Sw. P. melongena. Pl. V., Fig. 7. Operculum pointed, curved.

Fusus, Lam. Spindle-shell.

Synonyms, Colus, Humph. Leiostoma (bulbiformis). Sw. Strepsidura, Sw.

Type, F. colus. Pl. V., Fig. 8.

Shell fusiform; spire many-whorled; canal straight, long; operculum ovate, curved, nucleus apical. Pl. V., Fig. 9*.

Distribution, 184 species. World-wide. The typical species are sub-tropical. Australia, New Zealand, China, Senegal, United States, Western America, Pacific.

Fossil, 320 species. Bath oolite? Gault—Eocene—. Britain, &c.

Sub-genera, *Trophon*, Montfort. F. magellanicus, Pl. IV., Fig. 16. 38 species. Antarctic and Northern seas. British coast. 5—70 fathoms. *Fossil*, Chili, Britain.

Clavella, Sw. (Cyrtulus, Hinds), body-whorl ventricose, suddenly contracted in front; canal long and straight. Resembling a turbinella, without plaits. 2 species. 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 species. Spitzbergen, Davis's Straits, Britain, Mediterranean, Kamtschatka, Oregon. Low-water to 100 fathoms. *Fossil*, Pliocene. Britain, Sicily.

Pusionella, Gray. F. pusio, L. species (= F. nifat, Lam.), columella keeled. Operculum, nucleus internal. 7 species; 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 Mediterranean, and on the coast of Spain; it abounds in the pliocene tertiary (crag) of Essex. The *fusus deformis*, a similar species, 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.

Etymology, *buccina*, a trumpet, or triton's-shell.

Type, B. undatum. Pl. V., Fig. 10.

Shell few whorled; whorls ventricose; aperture large; canal very short, reflected; operculum lamellar, nucleus external. (See *Pisania*.)

Distribution, 48 species. Northern and Antarctic seas. Low water to 100 fathoms. (Forbes.) (B. ? clathratum, 136 fathoms, off Cape). South Australia.

Fossil, 130 species, including *Pisania*, &c. Gault?—Miocene—Britain, France.

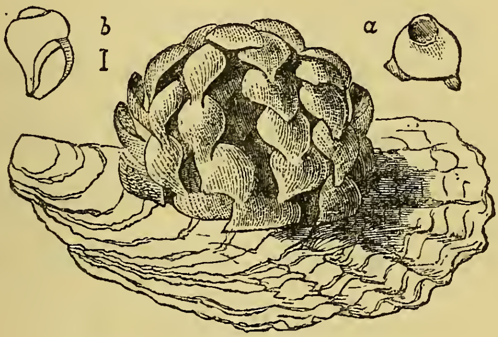


Fig. 83. Nidamental capsules of the Whelk.*

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. 83, *b*: *a* represents the inner side of a single capsule, showing the round hole from which the fry have escaped.

Sub-genus, *Cominella*, Gray. *Ex*. B. limbosum, purpura maculosa, &c. Operculum as in *fusus*. About 12 species.

PSEUDOLIVA, Swainson.

Etymology, named from its resemblance to *oliva*, in form.

Synonyms, Sulco-buccinum, D'Orbigny. Gastridium (Gray) G. Sowerby.

* Fig. 83. 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.

Type, P. plumbea. Pl. V., Fig. 12.

Shell globular, thick; with a deep spiral furrow near the front of the body-whorl, 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.

Distribution, 6 species. Africa and California.

Fossil, 5 species. Eocene. Britain, France, Chili.

? Anolax (Roissy), Conrad, Lea.

Etymology, *an aulax*, without furrow.

Synonyms, Buccinanops, D'Orbigny. 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.

Distribution 26 species. Brazil, West Africa, Ceylon, Pacific, Western America.

Fossil, 3 species. Eocene—. North America, France.

? Halia, Risso.

Etymology, *halios*, marine.

Synonym, Priamus, Beck.

Types, bulla helicoides (Brocchi). Miocene, Italy. Helix priamus (Meuschen). Coast of Guinea?

Shell like *achatina*; ventricose, smooth; apex regular, obtuse, operculum? The fossil species occurs with marine shells, and sometimes coated by a polyzoon (*lepralia*).

Terebra, Lamarck. Auger-shell.

Synonyms, Acus, Humph. Subula, Bl. Dorsanum, Gray.

Type, T. maculata. Pl. V., Fig. 13.

Shell long, pointed, many-whorled; aperture small; canal short; operculum pointed, nucleus apical.

Animal blind, or with eyes near the summit of minute tentacles.

Distribution, 109 species, mostly tropical. Mediterranean (1 species). India, China, Western America.

Fossil, 24 species. Eocene—. Britain, France, Chili.

Eburna, Lamarck. Ivory-shell.

Etymology, *ebur*, ivory.

Synonym, 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.

Distribution, 9 species. 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 fathoms. (Adams.)

Nassa, Lam. Dog-whelk.

Etymology, *nassa*, a basket used for catching fish.

Synonyms, 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. Operculum 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.

Distribution, 210 species. Low water—50 fathoms. World-wide. Arctic, Tropical, and Antarctic Seas.

Fossil, 19 species. Eocene—. Britain, &c. North America.

Sub-genus, *Cyllene*, Gray. C. Oweni, Pl. V., Fig. 17. Outer lip with a slight sinus near the canal; sutures channelled. West Africa, Sooloo Islands, Borneo. *Fossil*, Miocene, Touraine.

Cyclonassa, Swainson. C. neritea, Pl. V., Fig. 16.

Phos, Montfort.

Etymology, *phos*, light.

Synonym, 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.

Distribution, 30 species. (Cuming.) Red Sea, Ceylon, Philippines, Australia, West America.

? RINGICULA, Deshayes.

Etymology, 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.

Distribution, 7 species? Mediterranean, India, Philippines, Gallapagos.

Fossil, 9 species. Miocene—. Britain, France. *Ringicula* is placed with *nassa* by Dr. Gray and Mr. S. Wood; it appears to us very nearly allied to *cinulia* = *avellana*, D'Orbigny) 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; upper lip much worn and flattened. Operculum lamellar, nucleus external. Pl. VI., Fig. 2. Lingual dentition like *murex erinaceus;* teeth transverse, three 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.)

Distribution, 140 species. West Indies, Britain, Africa, India, New Zealand, Pacific, Chili, California, Kamtschatka. From low water—25 fathoms.

Fossil, 40 species. Tertiary—. Britain, France, &c.

Concholepas, Favan. C. lepas (Gmelin species) Pl. VI., Fig. 3. Peru. The only species differs from purpura in the size of its aperture and smallness of the spire.

Cuma (Humphrey) P. angulifera, inner lip with a single prominent fold.

? PURPURINA (Lycett, 1847), D'Orbigny.

Shell ventricose, coronated; spire short; aperture large, scarcely notched in front.

Fossil, 9 species. Bath-oolite. Britain, France. The type *P. rugosa*, somewhat resembles *purpura chocolatum* (Duclos), but the genus probably belongs to an extinct group.

RHIZOCHILUS, Stp. 1850.

Example, R. antipathum. Founded on a species of *Purpura*?

which lives on the *antipathes ericoides*. When adult they attach themselves, singly or in groups, to the branches of the coral, or to each other, by a solid extension of the lips of the shell. The aperture becomes closed, with the exception of the respiratory canal.

MONOCEROS, Lam.

Etymology, *monos*, one; *ceras*, a horn.

Synonyms, Acanthina, Fischer. Chorus, Gray.

Type, M. imbricatum. Pl. VI., Fig. 4. (Buc. monoceros, Chemn.)

Shell like purpura; with a spiral groove on the whorls, ending in a prominent spine on the outer lip. This genus is retained on account of its geographical curiosity; it consists of species of *purpura*, *lagena*, *turbinella*, *pseudoliva*, &c.

Distribution, 18 species. West coast of America.

Fossil, Tertiary. Chili.

M. giganteus (chorus) has the canal produced like *fusus*. *M. cingulatum* is a *turbinella*, and several species 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.

Distribution, 1 species. Sicily, adhering to corals. Closely allied to *purpura madreporarum*, Sby. Chinese Sea.

RICINULA, Lam.

Etymology, diminutive of *ricinus*, the (fruit of the) castor-oil plant.

Example, R. arachnoïdes. Pl. VI., Fig. 9 (= murex ricinus, L.).

Shell thick, tuberculated, or spiny; aperture contracted by callous projections on the lips. Operculum as in purpura.

Distribution, 34 species. India, China, Philippines, Australia, Pacific.

Fossil, 3 species. Miocene—. France.

PLANAXIS, Lam.

Type, P. sulcata. Pl. VI., Fig. 6.

Synonyms, Quoyia and Leucostoma.

Shell, turbinated; aperture notched in front; inner lip callous, channelled behind; operculum *subspiral* (quoyia) or semi-ovate. Pl. VI., Fig. 7.

Distribution, 27 species. West Indies, Red Sea, Bourbon, India, Pacific, and Peru.

Fossil, Miocene?

Small coast shells, resembling periwinkles, with which Lamarck placed them. This genus is now generally placed among the Littorinidæ.

MAGILUS, Montfort, 1810.

Synonyms, 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.

Distribution, 4 species. Red Sea, Mauritius.

The magili live fixed amongst corals, and grow upwards with the growth of the zoophytes in which they become immersed; they fill the cavity of the tube with solid shell as they advance.

CASSIS, Lam. Helmet-shell.

Synonyms, Bezoardica, Schum. Levenia, Gray. Cypræcassis, Stutch.

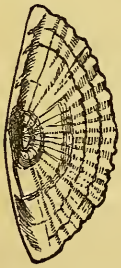


Fig. 84. Operc. of *Cassis*.

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-whorl; canal sharply recurved. Operculum small, elongated; nucleus in the middle of the straight inner edge (Fig. 84). Lingual teeth 3, 1, 3, as in Fig. 85.

The spiny *buccal plates* of Cassis have been mistaken by Gray and Adams for the *teeth*, which in this genus, and also in *Triton*, are very minute and transparent.

Fig. 85. *Cassis saburon*. (Original).

Distribution, 37 species. Tropical seas; in shallow water. West Indies, Mediterranean, Africa, China, Japan, Australia, New Zealand, Pacific, Mexico.

Fossil, 36 species. Eocene—. Chili, France.

The queen-conch (C. madagascariensis) and other large species are used in the manufacture of shell cameos, p. 38. The periodic mouths (*varices*) which are very prominent, are not absorbed internally as the animal grows.

ONISCIA, Sowerby.

Etymology, *oniscus*, a wood-louse.

Synonym, 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.

Distribution, 9 species. West Indies, China, Gallapagos, United States. (20 fathoms).

Fossil, 3 species. Miocene. United States, Domingo.

CASSIDARIA, Lam.

Etymology, *cassida*, a helmet.

Synonyms, Morio, Montfort. Sconsia, Gray.

Type, C. echinophora. Pl. VI., Fig. 13.

Shell ventricose; canal produced, rather bent. No operculum.

Distribution, 6 species. Mediterranean.

Fossil, 10 species. Eocene—. Britain, France, &c.

BACHYBATHRON, Gaskoin.

Shell small, oblong, striated with lines of growth; spire small, depressed, with channelled suture; aperture with callous denticulated lips, like *Cypræa*.

Distribution, 3 species.

Fig. 86. *Dolium perdix.* (Original).

DOLIUM, Lam. The Tun.

Type, D. galea. Pl. VI., Fig. 12.

Shell ventricose, spirally furrowed; spire small; aperture very large; outer lip crenated. No operculum. Teeth 3, 1, 3. Fig. 86. The genus Macgillivrayia, formerly assigned to the Atlantidæ, belongs here. It comprises the larva forms of several species of Dolium.

Distribution, 14 species. Mediterranean, Ceylon, China, Australia, Pacific.

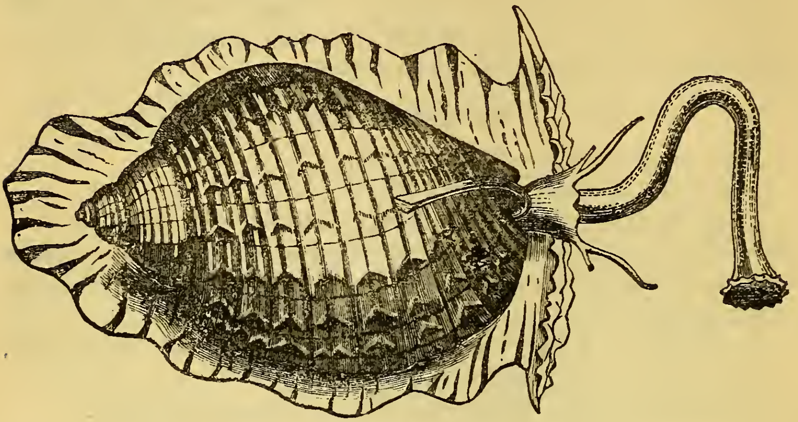


Fig. 87.*

Fossil, 7 species. (? Chalk. Britain). Tertiary. South 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 operculum.

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.

Distribution, 12 species. Mauritius, Ceylon, Philippines. Pacific.

Fossil, 4 species. Eocene—. France.

COLUMBELLA, Lam.

Etymology, 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.

Distribution, 205 species. Sub-tropical. West Indies, Mediterranean, India, Gallapagos, California. Small, prettily-

* *D. perdix, L.* species. $\frac{1}{3}$ natural size (after Quoy). Vanicoro, Pacific. The proboscis is exserted, and the siphon recurved over the front of the shell.

marked shells; living in shallow water, on sandy flats, or congregating about stones. (Adams.)

Fossil, 8 species. Tertiary. (The British species are *pisaniæ*.)

Sub-genus, *Columbellina*, D'Orbigny. 4 species. Cretaceous. France, India.

OLIVA, Lam. Olive, rice-shell.

Type, O. porphyria. Pl. VI., Fig. 16.

Synonym, Strephona, Brown.

Shell cylindrical, polished; spire very short, suture channelled; aperture long, narrow, notched in front; columella callous, striated obliquely; body-whorl furrowed near the base. No operculum in the typical species.

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 fathoms.

Distribution, 120 species. Sub-tropical, West and East America. West Africa, India, China, Pacific.

Fossil, 20 species. Eocene—. Britain, France, &c.

Sub-genera. *Olivella*, Sw. O. jaspidea, Pl. VI., Fig. 19.

Animal with small, acute frontal lobes. Operculum nucleus sub-apical.

Scaphula, Sw. = Olivancillaria, D'Orbigny, 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.

Etymology, *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. Operculum minute, thin, pointed. Lingual teeth pectinated. Uncini simple, hooked.

Animal like oliva; said to use its mantle-lobes for swimming. (D'Orbigny.) In *A. glabrata*, a space resembling an umbilicus, is left between the callous inner lip and the body-whorl.

Distribution, 23 species. Red Sea, India, Madagascar, Australia, Pacific.

Fossil, 21 species. Eocene—. Britain, France, &c.

FAMILY IV.—CONIDÆ, Cones.

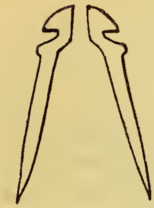


Fig. 88.*

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.

CONUS, L. Cone-shell

Types, C. marmoreus, Pl. VII., Fig. 1. C. geographicus, antediluvianus, &c.

Shell conical, tapering regularly; spire short, many-whorled; columella smooth, truncated in front; outer lip notched at the suture; operculum pointed, nucleus apical.

Distribution, 371 species. All tropical seas.

Fossil, 84 species. Chalk—. Britain, France, India, Java, &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—. Britain, France.

PLEUROTOMA, Lam.

Etymology, *pleura*, the side, and *toma*, a notch.

Synonym, Turris, Humphrey.

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.

Distribution, 430 species. World-wide. Greenland, Britain, 17; Mediterranean, 19; Africa, 15; Red Sea and India, 6; China, 90; Australia, 15; Pacific, 0? West America, 52; West

* Fig. 88. Lingual teeth of *Bela turricula* (after Lovén).

Indies and Brazil, 20. The typical species about 20 (China, 16; West America, 4). Low water to 100 fathoms.

Fossil, 378 species. Chalk—. Britain, France, &c. Chili.

Sub-genera, *Drillia*, Gray. D. umbilicata, canal short.

Clavatula, Lam., canal short, operculum 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 species. (= P. buccinoides), freshwaters, Africa.

Mangelia, Leach (not Reeve). Apertural slit at the suture; no operculum, M. tæniata, Pl. VII., Fig. 5. Greenland, Britain, Mediterranean.

Bela, Leach. Operculum nucleus apical. B. turricula, Pl. VII., Fig. 6.

Defrancia, Millet,* no operculum. D. linearis, Pl. VII., Fig. 7.

? *Lachesis*, Risso, L. minima, Pl. VII., Fig. 8, apex mammillated; operculum claw-shaped. Mediterranean, South Britain, Japan. In shallow water.

Daphnella, Hinds. D. marmorata, New Guinea. (Buc. junceum. L. clay).

Borsonia, Edwards. 2 species recent; tropical seas. *Fossil*, 6 species. Tertiary. Europe.

Cithara, Schumacher.

Etymology, *cithara*, a guitar.

Synonym, 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. Operculum.

Distribution, above 50 species of this pretty little genus were discovered by Mr. Cuming in the Philippine Islands.

Family V.—Volutidæ.

Shell turreted, or convolute; aperture notched in front; columella obliquely plaited. No operculum.

Animal with a recurved siphon; foot very large, partly hiding the shell; mantle often lobed and reflected over the shell; eyes

* According to Mr. S. Hanley, *Defrancia* is synonymous with *Mangelia*.

on the tentacles, or near their base. Lingual ribbon linear; *rachis*, toothed; *pleuræ*, unarmed.

Fig. 89.*

VOLUTA. L. Volute.

Type, V. musica, Pl. VII., Fig. 9.

Synonyms, Cymbiola, Harpula, Sw. Volutella, D'Orbigny. 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.

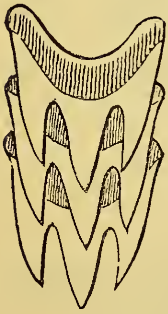


Fig. 90. *Voluta* (Wilton).

Animal eyes on lobes at the base of the tentacles; siphon with a lobe on each side, at its base; lingual teeth 3-cusped (Fig. 90).

V. vespertilio and *hebræa* fill the nuclei of their spires with solid shell. *V. brasiliana* forms nidamental capsules 3 inches long. (D'Orbigny.) In *V. angulata* the mantle is produced into a lobe on the left side, and overlaps the shell.

Distribution, 70 species. West Indies, Cape Horn, West Africa, Australia, Java, Chili.

Fossil, 80 species. Chalk—. India, Britain, France, &c.

Sub-genera, *Volutilithes*, Sw. Spire pointed, many-whorled, columella plaits indistinct. *V. spinosus*, Pl. VII., Fig. 10.

Living, 1 species (*V. abyssicola*), dredged at 132 fathoms; off the Cape. (Adams.)

Fossil, Eocene. Britain, Paris.

Scaphella, Sw. Fusiform, smooth.

Example, V. magellanica.

* Fig. 89. *V. undulata*, Lam. ½ Australia. (From Quoy and Gaimard.)

Fossil, V. Lamberti, Crag, Suffolk.

Melo, Brod. Large, oval; spire short.

Type, M. diadema, Pl. VII., Fig. 11. New Guinea, 8 species.

CYMBA, Broderip. Boat-shell.

Synonym, Yetus (Adans.), Gray.

Type, C. proboscidalis, Pl. VII., Fig. 12, and Fig. 91 (= V. cymbium, L.).

Shell like voluta; nucleus large and globular; whorls 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.

Distribution, 10 species. West Africa, Lisbon.

Fig. 91. *Cymba.*

MITRA, Lam. Mitre-shell.

Synonyms, Turris, Montfort. 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.

Distribution, 420 species. Philippines, India, Red Sea, Mediterranean, West Africa, Greenland (1 species), Pacific, West America. The extra-tropical species are minute. *M. Greenlandica* and *M. Cornea* (Mediterranean species) are found together in the latest British Tertiaries. (Forbes.)

Fossil, 90 species. Chalk—. India, Britain, 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.

Etymology, *volva*, a wrapper.
Type, V. bulloïdes, Pl. VII., Fig. 17.
Shell cylindrical, convolute: spire minute; aperture long and narrow; columella with three oblique plaits in front.
Distribution, 29 species, tropical seas.
Fossil, 5 ? species. Eocene. Britain, France.

Marginella, Lam.

Etymology, diminutive of *margo*, a rim.
Synonyms, 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.
Distribution, 139 species. Tropical, West Indies, Brazil, Mediterranean (1 small species), West Africa, China, Australia.
Fossil, 30 species. Eocene—. France, &c.
Sub-genus, *Hyalina*, Schum. Outer lip scarcely thickened.
Type, voluta pallida, Montfort, West 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. In *Ovulum* the teeth are 2. 1. 2. the outermost broad, with pectinated margins. Lovèn describes the Cypræidæ as having a short, non-retractile muzzle, and places them between the *Naticidæ* and *Lamellaria*. The cowries inhabit shallow water, near shore, feeding on zoophytes.

Cypræa, L. Cowry.

Etymology, *Cypris*, a name of Venus.
Types, C. tigris, C. mauritiana Pl. VII., Fig. 20.

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).

Fig. 92. *Cypræa*, young.*

Fig. 93. *Trivia.*†

The young shell has a thin and sharp outer lip, a prominent spire, and is covered with a thin epidermis (Fig. 92). 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-cowry (*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. 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.

Distribution, 150 species. In all warm seas (except east coast South America ?), but most abundant in those of the old world. On reefs and under rocks at low water.

Fossil, 84 species. Chalk—. India, Britain, 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.

Trivia, Gray. C. europæa, Pl. VII., Fig. 23; Fig. 93, and 15, B. Small shells with striæ extending over the back. (*Uncini:* 1st denticulate, 2, 3, simple.)

* Fig 92. *Cypræa testudinaria*, L., young, China.

† Fig. 93. *Trivia Europæa*, Mont. From the "British Mollusca," by Messrs. Forbes and Hanley.

Distribution, 30 species. Greenland, Britain, West Indies, Cape, Australia, Pacific, West America.

Erato, Risso.

Etymology, *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*.
Distribution, 11 species. Britain, Mediterranean, West Indies, China.
Fossil, 2 species. Miocene—. France, Britain (Crag).

Ovulum, Lam.

Etymology, diminutive of *ovum*, an egg.
Synonym, Amphiceras, Gronov.
Types, O. Ovum, Pl. VII., Fig. 25. O. gibbosa and verrucosa.
Shell like *cypræa;* inner lip smooth.
Distribution, 36 species. Warm seas. West Indies, Britain, Mediterranean, China, West America.
Fossil, 11 species. 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 south coast of Britain, it is very thin, and has a sharp outer lip.
Calpurnus, Montfort (name) = Ovulum verrucosum.
Volva (Fleming) = Ovulum patulum (*Calpurna*, Leach).
Radius (Montfort) Schum. = Ovulum volva

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. 68), 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.*

* 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.

FAMILY I.—NATICIDÆ.

Shell globular, few-whorled; spire, small, obtuse; aperture semi-lunar; lip acute; pillar often callous.

Fig. 94. *Natica monilifera* (Wilton).

Animal with a long retractile proboscis; lingual ribbon linear; *rachis* 1 toothed; *uncini* 3 (as in Fig. 94); foot very large; mantle-lobes largely developed, hiding more or less of the shell. Species all marine.

NATICA (Adans.), Lamarck.

Synonym, Mamilla, 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; operculigerous lobe large, covering part of the shell; jaws horny; lingual ribbon short; branchial plume single.

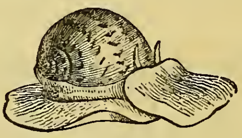


Fig. 95. *Natica.**

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.

Distribution, 197 species. Arctic seas, Britain, Mediterranean, Caspian, India, Australia, China, Panama, West Indies.

Fossil, 260 species. Devonian—. South America, North America, Europe, India.

Sub-genera. *Naticopsis*, M'Coy. N. Phillipsii. Shell imperforate; inner lip very thick, spreading; operculum shelly (British Museum). Carb. limestone, 7 species.

* Fig. 95. *Natica Alderi*, Forbes. From an original drawing, communicated by Joshua Alder, Esq

Operculum, horny.

Neverita, Risso. N. Alderi. Fig. 95.

Lunatia, Gray. N. Ampullaria. Perforation simple; epidermis dull, olivaceous. Northern seas.

Globulus, J. Sby. (Ampulina, Deshayes not Bl.) N. Sigaretina. Pl. VIII., Fig. 2. Umbilicus narrow (rimate), lined by a thin callus.

Fossil, Eocene. Britain, Paris.

Polinices, Montfort (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-whorl.

Naticella, Müller. 19 species.

Fossil, Trias, S. Cassian.

Deshayesia, Raulin

Miocene, France. Some additional species have been found with a similar oblique aperture and corrugated inner lip. Baron Ryckholt has described a species (*D. Raulini*), from the *Devonian*, Belgium. The relation of the genus is uncertain.

Naticella, Münster.

This genus, abounding in the Trias of St. Cassian, has been referred to *Natica* by D'Orbigny. A characteristic species occurs in the green-sand of Blackdown, and has been named *Natica carinata*, J. Sby. (Narica, D'Orbigny.) It is exactly intermediate between *Narica* (p. 237) and *Fossarus* (p. 253), and appears to form with them a little group nearly related to *Lacuna* (p. 255).

Sigaretus (Adans.), Lamarck.

Synonyms, 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.

Distribution, 31 species. West Indies, India, China, Peru.

Fossil, 10 species. Eocene—. Britain, France, South America.

Sub-genus. *Naticina*, Gray. N. papilla, Pl. VIII., Fig. 3. Shell ventricose, thin, perforated. West Indies, Red Sea, China, North Australia, Tasmania. *Eocene*, Paris.

Lamellaria, Montagu.

Etymology, *lamella*, a thin plate.

Synonyms, 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 operculum.

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.

Distribution, 10 species. Norway, Britain, Mediterranean, New Zealand, Philippines.

Fossil, 2 species. Pliocene—. Britain (Crag).

Narica, Recluz.

Synonyms, 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; operculum very small, thin.

Animal eyes at the outer base of the tentacles; foot with wing-like lobes.

Distribution, 26 species. West Indies, Nicobar, Vanikoro, Pacific.

Fossil. 4 species, Gault—. (D'Orbigny.) Britain, France.

Velutina, Fleming.

Etymology, *velutinus*, velvety (from *vellus*, a fleece).

Type, V. lævigata. Pl. VIII., Fig. 7.

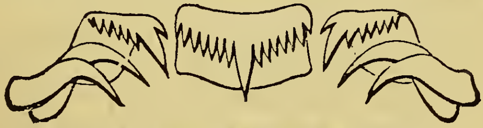


Fig. 96. *Velutina lævigata* (Warington).

Shell thin, with a velvety epidermis; spire small; suture deep; aperture very large, rounded; peristome continuous, thin. No operculum.

Animal with a large oblong foot; margin of tne 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 (Fig. 96). It resembles that of *trivia* (Fig. 15, B).

Distribution, 4 species. Britain, Norway, North America, Icy Sea to Kamtschatka.

Fossil, 3 species. Pliocene—. Britain.

Sub-genus. Otina (Gray). V. otis.

Shell minute, ear-shaped.

Animal with a simple mantle, and very short tentacles. West and south-west British coast; inhabiting chinks of rocks, between tide-marks. (Forbes.)

Velutina inhabits the laminarian zone, and ranges to 40 fathoms. *V. lævigata* is sometimes brought in on the fishermen's lines (off Northumberland), generally adhering to *Alcyonium digitatum* (Alder). Dr. Gould obtained it from the stomach of fishes.

Cryptocella. H. and A. Adams, 1853.

Shell thin, pellucid, calcareous; spire small; aperture large.

Family II.—Pyramidellidæ.

Shell spiral turreted; nucleus minute, sinistral; aperture small; columella sometimes with one or more prominent plaits; operculum horny, imbricated, nucleus 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. They are very numerous in the Japanese seas.

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 *opisthobranchiate.*

Pyramidella, Lam.

Etymology, diminutive of *pyramis*, a pyramid.

Synonyms, Obeliscus. Humphrey. (P. dolabrata. Pl. VIII., Fig. 11.) Syrnola, Adams, 1860.

Type, P. auris-cati. Pl. VIII., Fig. 10.

Shell slender, pointed, with numerous plaited or level whorls; apex sinistral; columella with several plaits; lip sometimes furrowed internally; operculum indented on the inner side to adapt it to the columellar plaits. The shell of the typical pyramidellæ bears some resemblance to *cancellaria.*

* "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.*

Distribution, 111 species. West Indies, Mauritius, Australia.
Fossil, 12 species. Chalk—. France, Britain.

ODOSTOMIA, Fleming, 1824.

Etymology, *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.
Distribution, ? species. Britain, Mediterranean, Red Sea, Australia.
Fossil, 15 species? Eocene—. Britain, France.
Very minute and smooth shells, having the habit of *rissoœ*, and like them sometimes found in brackish water. They range from low water to 40 fathoms. The animal is undistinguishable from *chemnitzia*.

CHEMNITZIA, D'Orbigny.

Etymology, named in honour of Chemnitz, a distinguished conchologist of Nuremburg, who published seven volumes in continuation of Martini's "*Conchylien-cabinet*," 1780-95.
Synonyms, Turbonilla, Risso. Parthenia, Lowe. Pyramis and Jaminea, Br. Monoptigma, Lea, part. Amoura, Moller.
Type, C. elegantissima. Pl. VIII., Fig. 13.
Shell slender, elongated, many-whorled; whorls 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*.
Distribution, 32 species. Britain (4 species), Norway, Mediterranean. Probably world-wide. Range from low water to 90 fathoms.
Fossil, 240 species. Silurian—. Britain, France, &c.
The "melaniæ" of the secondary rocks are provisionally referred to this genus. Those of the palæozoic strata to *loxonema*.
Sub-genera. *Eulimella*, Forbes. E. scillæ, Scacchi. 4 British species. Shell smooth and polished; columella simple; apex sinistral.
Stylopsis (Adams, 1860) much resembles and is probably synonymous with this sub-genus.

Eulima, Risso, 1826.

Etymology, *eulimia*, ravenous hunger

Synonym, Pasithea, Lea.

Type, E. polita. Pl. VIII., Fig. 14.

Shell small, white, and polished; slender, elongated with numerous level whorls; 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; operculum 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.)

Distribution, 49 species. Britain, Mediterranean, India, Australia, Pacific. In 5—90 fathoms water.

Fossil, 40 species. Carb. ?—. Britain, France, &c.

Sub-genus. *Niso*, Risso (= Bonellia, Deshayes). N. terebellatus, Lam. species. Axis perforated.

Fossil, 3 species. Eocene—. Paris.

Distribution, 5 species. China, West America. (Cuming.)

Monoptigma, Lea.

Synonyms, Melanioides, Lea = M. striata, Gray (name only).

Shell like *Chemnitzia*, rather fusiform, spirally grooved; columella slightly folded, with a sinus at the base.

Distribution, 12 species. Indo-Pacific.

Menestho, Möller (Turbo albulus, Fabr. Greenland) v. Chemnitzia.

Aclis, Lovén.

Etymology, *A*, without, *kleis*, a projection.

Synonym, Alvania, Leach (not Risso).

Type, A. supranitida. Wood. A. ascaris, Turt. Pl. IX., Fig. 4.

Shell minute, like *turritella;* spirally striated; aperture oval; outer lip prominent; axis slightly rimate; operculate; apex sinistral.

Animal with a long retractile proboscis; tentacles close together, slender, inflated at the tips; eyes immersed at the bases of the tentacles; operculum lobe ample, unsymmetrical; foot truncated in front. Ranges to 80 fathoms water. 5 British species, Norway.

Fossil. ? species. Pliocene—. Britain (Crag).

STYLOPTYGMA, Adams. 1860.

Shell pupiform, semi-transparent; with slightly convex whorls. Aperture sub-quadrate.

MYONIA, Adams.

Shell ovate, turreted; white, thin, with slightly convex whorls. Aperture oblong.

LEUCOTINA, Adams.

Shell like last, but with last whorl ventricose; with minute dots.

STILIFER, Brod.

Example, S. astericola. Pl. VIII., Fig. 15.

Synonym, Stylina, Fleming.

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 whorls 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.

Distribution, 16 species. West Indies, Britain, Philippines, Gallapagos, Pacific.

LOXONEMA, Phillips.

Etymology, *loxos*, oblique, and *nema*, thread; in allusion to the striated surface of many species.

Type, L. sinuata, U. Devonian, Petherwin.

Shell elongated, many-whorled; aperture simple, attenuated above, effused below, with a sigmoidal edge to the outer lip.

Fossil, 75 species. L. silurian—Trias. North America, Europe.

MACROCHEILUS, Phillips.

Etymology, *macros*, long, and *cheilos*, lip.

Synonym, Polyphemopsis, Portlock.

Shell thick, ventricose, buccinoid; aperture simple, effuse below; outer lip thin, inner lip wanting, columella callous, slightly tortuous.

Type, M. arculatus, Schlotheim species. Devonian. Eifel.

Distribution, 1 species (M. Japonicus), Korea Straits.

Fossil, 12 species. Devonian — Carboniferous. Britain, Belgium.

FAMILY III.—CERITHIADÆ. Cerites.

Shell spiral, elongated, many-whorled, frequently varicose; aperture channeled 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. Mr. Wilton has examined the dentition of four *Cerithiadæ;* the teeth are broad, as in *Melaniadæ*, with incurved and dentated summits. In *Cerithidium* the median teeth are slender with minute hooks. *Habitat.* Marine, estuary, or fresh water.

CERITHIUM (Adans.), Bruguiere.

Etymology, *ceration*, a small horn.

Type, C. nodulosum. Pl. VIII., Fig. 16.

Shell turreted, many-whorled, with indistinct varices; aperture small, with a tortuous canal in front; outer lip expanded; inner lip thickened; operculum horny, paucispiral. Pl. VIII., Fig. 16.*

Distribution, 136 species. World-wide, the typical species tropical. Norway, Britain, Mediterranean, West Indies, India, Australia, China, Pacific, Gallapagos.

Fossil, 460 species. Trias—. Britain, France, United States, &c.

Sub-genera. *Rhinoclavis*, Sw. C. vertagus. Canal long, bent abruptly; operculum, sub-spiral.

Bittium, Leach. C. reticulatum, Pl. VIII., Fig. 17. Small northern species, ranging from low water to 80 fathoms.

Triforis, Deshayes. C. perversum, Pl. VIII., Fig. 18. 30 species. Norway—Australia.

Fossil, Eocene—. Britain, France.

Shell sinistral; anterior and posterior canals tubular. The third canal is only accidentally present, forming part of a varix.

Cerithiopsis, Forbes. C. tuberculare, Britain.

Shell like *bittium;* proboscis retractile; operculum pointed, nucleus apical. Range 4—40 fathoms.

POTAMIDES, Brongniart. Fresh-water Cerites.

Etymology, *potamos*, a river, and *ides*, patronymic termination.

Type, P. Lamarckii, Brong. (= Cerit. tuberculatum, Brard.)

Example, P. mixtus. Pl. VIII., Fig. 19.

Synonyms, Tympanotomus, Klein, C. fuscatum, Africa. Pirenella, Risso, C. mammillatum, Pl. VIII., Fig. 22.

Shell like *cerithium*, but without *varices* in the very numerous typical fossil species; epidermis thick, olive brown; operculum orbicular, many-whorled.

Distribution, 41 species. California, Africa, India. In the mud of the Indus they are mixed with species of *ampullaria*, *venus*, *purpura*, *ostrea*, &c. (Major W. E. Baker.)

Fossil (species included with *cerithium*), Eocene—. Europe.

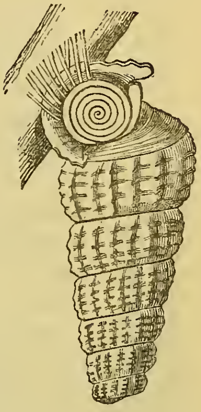


Fig. 97. Cerithidea.*

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. 97).

Distribution, 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 whorls (as in *nerinœa* (Fig. 98). India, North 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, Montfort. Cerit. palustre, Pl. VIII., Fig. 20.

Shell with numerous indistinct varices; canal straight, often tubular; outer lip expanded. India, North Australia.

* *C. obtusa*, Lam. sp. copied from Adams.

Cerith. radulum and granulatum of the West African rivers approach very near the fossil *potamides*, but they have numerous varices.

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.

Fig. 98.*

NERINÆA, Defrance.

Etymology, *nereis*, a sea-nymph.

Example, N. trachea. Fig. 98.

Shell elongated; many-whorled, nearly cylindrical; aperture channeled in front; interior with continuous ridges on the columella and whorls.

Fossil, 150 species. Inf. oolite—U. chalk. Britain, France, Germany, Spain, and Portugal. They are most abundant, and attain the largest size to the south; and usually occur in calcareous 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 species.

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.

? FASTIGIELLA, Reeve.

Type, F. carinata, Reeve.

Shell like turritella; aperture with a short canal in front (Cuming Museum, and British Museum).

Fossil, Eocene. Paris (*Cerithium rugosum*, Lam.).

APORRHAIS, Aldrovandus.

Etymology, *aporrhais* (Aristotle), "spout-shell," from *aporrheo*, to flow away.

* Fig. 98. *Nerinæa trachea*, Desl., partly ground down to show the form of the interior. Bath oolite, Ranville. Communicated by John Morris, Esq.

Synonym, Chenopus, Philippi.

Type, A. pes-pelecani. Pl. IV., Fig. 7, and Fig. 99.

Shell with an elongated spire; whorls numerous, tuberculated; aperture narrow, with a short canal in front; outer lip of the adult expanded and lobed oı digitated; operculum pointed, lamellar.

Animal with a short broad muzzle; tentacles cylindrical, bearing the eyes on prominences near their bases, outside; foot short, angular in front; branchial plume single, long;

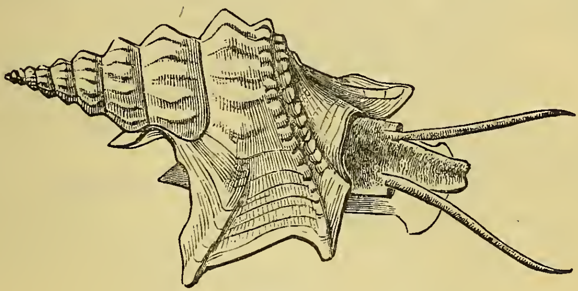


Fig. 99.*

lingual ribbon linear; teeth single, hooked, denticulated; uncini 3, the first transverse, 2 and 3 claw-shaped (Fig. 100). The dentition of *Aporrhais* is most like *Strombus* and *Carinaria;* and quite unlike the *Cerithiadæ* with which it has been placed,

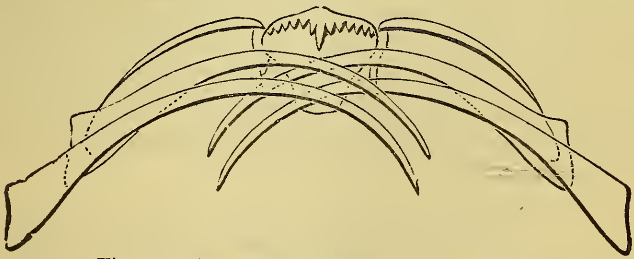


Fig. 100. *Aporrhaïs pes-pelecani.* (Warington.)

in accordance with the views of Professor Forbes. The animal is carnivorous.

Distribution, 4 species. Labrador, Norway, Britain, Mediterranear, West Africa. Range 100 fathoms.

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.

* Fig. 99. *Aporrhaïs pes-pelcanı*, L., from a drawing by Joshua Alder, Esq., in the "British Mollusca."

STRUTHIOLARIA, Lam.

Etymology, *struthio*, an ostrich (-foot), from the form of its aperture.

Type, S. straminea, Pl. IV., Fig. 6.

Shell turreted; whorls 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 (Fig. 101).

Fig. 101. Operculum of *Struthiolaria*.

Animal with an elongated muzzle? tentacles cylindrical; eye-pedicels short, adnate with the tentacles, externally; foot broad and short. (Kiener.)

Distribution, 5 species. Australia and New Zealand, where alone it occurs sub-fossil.

FAMILY IV.—MELANIADÆ.

Shell spiral, turreted; with a thick, dark epidermis; aperture often channeled, 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.

MELANIA, Lam.

Etymology, *melania*, blackness (from *melas*).

Type, M. amarula. Pl. VIII., Fig. 25.

Synonyms, Thiara, Megerle. Pyrgula, Crist.

Shell turreted, apex acute (unless eroded); whorls ornamented with striæ or spines; aperture oval, pointed above; outer lip sharp, sinuous; operculum subspiral. Pl. VIII., Fig. 25.*

Distribution, 361 species. South Europe, India, Philippines, Pacific Islands. Distinct groups in the southern States of North America.

Fossil, 25 species. Wealden—. Europe (v. *chemnitzia*).

Sub-genera. Melanàtria, Bowdich. M. fluminea.* Pl. VIII., Fig. 26. Aperture somewhat produced in front; operculum with rather numerous whorls. This section includes some of the largest species 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. West Africa. Whorls spirally ridged, or muricated; aperture broadly channeled in front.

Ceriphasia, Sw., C. sulcata. North America. Aperture like vibex; slightly notched near the suture.

Hemisinus, Sw., H. lineolatus. West Indies. Aperture channeled in front.

Melafùsus, Sw, (Io, Lea. Glottella, Gray.) M. fluviatilis. Pl. VIII,, Fig. 27. United States. Aperture produced into a spout in front.

Melàtoma, Anthony (not Sw.) M. altilis.

Shell like anculotus; with a deep slit at the suture. United States.

Anculotus, Say. A. præmorsus. Pl. VIII., Fig. 28.

Shell globular; spire very short; outer lip produced. United States.

Amnicola, G. and H. A. isogona. Pl. IX., Fig. 23. United States; inhabits the fresh waters of New England, gregarious on stones and submerged plants.

Chilostoma, Desh. M. marginata, Eocene. Paris. Peristome thickened externally, all round.

Clea, Bens. C. annesleyi. South India.

Paludomus, Swainson.

Etymology, *palus*, a marsh, and *domus*, home.

Synonyms, Tanalia, Gray. Hemimitra, Sw.

Type, P. aculeatus, Gm. species. Pl. IX., Fig. 34.

Shell turbinated, smooth, or coronated; outer lip crenulated; olivaceous with dark brown spiral lines.

Distribution, 25 species. Ceylon (Himalaya ?) in the mountain-streams, sometimes at an elevation of 6,000 feet. The Himalayan species (*melania conica*, Gray, *hemimitra retusa*, Sw., and several others), referred to this genus, have a concentric operculum, like *paludina*.

* 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.

Melanopsis, Lam.

Types, M. buccinoides, M. costata. Pl. VIII., Fig. 30.

Shell body-whorl elongated; spire short and pointed; aperture distinctly notched in front; inner lip callous; operculum sub-spiral.

Distribution, 21 species. Spain, Asia Minor, New Zealand.

Fossil, 25 species. Eocene—. Europe.

Sub-genus. *Pirena*, Lam, (faunus, Montfort) P. atra. Pl. VIII., Fig. 31. Spire elongated, many-whorled; outer lip of

Fig. 102. *Pirena atra*. (Wilton.)

the adult produced. Teeth 3. 1. 3, as in Fig. 102.

Distribution, 4 species? South Africa, Madagascar, Ceylon, Philippines.

Family V.—Turritellidæ.

Shell tubular, or spiral; upper part partitioned off; aperture simple; operculum horny, many-whorled.

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; dentition 3. 1. 3.

Turritella, Lam.

Etymology, diminutive of *turris*, a tower.

Synonyms, Terebellum, Torcula, Zaria, and Eglisia (Gray.)

Type, T. imbricata. Pl. IX., Fig. 1.

Shell elongated, many-whorled, spirally striated; aperture rounded, margin thin; operculum horny, many-whorled, 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?

Distribution, 73 species. World-wide. Ranging from the Laminarian Zone to 100 fathoms. West Indies, United States, Britain (1 species), Iceland, Mediterranean, West Africa, China, Australia, West America.

Fossil, 172 species. Neocomian—. Britain, &c., South America, Australia, Java.

Sub-genera. Proto, Defr., P. cathedralis, Pl. IX., Fig. 3, aperture truncated below.

Mesalia, Gray, M. sulcata (var.), Pl. IX., Fig. 2. Greenland—South Africa.

Fossil, Eocene. Britain, France.

CÆCUM, Fleming.

Synonyms, Corniculina, Münster. Brochus, Bronn. Odontidium, Phil.

Type, C. trachea, Pl. IX., Fig. 5. Young species, Fig. 6.

Shell at first discoidal, becoming decollated when adult; tubular, cylindrical, arched; aperture round, entire; apex closed by a mammillated septum. Operculum horny, many-whorled. Lingual teeth, 0; uncini, 2, the inner broad and serrulated.

Distribution, Britain, 11 species, 10 fathoms. Mediterranean.

Fossil, 4 species. Eocene—. Britain, Castelarquato.

VERMETUS, Adanson. Worm-shell.

Synonyms, 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; operculum circular, concave externally.

Distribution, 31 species. Portugal, Mediterranean, Africa, India.

Fossil, 12 species. Neocomian—. Britain, France, &c.

? *Sub-genus*. *Spiroglyphus*, Daud. S. spirorbis Dillwyn species, irregularly tubular; attached to other shells, and half buried in a furrow which it makes as it grows. Perhaps an annelide?

Petaloconchus, sculpturatus, Lea, 1843.

Miocene, United States, St. Domingo, South Europe.

Shell with two internal ridges running spirally along the columella, becoming obsolete near the apex and aperture.

SILIQUARIA, Brug.

Etymology, *siliqua*, a pod.

Typo, S, anguina, Pl. IX., Fig. 8.

Shell tubular; spiral at first, irregular afterwards; tube with a continuous longitudinal slit.

Distribution, 8 species. Mediterranean, North Australia. Found in sponges.

Fossil, 10 species. Eocene—. France, &c.

Scalaria, Lam. Wentle-trap.

Etymology, *scalaris*, like a ladder.

Type, S. pretiosa, Pl. IX., Fig. 9. (= T. scalaris, L.)

Shell mostly pure white and lustrous; turreted; many-whorled; whorls round, sometimes separate, ornamented with numerous transverse ribs; aperture round; peristome continuous; operculum horny, few-whorled.

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.

Distribution, 104 species. Mostly tropical. Greenland, Norway, Britain, Mediterranean, West Indies, China, Australia, Pacific, West America.

Fossil, nearly 100 species. Coral-rag—. Britain, North America, Chili, India.

Family VI.—Littorinidæ.

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; operculum lobe appendaged.

The species inhabit the sea, or brackish water, and are mostly littoral, feeding on algæ.

Littorina, Férussac. Periwinkle.

Etymology, *littoralis*, belonging to the sea-shore.

Type, L. littorea, Pl. IX., Fig. 10.

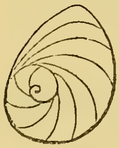


Fig 103.

Shell turbinated, thick, pointed, few-whorled; aperture rounded, outer lip acute, columella rather flattened, imperforate, operculum pauci-spiral, Fig. 103. Lingual teeth hooked and trilobed; uncini hooked and dentated (Fig. 104).

Distribution, 131 species. 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.

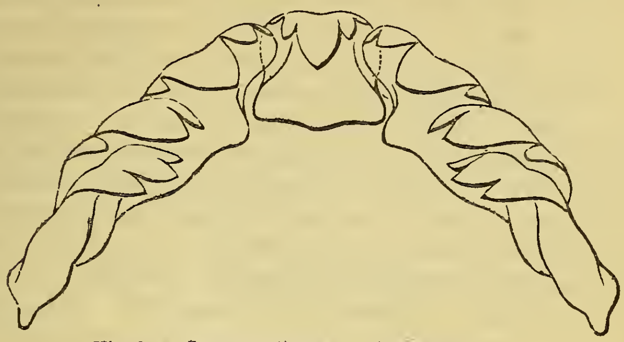


Fig. 104. *Littorina littorea.* (Warington.)

The common species (*L. littorea*) is oviparous; it inhabits the lowest zones of sea-weed between tide-marks. An allied species

r, rostrum or muzzle.
k, buccal mass.
g, nervous ganglia (reproductive orifice, on the right side).
s, salivary gland.
œ, œsophagus.
l, lingual coil.
m, shell-muscle.
b, branchia or gill.
c, heart.
n, aorta.
e, stomach.
f, liver.
h, biliary canal.
i, intestine.
a, anus.
o, ovary.
d, oviduct.
u, uterus.
o', ovarian orifice.
x, renal organ.
y, mucus gland.

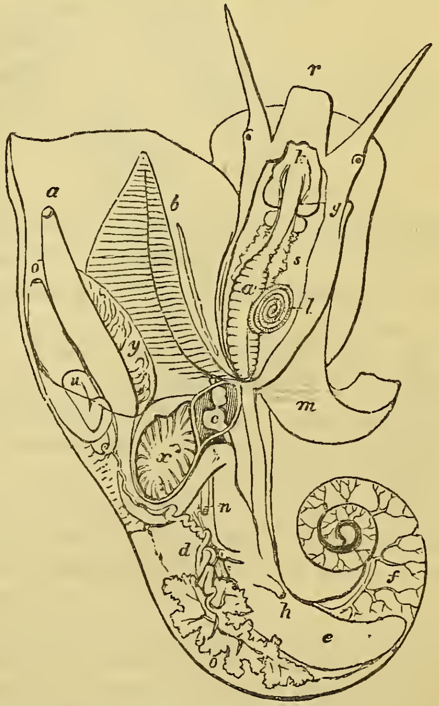


Fig. 105. *Littorina littoralis* ♀: (after Souleyet). Animal removed from its shell; branchial cavity and back laid open.

(*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. The lingual canal of the periwinkle passes from the back of the mouth under the œsophagus for a short distance, then turns up on the right side, and terminates in a coil (like spare rope) resting on the plaited portion of the gullet. It is $2\frac{1}{2}$ inches long, and contains about 600 rows of teeth; the part in use, arming the tongue, comprises about 24 rows.* The dental ribbon of *Risella* is above 2 inches long, and coiled as in *Littorina*. (Wilton.)

Fossil, 10 species? Miocene—. Britain, &c. It is probable that a large proportion of the oolite and cretaceous shells

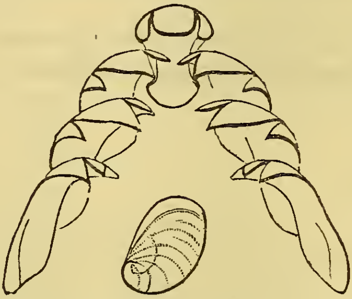


Fig. 106. Operculum and teeth of *Risella*. (Wilton.) The central tooth should be pointed, not blunt as in the figure.

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; operculum with a broad, membranous border. West Indies, Zanzibar, Pacific.

Modulus, Gray. M. Tectum, Pl. IX., Fig. 13.

Shell trochiform or naticoid; porcellanous; columella perforated; inner lip worn or toothed; operculum horny, few-whorled.

* In Fig. 105 is shown the manner in which a gasteropod may be laid out for examination, *under water*; the body requires to be fixed, and the cut edges of the mantle to be kept open with needle points. A convenient trough may be made of a plain earthenware *soap-dish*, by cutting a piece of sheet-cork (such as bootmakers use) to fit the bottom, and fixing it to a piece of sheet-lead of the same size with a couple of india rubber bands. The instruments required for dissecting are simply a pair of fine-pointed scissors, a few broken needles, a penknife, or scalpel, and a pair of forceps with fine curved points.

Distribution, Philippines, West America.

Fossarus (Adans.), Philippi. F. sulcatus, Pl. IX., Fig. 12.

Synonym, Phasianema, Wood.

Shell perforated; inner lip thin; operculum not spiral.

Distribution, Mediterranean.

Fossil, 3 species. Miocene—. Britain, Mediterranean.

Risella, Gray. Lit., melanostoma, Pl. IX., Fig. 14.

Shell trochiform, with a flat or concave base; whorls keeled; aperture rhombic, dark or variegated, operculum pauci-spiral.

Distribution, New Zealand.

Conradia, Adams. Aperture circular. 3 species, Japanese seas.

Couthouyia, Adams. *Shell* ovate, with an acute spine; aperture semi-oval. 1 species, Japanese seas.

SOLARIUM, Lam. Stair-case shell.

Etymology, *solarium*, a dial.

Synonyms, architectoma, Bolten. Philippia, Gray. Helicocryptus, D'Orbigny?

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 whorls, seen in the umbilicus, have been fancifully compared to a winding stair-case.

Distribution, 25 species. Tropical seas. Mediterranean, East Africa, India, China, Japan, Australia, Pacific, West America.

Fossil, 56 species. Eocene—. Britain, &c. 26 other species (oolites—chalk) are provisionally referred to this genus; the cretaceous species are *nacreous* (v. trochus).

Sub-genera. *Torinia*, Gray. T. cylindracea, operculum conical, multi-spiral, with projecting edges, Fig. 107. Living, New Ireland.

Fig. 107.*

Fossil, Eocene. Britain, Paris.

Bifrontia, Desh. (*Omalaxis*, Desh.) S. bifrons, discoidal, the last whorl disengaged. 1 recent species. Madeira.

Fossil, 6 species. Eocene. Paris, Britain.

? *Orbis*, Lea. Discoidal, whorls quadrate.

Fossil, Eocene. America.

Discohelix (calculiformis) Dunker, 1851. *Lias*, Gottingen. This name was proposed for the depressed *Euomphali* of the Lower Oolites, of which there are several species in Normandy and England.

* Operculum of S. *patulum*, Lam. $\frac{3}{1}$, from Deshayes.

Shell usually sinistral, flat, or concave above; aperture quadrangular.

Platystoma (Suessi) Hörnes, 1855. *Trias*, Hallstadt.

Shell discoidal, sinistral? sculptured; peristome suddenly expanded, plain; aperture with an inner rim, circular, and deflected (upwards) at right angles to the plane of the shell. Several examples have occurred.

Philippia (lutea) Gray, has a multi-spiral operculum, and the animal is like *Trochus*. (Philippi.)

Paludestrina (lapidum) D'Orbigny part. Fresh waters of South America.

Shell conic, few-whorled, epidermis green; aperture oblique, peristome abruptly reflected; operculum claw-like. The typical species appear to be *Melaniadæ*, but some small shells like *Hydrobia* have been included in the genus.

PHORUS, Montfort. Carrier-shell.

Etymology, *phoreus*, a carrier.

Synonyms, Onustus, Humph., Xenophorus, Fischer.

Examples, P. conchyliophorus, Born. P. corrugatus, Pl. X., Fig. 1.

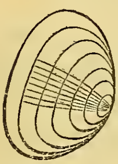


Fig. 108.

Shell trochiform, concave beneath; whorls 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; operculum horny, imbricated, nucleus external, as in *purpura* and *paludomus*, with the transverse scar seen through it, Fig. 108. (Museum Cuming.)

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.

Distribution, 9 species. West Indies, India, Malacca, Philippines, China, and West America.

Fossil, 15 species. Chalk ?—Eocene—. Britain and France.

Shells extremely like the recent *phorus*, are met with even in the carb. limestone and lias.

Lacuna, Turton.

Etymology, *lacuna*, a fissure.

Type, L. pallidula (Pl. IX., Fig. 16).

Synonym, Medoria, Gray.

Shell turbinated, thin; aperture semi-lunar; columella flattened, with an umbilical fissure; operculum 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, semi-circular. Range, low water—50 fathoms.

Distribution, 16 species. Northern shores, Norway, Britain, Spain.

Fossil, 1 species. Glacial beds, Scotland.

Litiopa, Rang.

Etymology, *litos*, simple, *ope*, aperture.

Type, L. bombyx (Pl. IX., Fig. 24).

Shell minute, pointed; aperture slightly notched in front; outer lip simple, thin; inner lip reflected; operculum spiral.

Distribution, 6 species. Atlantic and Mediterranean, on floating sea-weed, to which they adhere by threads.

Fossil, 1 species. Pliocene (Crag).

Rissoa, Frémenville.

Etymology, named after Risso,* a French zoologist.

Type, R. labiosa (Pl. IX., Fig. 17).

Synonym, Cingula, Flem.

Shell minute, white or horny; conical, pointed, many-whorled; smooth, ribbed, or cancellated; aperture rounded; peristome entire, continuous; outer lip slightly expanded and thickened; operculum 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-shaped. They range from high-water to 100 fathoms, but abound most in shallow water, near shore, on beds of *fucus* and *zostera*.

Distribution, about 70 species. Universally distributed, but

* 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.

most abundant in the north temperate zone. North America, West Indies, Norway, Britain, Mediterranean, Caspian, India, &c. *Rissoa parva* adheres to sea-weeds by threads, like litiopa. (Gray.)

Fossil, 100 species. Permian—. Britain, France, &c.

Sub-genera. Rissoina, D'Orbigny. Aperture channelled in front. 66 living species. Fossil (10 species Bath oolite.—Britain.)=*Tuba*, Lea? America.

Hydrobia, Hartm. (=Paludinella, Lovén.) *Shell* smooth; foot rounded behind; operculigerous lobe without filament. *Type*, littorina ulvæ (Pl. IX., Fig. 18). *Distribution*, 50 species. *Fossil*, 10 species. Wealden—. Britain, &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. *Distribution*, 2 species, brackish water. Britain and India.

Nematura, Benson. N. deltæ (Pl. IX., Fig. 21.) Aperture contracted; peristome entire; operculum pauci-spiral. *Fossil*, Eocene. Isle of Wight.

Jeffreysia, Alder (=Rissoëlla, Gray, MS.), J. diaphana. *Shell* minute, translucent; operculum 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. 6 species. Britain. On sea-weed, near low-water. (Alder.) There are eight other species in the Japanese seas.

Skenea, Fleming.

Etymology, named after Dr. Skene, of Aberdeen, a contemporary of Linnæus.

Synonym, Delphinoïdea, Brown.

Type, S. planorbis (Pl. IX., Fig. 20).

Shell minute orbicular, depressed, few-whorled; peristome continuous, entire, round; operculum pauci-spiral. *Animal* like *rissoa*, foot rounded behind. Found under stones at low-water, and amongst the roots of *corallina officinalis*.

Distribution, ? species. Northern seas, Norway, and Britain. *S. cornuella*, Straits of Korea (Adams).

? Truncatella, Risso. Looping-snail.

Type, T. truncatula (Pl. IX., Fig. 25). (Mus., Hanley.)

Shell minute, cylindrical, truncated; whorls 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.

Distribution, 15 species. West Indies, Britain, Mediterranean, Rio, Cape, Mauritius, Philippines, Australia, Pacific. (Cuming.)

? Lithoglyphus, Megerle.

Type, L. fuscus (Pl. IX., Fig. 22).

Shell naticoid, often eroded; whorls few, smooth; aperture large, entire; peristome continuous, outer line sharp, inner lip callous; umbilicus rimate; epidermis olivaceous; operculum pauci-spiral.

Distribution, 5 species. Europe and 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.

Etymology, *palus* (*paludis*), a marsh.

Synonym, Viviparus, Gray.

Type, P. Listeri (Pl. IX., Fig. 26). (P. vivipara, Fig. 68.)

Shell turbinated, with round whorls; aperture slightly angular behind; peristome continuous, entire; operculum 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.

Distribution, 60 species. Rivers and lakes throughout the northern hemisphere; Black Sea, Caspian.

Fossil, 53 species. Wealden—. Britain, &c.

Sub-genus. *Bithynia* (Prideaux), Gray. B. tentaculata (Pl. IX., Fig. 27). *Shell* small; operculum shelly. *Animal* oviparous; with only one neck-lappet, on the right side. The bithynia 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.

Etymology, *ampulla*, a globular flask.

Example, A. globosa (Pl. IX., Fig. 30).

Synonym, Pachylabra, Sw.

Shell globular, with a small spire, and a large ventricose body-whorl; peristome thickened and slightly reflected; operculum shelly.

Animal with a long incurrent siphon, formed by the left neck-

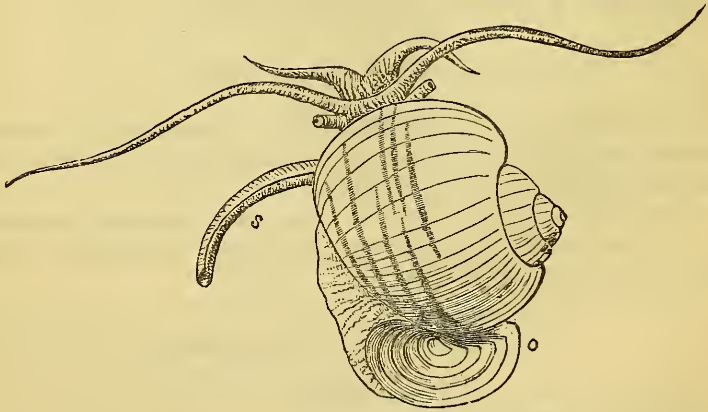


Fig. 109.*

lappet; left gill developed, but much smaller than the right;† muzzle produced into two long tentacular processes; tentacles

* Fig. 109. *Ampullaria canaliculata*, Lam. (from D'Orb). South America. The branchial siphon (*s*) is seen projecting from the left side; *o*, operculum.

† 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.

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 w th marine shells. Their eggs are large, enclosed in capsules,

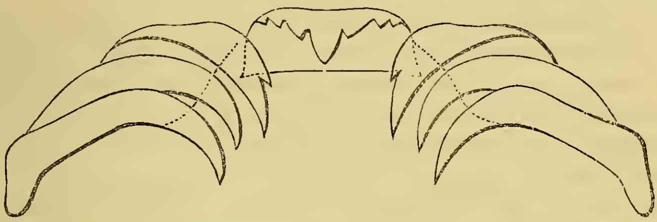


Fig. 110. *Ampullaria globosa.* (Wilton.)

and aggregated in globular masses. The dentition of *A. globosa* is shown in Fig. 110.

Distribution, 136 species. South America, West Indies, Africa, India.

Sub-genera. Pomus, Humph. A. ampullacea. Operculum horny.

Marisa, Gray (ceratodes, Guilding). A. cornu-arietes (Pl. IX., Fig. 31). Operculum horny. *Shell* discoidal.

Asolene, D'Orbigny. A. platæ. Animal without a respiratory siphon; operculum shelly. *Distribution*, South America.

Lanistes, Montf. A. bolteniana, L. (Pl. IX., Fig. 32). *Shell* reversed, umbilicated, peristome thin; operculum horny. *Distribution*, West Africa, Zanzibar, Nile.

Meladomus, Sw. Paludina olivacea, Sby. *Shell* reversed, imperforate; peristone thin; operculum horny.

? AMPHIBOLA, Schumacher.

Synonyms, Ampullacera, Quoy. Thallicera, Sw.

Type, A. australis (Pl. IX., Fig. 33).

Shell globular, with an uneven, battered surface; columella fissured; outer lip channeled near the suture; operculum 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*.

Distribution, 3 species. 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; whorls round or keeled; aperture not modified by the last whorl; peristome entire; operculum horny, multi-spiral.

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.

Distribution, 18 species. Britain and North America.

Fossil, 19 species. Wealden—. Britain, Belgium, &c.

Family VIII.—Neritidæ.

Shell thick, semi-globose; spire very small; cavity simple, from the absorption of the internal portions of the whorls; aperture semi-lunate; columellar side expanded and flattened; outer

Fig. 111.*

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.

Nerita, L. Nerite.

Etymology, *Nerites*, a sea-snail, from *nereïs*.

Type, N. ustulata (Pl. IX., Fig. 35).

* Fig. 111. *Nerita polita*, L. (from Quoy and Gaimard), New Ireland.

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; operculum shelly, Fig. 112.

Fig. 112.*

Distribution, 173 species. Nearly all warm seas. West Indies, Red Sea, Zanzibar, Philippines, Australia, Pacific, West America. (Cuming.) Many of the American species dwell in the streams; one species at the Philippines sometimes climbs up trees.

Fossil, 60 species. Lias—. Britain, &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.

Distribution, 1 species. Pacific.

Fossil, 20 species. Trias ? Britain, 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.

Etymology, *pileolus*, a little cap.

Type, P. plicatus (Pl. IX., Figs. 37, 38).

Shell limpet-like above, with a sub-central apex; concave beneath, with a small semi-lunar aperture, and a columellar disc, surrounded by a broad, continuous peristome.

Distribution, marine; only known as fossils of the Bath oolite, Ancliffe, and Minchinhampton, 3 species, *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; operculum

* Fig. 112. Operculum of *N. peloronta*. West Indies.

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. They are mostly confined to the fresh waters of warm regions. One species (*N. fluviatilis*) is found in British rivers, and in the brackish water of the Baltic. Another extends its range into the brackish waters of the North 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.

Distribution, 111 species. West Indies, Norway, Britain, Black Sea, Caspian, India, Philippines, Pacific, West America.

Fossil, 20 species. Eocene—. Britain, France, &c.

Navicella, Lam.

Etymology, *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

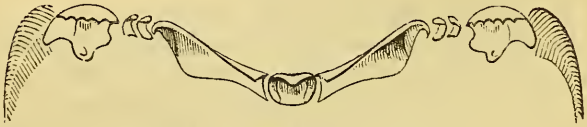


Fig. 113. *Navicella*. (Wilton.)

columellar shelf, and elongated lateral muscular scars; operculum very small, shelly.

Distribution, 33 species. India, Mauritius, Moluccas, Australia, Pacific.

Navicella inhabits fresh waters, adhering to stones and plants.

Median tooth small; laterals 3, first large, trapeziform, 2, 3, minute; uncini numerous, first large, strong, and opague, the rest slender, translucent, with denticulate hooks (Fig. 113).

FAMILY IX.—TURBINIDÆ.

Shell spiral, turbinated or pyramidal, nacreous inside; operculum calcareous 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.

Etymology, *turbo*, a whipping-top.

Synonyms, Batillus, Marmorostoma, Callopoma, &c.—Gray.

Type, T. marmoratus. Pl. X., Fig. 2.

Shell turbinated, solid; whorls 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.

Distribution, 60 species. Tropical seas, West Indies, Mediterranean, Cape, India, China, Australia, New Zealand, Pacific, Peru.

Fossil, 360 species (including littorina) L. Silurian—. Universal.

PHASIANELLA, Lam. Pheasant-shell.

Synonyms, Eutropia (Humphrey), Gray. Tricolea, Risso.

Type, P. australis. Pl. X., Fig. 3.

Shell elongated, polished, richly coloured; whorls convex; aperture oval, not pearly; inner lip callous, outer thin; operculum shelly, callous outside, sub-spiral inside.

Animal with long ciliated tentacles; head-lobes pectinated, wanting in the minute species; neck-lobes fringed; sides ornamented with three 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.

Distribution, 25 species. Australia, large species; India, Philippines, small species; Mediterranean, Britain, West Indies, very small species.

Fossil, 70 species. 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.

Fig. 114.*

IMPERATOR, Montfort.

Type, I. imperialis. Pl. X., Fig. 4.

Synonym, Calcar.

Shell trochiform, thick, with a flat or concave base; whorls keeled or stellated; aperture angulated outside, brilliantly pearly; operculum shelly.

Distribution, 20 species? South Africa, India, Australia, New Zealand.

TROCHUS, L.

Etymology, *trochus*, a hoop.

Synonyms, Cardinalia, Tegula, and Livona, Gray. Infundibulum, Montfort. Chlorostoma, Sw. Trochiscus, Sby. Monilea, Sw.

Types, T. niloticus. Pl. X., Fig. 5. T. zizyphinus. Fig. 114.

Shell pyramidal, with nearly a flat base; whorls numerous, flat, variously striated; aperture oblique, rhombic, pearly inside; columella twisted, slightly truncated; outer lip thin; operculum horny, multispiral, Fig. 115 (T. pica).

Fig. 115.

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.

* Fig. 114. *Trochus zizyphinus*, L., Pegwell Bay, Kent.

Distribution, 200 species. World-wide. Low water to 15 fathoms; the smaller species range nearly to 100 fathoms.

Fossil, 361 species. Devonian—. Europe, North America, Chili.

Sub-genera. Pyramis, Chemn., Tr. obeliscus. Pl. X., Fig. 6. Columella contorted, forming a slight canal.

Gibbula, Leach. Tr. magus, Britain.

Shell depressed, widely umbilicated; whorls tumid. Head-lobes largely developed; lateral cirri, 3.

Enida, Adams. 3 species, Japan.

Margarita, Leach. Tr. helicinus. Pl. X., Fig. 7.

Shell thin; cirri, 5 on each side.

Distribution, 17 species. Greenland, Britain, Falkland Islands. Near low water, under stones and sea-weed.

Elenchus, Humphrey (= Canthiridus, Montfort) E. iris. Pl. X., Fig. 8. Smooth, thin, imperforate, with a prominent base. Australia, New 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 fossilised. Pl. X., Fig. 9.

Alcynus, Adams. 2 species, Japan.

Minolia, Adams. 1 species, Japan.

Turcica, Adams. 1854.

Vitrinella, C. B. Adams, 1850. *Shell* minute, hyaline, turbiniform, umbilicated; aperture large, orbicular.

Distribution, 18 species. West Indies (5), Panama.

Photinula, H. and A. Adams, 1855. *Shell* heliciform; spire somewhat acute.

ROTELLA, Lamarck.

Etymology, diminutive of *rota*, a wheel.

Synonym, Helicina, Gray.

Type, R. vestiaria. Pl. X., Fig. 10.

Shell lenticular, polished; spire depressed; base callous; lingual teeth 13; uncini numerous, sub-equal.

Distribution, 15 species. India, Philippines, China, New Zealand.

MONODONTA, Lam.

Etymology, *monos*, one, and *odous* (*odontos*), a tooth.

Synonyms, Labio, Oken. Clanculus. Montfort, Olivia, Risso.

Types, M. labeo. Pl. X., Fig. 21. M. pharaonis. Pl. X., Fig. 12.

Shell turbinated, few-whorled; whorls spirally grooved and granulated; lip thickened internally, and grooved; columella toothed, more or less prominently and irregularly; operculum horny, many-whorled.

Distribution, 13 species? West Africa, Red Sea, India, Australia.

Fossil (included with trochus), Devonian—. Eifel.

Delphinula (Roissy), Lam.

Etymology, diminutive of *delphinus*, a dolphin. (= Cyclostoma, Gray!)

Type, D. laciniata. Pl. X., Fig. 13. (= T. delphinus, L.)

Shell orbicular, depressed; whorls few, angulated, rugose, or spiny; aperture round, pearly; peristome continuous; umbilicus open; operculum horny, many-whorled. On reefs at low water.

Animal without head-lobes; sides lobed and cirrated.

Distribution, 70 species. Red Sea, India, Philippines, China, Australia.

Fossil, 30 species? Trias?—Miocene—. Europe.

Sub-genera. *Liotia*, Gray. L. gervillii. Pl. X., Fig. 14. Aperture pearly, with a regular, expanded border; operculum multi-spiral, calcareous.

Distribution, 6 species. Cape, India, Philippines, Australia.

Fossil, Eocene—. Britain, France.

Collonia, Gray, 1850. C. marginata. Pl. X., Fig. 15. Peristome simple; operculum calcareous, with a spiral rib on the outer side.

Distribution, Africa.

Fossil, Eocene—. Paris.

Cyclostrema, Marryat. C. cancellata, Pl. X., Fig. 16.

Shell nearly discoidal, cancellated, not pearly; aperture round, simple; umbilicus wide; operculum, spiral, calcareous.

Distribution, 12 species. Cape, India, Philippines, Australia, Peru. In 5—17 fathoms.

Serpularia, Rœmer, has the whorls smooth and disunited.

Type, Euomphalus Serpula, Kon. *Carb.* Belgium.

Crossostoma, Morris and Lycett. Columella toothed when young, concealed by callus in the adult. 2 species, Great oolite.

Adeorbis, Searles Wood.

Type, A. sub-carinatus. Pl. X., Fig. 17.

Shell minute, not nacreous, depressed, few-whorled, deeply umbilicated; peristome entire, nearly continuous, situated in its inner side, and slightly so externally; operculum shelly, multi-spiral.

Distribution, 6 species. West Indies—China. Low water to 60 fathoms.

Fossil, 5 species. Tertiary—. Britain.

EUOMPHALUS, Sowerby.

Etymology, *eu*, wide, and *omphalos*, umbilicus.

Synonyms, Schizostoma, Bronn. Straparollus, D'Orbigny. Ophileta, Vanuxem. Platyschisma, M'Coy.

Type, E. pentagonalis. Pl. X., Fig. 18.

Shell depressed or discoidal; whorls angular or coronated; aperture polygonal; umbilicus very large; operculum shelly, round, multi-spiral. (Salter.)

Fossil, 80 species, L. silurian—Trias. North America, Europe, Australia.

Sub-genus. *Phanerotinus*, J. Sby. 1840, E. cristatus, Phil. Carb. limestone. Britain.

Shell discoidal; whorls separate; outer margin sometimes foliaceous.

STOMATELLA, Lam.

Etymology, 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; operculum circular, horny, multi-spiral. On reefs and under stones at ow water.

Distribution, 33 species. Cape, India, North Australia, China, Japan, Philippines.

Sub-genus? *Gena*, Gray. Spire minute, marginal; no operculum. 16 species. Red Sea, India, Seychelles, Swan River, Philippines. (Adams.)

Niphonia, Adams. 1 species, Japan.

BRODERIPIA, Gray.

Etymology, 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.

Distribution, 3 species. Philippines; Grimwood's Island, South 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; operculum lobe rudimentary; lingual dentition similar to trochus.

In addition to the true haliotids, we have retained in this group such of the trochiform shells as have a notched or perforated aperture.

Haliotis, L. Ear-shell.

Etymology, *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 impression horse-shoe shaped, the left branch greatly dilated in front. In *H. tricostalis* (padollus, Montfort) 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.

Distribution, 75 species. Britain, Canaries, Cape, India, China, Australia, New Zealand, Pacific, California.

Fossil, 4 species. 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.

Etymology, *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.

Distribution, 12 species. Java, Philippines, Torres Straits, Pacific. Under stones at low water. (Cuming.)

Fossil, M. D'Orbigny refers to this genus 18 species, ranging from the L. Silurian to the chalk. North America, Europe.

TEINOTIS, H. and A. Adams, 1854.

Shell depressed, elongated, ear-shaped; spire small, and placed posteriorly; hinder part of the foot in the animal stretches far over the shell.

Distribution, 2 species. East India.

SCISSURELLA, D'Orbigny.

Etymology, diminutive of *scissus*, slit.

Type, S. crispata, Pl. X., Fig. 23.

Synonyms, Anatomus, Montfort; Woodwardia, Fischer.

Shell minute, thin, not pearly; body-whorl large; spire small; surface striated; aperture rounded, with a slit in the margin of the outer lip; operculate. The young have no slit.

Animal like *Margarita;* tentacles long, pectinated, with the eyes at their base; foot with two pointed lappets and two long slender pectinated cirri on each side; operculum ovate, very thin, with an obscure sub-spiral nucleus.

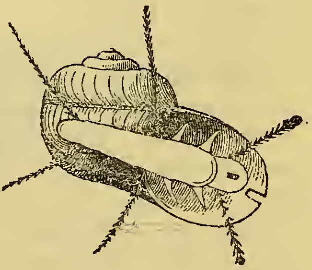


Fig. 116. *Scissurella.* $\frac{8}{1}$.

No part of the animal was external to the shell. The only living example occurred at Hammerfest, in 40—80 fathoms water; when placed in a glass of sea-water it crawled up the side and scraped the glass with its tongue. It was pale and translucent when living, but turned inky black after immersion in alcohol. (Barrett, An. Nat. Hist., 2nd ser. vol. 17, p. 206.)

Mr. Jeffreys found *S. elegans* (D'Orbigny) plentifully alive in sea-weed on the coast of Piedmont. It has a multi-spiral operculum, like *Margarita.* In this species, as noticed by Mr. G. Sowerby, the *slit* in the peristome of the young shell is converted into a *foramen* in the adult, as in the Jurassic *Trochotoma.*

Distribution, 5 species. Norway, Britain, Mediterranean. In

7 fathoms water off the Orkneys, and in deep water east of the Zetland Isles.

Fossil, 4 species. Tertiary—. Britain Sicily.

Pleurotomaria, Defrance

Etymology, *pleura*, side, and *tome*, notch.

Type, P. anglica, Pl. X., Fig. 24.

Shell trochiform, solid, few-whorled, 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 whorls.

Distribution, 2 species. One occurs in deep water in West Indian seas.

Fossil, 400 species. Lower Silurian—Chalk. North 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-genera. *Scalites*, Conrad, L. Silurian, New York.

Shell thin; whorls angular, flat above (tabulated), 8 species. L. Silurian—Carb.

Polytremaria, D'Orbigny, is founded on *P. catenata* (Koninck), in which the margins of the slit are wavy, converting it into a series of perforations.

Catantostoma (clathratum) Sandberger, 1842. *Shell* like *Pleurotomaria;* last whorl deflected, peristome incomplete, slightly varicose, irregular. *Fossil*, Devonian, Eifel.

Raphistoma (angulata), Hall. L. Silurian, United States, Canada. *Shell* depressed, outer lip sinuated. In *R. compacta* (Salter) the spire is sunk and basin-shaped, the umbilical side flat, and the last whorl a little disunited.

Murchisonia, D'Archiac.

Etymology, named in honour of Sir Roderick I. Murchison.

Type, M. bilineata, Pl. X., Fig. 25.

Shell elongated, many-whorled; whorls variously sculptured, and zoned like *pleurotomaria;* aperture slightly channeled 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 species. L. Silurian—Permian. North America, Europe.

TROCHOTOMA, Lycett.

Etymology, *Trochus*, and *tome*, a notch.

Synonym, Ditremaria, D'Orbigny.

Type, T. conuloides, Pl. X., Fig. 26.

Shell trochiform, slightly concave beneath; whorls flat, spirally striated, rounded at the outer angles; lip with a single perforation near the margin.

Fossil, 10 species. Lias—Coral Rag. Britain, France, &c.

? CIRRUS, Sowerby.

Etymology, *cirrus*, a curl.

Type, C. nodosus, Sby. Min. Con. t. 141 and 219.

Shell sinistral, trochiform, base level; last whorl enlarging rather more rapidly, somewhat irregular.

Fossil, 2 species. Inf. oolite, Bath oolite. Britain, 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.

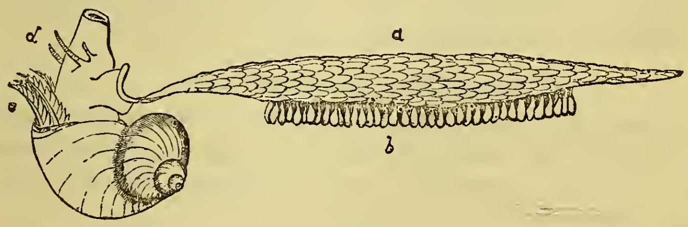


Fig. 117.*

IANTHINA, Lam. Violet-snail.

Etymology, *ianthina*, violet-coloured.

Type, helix ianthina, L. (I. fragilis, Lam.) Pl. X., Fig. 27.

Shell thin, translucent, trochiform; nucleus minute, styliform; sinistral; whorls 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-

* Fig. 117. *Ianthina fragilis*, Lam. (from Quoy and Gaimard). Atlantic. *a*, raft, *b*, egg capsules; *c*, gills; *d*, tentacles and eye-stalks.

pedicel on 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.

Distribution, 10 species. 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 acelephæ (*velella*). They are frequently drifted to the southern and western British shores, especially when the wind continues long from the south-west; 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 farther 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 generally thought to be an extreme modification of the operculum; but M. Lucaze-Duthiers, who has seen the raft formed, denies this. It is built up from glutinous matter secreted by the foot.*

? *Holopea* (symmetrica), Hall. 1847. Outer lip sinuated near the base. *L. Silurian*, New York.

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.

Etymology, diminutive of *fissura*, a slit.

Type, F. Listeri, Pl. XI., Fig. 1.

* *Annales des Sciences Naturelles*, 1865.

† *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 unmistakable indications of homologies with the lamelli-branchiata. See p. 39.

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;

Fig. 118. *Fissurella*. (Wilton.)

they chiefly inhabit the laminarian zone, but range downwards to 50 fathoms. For dentition see Fig. 118.

Distribution, 132 species. America, Britain, South Africa, India, China, Australia, Upper California, Cape Horn.

Fossil, 30 species. Carb.; oolites—. Britain and France.

Sub-genera. Pupillia, Gray. F. apertura, Born. (=hiantula, Lam.) *Shell* smooth, surrounded by a sharp white edge; perforation very large. *Distribution*, South Africa. *Fissurellidæa*, D'Orbigny. F. hiantula, Lam. (=megatrema, D'Orbigny.). *Shell* cancellated; covered by the mantle of the animal. 3 species. Cape and 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.

Distribution, Philippines and Swan River.

Lucapina, Gray. F. elegans, Gray (=aperta, Sby.). *Shell* white, cancellated, margin crenulated; covered by the reflected mantle. 3 species. California.

PUNCTURELLA, Lowe.

Synonyms, 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 cancellated.

Distribution, 6 (?) species. Greenland, Boreal America, Norway, North Britain, Tierra-del-Fuego. In 20—100 fathoms water.

Fossil, in the glacial formations of North Britain.

Rimula, Defrance.

Etymology, diminutive of *rima*, a fissure.

Synonym, Rimularia.

Recent type, R. Blainvillii, Pl. XI., Fig. 4.

Shell thin and cancellated, with a perforation near the anterior margin.

Distribution, several species found on sandy mud at low water, or dredged in from 10—25 fathoms. Philippines (Cuming).

Fossil, 3 species. Bath oolite—coral rag. Britain and France.

Emarginula, Lam.

Etymology, diminutive of *emarginata*, notched.

Type, E. reticula, Pl. XI., Figs. 5 and 6.

Shell oval, conical, elevated, with the apex recurved; surface cancellated; anterior margin notched. Muscular impression 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 sub-quadrate; laterals 4, oblong, imbricated; uncini about 60, the first large and thick, with a lobed hook, the rest linear, with serrulated hooks. (Lovén.)

Distribution, 40 species. West Indies, Britain, Norway, Philippines, Australia. Range from low water to 90 fathoms.

Fossil, 40 species. Trias—. Britain and France.

Sub-genus. *Hemitoma*, Sw.

Type, E. octoradiata (E. rugosa, Pl. XI., Figs. 7 and 8).

Shell depressed, anterior margin slightly channeled.

Parmôphorus, Blainville. Duck's-bill limpet.

Etymology, *parme*, a shield, and *phoreus*, a bearer.

Type, P. australis, Pl. XI., Fig. 9.

Synonym, 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.)

Distribution, 15 species. New Zealand, Australia, Philippines, Singapore, Red Sea, Cape.

Fossil, 3 species. Eocene ?—. Paris Basin.

FAMILY XII.—CALYPTRÆIDÆ. Bonnet-limpet.

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, as in Fig. 119, which shows dentition

Fig. 119. *Crepidula.* (Wilton.)

of *crepidula.* The rostrum is prominent and split, but non-retractile; the median tooth hooked and dentate; the first, or first and second laterals serrated, the third claw-shaped and simple. Lovén places this family next to the *Velutinidæ.*

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 animalcules; 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.)

Dr. Gray arranges the bonnet-limpets next after the vermetidæ; their lingual dentition is like *velutina.*

CALYPTRÆA, Lam. Cup-and-saucer limpet.

Etymology, *calyptra*, a (lady's) cap.

Synonym, 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.)

Distribution, 50 species. West Indies, Honduras, Britain, Mediterranean, Africa, India, Philippines, China, Japan, New Zealand, Gallapagos, Chili.

Fossil, 31 species. Carb. ? chalk—. Britain, France, &c.

Sub-genera. *Crucibulum*, Schum. (Dispotæa. Say., Calypeopsis, Less.)

Example, C. rudis, Pl. XI., Fig. 12.

Shell spinulose; internal cup entire; attached by one of its sides.

Distribution, West America, Japan, West 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.

Distribution, 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 "Chinaman's hat" of collectors—is found on the southern shores of England, and in the Mediterranean, in 5—10 fathoms 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.

Etymology, *crepidula*, a small sandal.

Type, C. fornicata, Pl. XI., Fig. 16.

Synonym, 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.

Distribution, 54 species. West Indies, Honduras, Mediterranean, West Africa, Cape, India, Australia, West America.

Fossil, 14 species. Eocene—. France, North America, and Patagonia.

PILEOPSIS, Lam. Bonnet-limpet.

Etymology, *pileŏs*, a cap, and *opsis*, like.

Synonyms, 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 fathoms water; more rarely as deep as 80 fathoms, and then very small. *P. militaris* is extremely like a *velutina*.

Distribution, 8 species. West Indies, Norway, Britain, Mediterranean, India, Australia, California.

Fossil, 20 species. 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. Britain.

Fossil, 20 species. Devonian—Trias. America, Europe.

Metoptoma, Phillips. M. Pileus, Ph.

Shell limpet-like, side beneath the apex truncated, resembling the posterior valve of a chiton. 7 species. Carb. limestone. Britain.

Hipponyx, Defrance.

Etymology, *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.
Distribution, 13 species. West Indies, Persian Gulf, Philippines, Australia, Pacific, West America.
Fossil, 10 sp. U. chalk—. Britain, France, North America.
Sub-genus. *Amalthea*, Schum. A. conica. Like hipponyx, but forming no shelly base; surface of attachment worn and marked with a cresent-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 upper jaw, 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 (*acmœa*) 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.

Etymology, *patella*, a dish.
Synonyms, Helcion Montfort; Cymba, Adams.

Example, 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. Fig. 120 shows the teeth, but not the uncini of *P. vulgata*. The Cape limpets (e.g. *P. denticulata*) have a minute central tooth, which is wanting in any other species hitherto examined. (Wilton.)

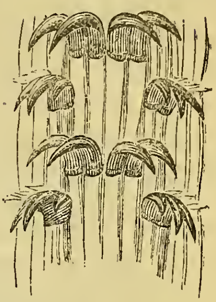


Fig. 120. *Patella vulgata*. (Original, Wilton.)

The dental canal 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 (15 lbs. per square inch), and the difficulty of detaching them is increased by the form of the shell. On soft calcareous 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 between tides 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;

* 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.

many tons weight are collected annually near the town of Larne alone. (R. Patterson.)

On the western coast of South America there is a limpet which attains the diameter of a foot, and is used by the natives as a basin. (Cuming.)

The common limpet makes oval pits in timber as well as in chalk. Small individuals sometimes roost habitually on larger specimens, and make an oval furrow on the shell. The surface on which limpets roost, and some space around it, is often covered with radiating striæ not *parallel* like those *produced by their teeth on nullipore.* Mr. Gaskoin has a limpet-shell encrusted with nullipore, which other limpets have rasped all over. In M. D'Orbigny's collection of Cuban shells there is a group of oysters (*O. cornucopiæ*), with a colony of the *Hipponyx mitrula* sheltered in their interstices; these limpets have not only fed on the nullipore with which the oysters are encrusted, but have extensively eroded the epidermal layer of shell beneath.*

As to the *Calyptræidæ* generally, although furnished with lingual teeth (Fig. 96) like those of the animal-feeding *Velutina*, and themselves manifesting carnivorous propensities (p. 275), it is difficult to understand how they can travel in quest of food.

The shape of some species of limpet is believed to vary with the nature of the surface on which they habitually live. Thus the British *Nacella pellucida* is found on the *fronds* of the tangle, and assumes the form called *N. lævis*, when in lives on their *stalks.* (Forbes.) The *Acmæa testudinalis* becomes laterally compressed and is called *A. alvea* when it grows on the blades of the *Zostera* (Gould); and *Patella miniata* of the Cape becomes a new " genus " (*Cymba*, Adams, not Broderip) when it roosts on the round stems of sea-weed, and takes the form called *P. compressa.* (Gray.)

Distribution, 144 species. Britain, Norway, &c. Wellington Channel. World-wide.

Fossil, above 100 species of patellidæ, including *acmæa*, L. Silurian—. North 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 con-

* A similar circumstance has been noticed in the fresh-water *Paludinæ* and *Ampullaria*, by Dr. Bland and Mr. R. Swift; in the absence of other food they devour the green vegetable matter incrusting one another's shells, and in doing this remove the *epidermis*, or even make holes in the shell.

tinued in front of the head. Found on the fronds and stalks of sea-weeds. Britain, Cape, Cape Horn.

Scutellina, Gray. S. crenulata. *Shell* with a broad margin internally. 7 species. Red Sea, Philippines, Pacific, Panama. (Cuming.)

ACMÆA, Eschscholtz.

Etymology, *acme*, a

Synonyms, 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 fathoms. (Forbes.)

Distribution, 61 species. Norway, Britain, Australia, Pacific, West America.

Sub-genera. *Lepeta*, Gray (= pro-pilidium, Forbes). Patella cæca, Müller.

Shell minute, apex *posterior*. *Animal* blind. Britain. 30—90 fathoms.

Pilidium, Forbes. P. fulva, Müller. Britain. 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. Pl. XI., Fig. 26.

Synonym, 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.

Distribution, 8 species. Mediterranean, Red Sea, Africa, Peru.

Fossil, 1 species. Sicily.

SIPHONARIA, Sowerby.

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; Dr. Gray places them with the pulmonifera, between the auriculidæ and cyclostomidæ.

Distribution, 41 species. Cape, India, Philippines, Australia, New Zealand, Pacific, Gallapagos, Peru, Cape Horn. (Cuming.)

Fossil, 3 species. Miocene—. France.

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; aperture 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; blood 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 species range from 10—100 fathoms. (Forbes.)

Distribution, 50 species. West Indies, Norway, Britain, Mediterranean, India.

Fossil, 125 species. Devonian—. Europe, Chili.

Family XV.—Chitonidæ.

Chiton, L.

Etymology, *chiton*, a coat of mail.

Examples, C. squamosus, spinosus, fascicularis, fasciatus. Pl. XI., Figs. 28—31.

* *D. gadus* of Montagu is an annelid, belonging to the genus *ditrupa*.

Shell composed of eight 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 Dr. 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.

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.

Distribution. More than 250 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. Some of the small British species range as deep as 100 fathoms. (Forbes.) West Indies, Europe, South Africa, Australia, and New Zealand, California to Chiloë.

Fossil, 37 species. Silurian—. Britain, Belgium, &c.

*Sub-genera.** *Chiton. Synonyms*, Lophurus, Poli. Radsia, Callo-chiton, Ischno-chiton, and Lepto-chiton. (Gray.)

Example, C. squamosus. Pl. XI., Fig. 28. Border tessellated.

Distribution, Brazil, West Indies, Newfoundland, Greenland, Britain, Mediterranean, Cape, Philippines, Australia, New Zealand, West America.

Tonicia, Gray. C. elegans. Margin bare.

Distribution, Greenland, Cape Horn, New Zealand, Valparaiso.

Acanthopleura, Guilding. C. spinosus. Pl. XI., Fig. 29. Margin covered with spines, or elongated scales.

* The sub-genera of Dr. 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.

Synonyms, Schizo-chiton, Corephium, Plaxiphora, Onycho-chiton, Enoplo-chiton, Gray.

Distribution, West Indies, Cape Horn, Falklands, Africa, Philippines, Australia, New Zealand, Valparaiso.

Mopalia, Gray. C. Hindsii. Border hairy.

Distribution, West America, Falkland Islands.

Katharina, Gray. C. tunicatus. Mantle covering all but the centre of the plates.

Distribution, New Zealand, West America.

Cryptochiton, Gray, "Saw-dust chiton." C. amiculatus. Valves covered with scaly epidermis.

Synonyms, Cryptoconchus, Sw. Amicula, Gray.

Distribution, California, New Zealand.

Acanthochites, Leach. C. fascicularis. Pl. XI.. Fig. 30. Border ornamented with tufts of slender spines, opposite the plates.

Distribution, Britain, Mediterranean, New Zealand.

Chitonellus, Lam. C. fasciatus, Quoy. Pl. XI., Fig. 31. Border velvety; exposed portion of the plates small, distant; apophyses close together. The dentition of *chitonellus* is represented in Fig. 121.

Distribution, 10 species. West Indies, West Africa, Philippines, Australia, Pacific, Panama. The *chitonellœ* are found in fissures of coral rock. (Cuming.)

Fossil, Carb. Scotland.

Gryphochiton, Gray. C. nervicanus.

Helminthochiton, Salter, 1847. H. Griffithii, Salter, *Geological*

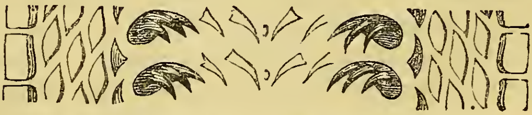


Fig. 121. *Chitonellus*. Tasmania. (Wilton.)

Journal. Plates sub-quadrate, not covered by the mantle: apophyses widely separated.

Fossil, Silurian. Ireland.

Brownia, Candei, D'Orbigny, 1853. A minute discoidal shell, associated with *Helicophlegma* in the first instance, but distinguished by the serrated keels on its whorls, and lateral notches to the aperture. Cuba.

Calcarella, spinosa, Souleyet, 1850.

Shell sub-globose, dextrally spiral, horny, pellucid, with three acutely serrated keels; aperture thickened, entire. Lateral 3 lines. South Seas (= Echinospira, Krohn and Jasonilla-Maed).

Recluzia, Petit, 1853. R. Jehennei, Red Sea. R. Rollandiana, Atlantic, and Mazatlan.

Animal pelagic, resembling ianthina; one inch long.

Shell paludiniform, thin, with a brown epidermis; whorls ventricose; aperture ovate-oblique, slightly effused at the base, margins disunited; inner lip oblique, rather sinuated in the middle; outer lip acute, entire.

These so-called genera, formerly thought to belong to the Atlantidæ, are, for the most part, composed of prosobranchiate larvæ; but the genera to which they belong has not yet been ascertained.

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 *nudibranchs* 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. 32). 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

* Hence they are called *Adelo-pneumona* (concealed-lunged) by Gray.

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 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 (*Limnœidœ*) 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 Charles 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 *Littorina*. 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.

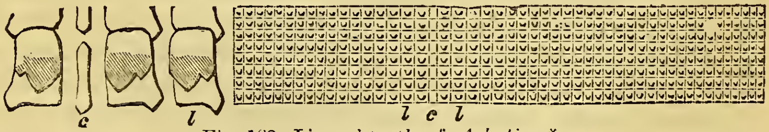


Fig. 122. Lingual teeth of *Achatina*.*

The absolute number of teeth is only a specific character, and is usually greatest in the larger species; but the *Helicellœ* have fewer teeth in proportion than the *Helices*, and Velletia has

* Fragment of the lingual membrane of *Achatina fulica*, with central and lateral teeth more enlarged, from a specimen communicated by J. W. Laidlay, Esq.

fewer than *Ancylus*. The anomalous genus *Amphibola* (p. 139) is said to have a tongue, armed with teeth similar to those of the slug.

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 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, at-

* 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 Entwickelungsgeschichte der Land-gasteropoden. Siebold and Kölliker's Zeitschrift, 1852.

tached 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 of calcareous 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 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 inconspicuous, laterals numerous, similar.

Helix, L.‡

Type, H. pomatia, L., Roman snail.

Etymology, *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.

* 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 p. 48.

Distribution, including the sub-genera, above 1,600 species (several hundred species 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 species at elevations exceeding 11,000 feet in South 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 species about 200. Eocene—. Europe.

Sections: Acavus, Montf. Shell imperforate. H. hæmastoma, Pl. XII., Fig. 1.

Geotrochus (lonchostoma) Hasselt, Trochiform, flat beneath.

Polygyra, Say. Depressed, many-whorled. H. polygyrata, Pl. XII., Fig. 2.

Tredopsis, 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 species. 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 species occur in the Eocene Tertiary of South France.

Streptaxis, Gray. H. contusa, Pl. XII., Fig. 6. Sub-globose, lower whorls receding from the axis of the upper; 34 species. Brazil, West Africa, Mascarene Islands, South Asia.

Sagda, Beck. H. epistylium, Pl. XII., Fig. 7. Imperforate, globosely conoid, close-whorled, aperture lamellate within, lip sharp; 3 species. Jamaica.

Prosérpina (nitida), Guilding. *Shell* depressed, shining, callous beneath; aperture toothed inside; peristome sharp.

Distribution, 6 species. Jamaica, Cuba, Mexico.

Fossil, Eocene—. Isle of Wight. (F. Edwards.)

Helicella, Lam.* *Type*, H. cellaria, Pl. XII., Fig. 8. *Shell* thin, depressed; peristome sharp, not reflected. Lingual edge-teeth aculeate. 110 species.

Stenopus (cruentatus), Guild.

* For this group Dr. Gray formerly employed the name *Zonites*, given originally by Montfort to *Helix Algira;* in his later works he adopts *Helicella*.

Synonyms, 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.

Distribution, 295 species. South Asia and Islands, New Zealand, Pacific Islands, West Indies.

Tanystoma (tubiferum), Benson, 1856. *Shell* like *Anastoma*, minute, umbilicated; aperture disengaged, trumpet-like, toothed. Banks of the Irawadi, above Prome.

Pfeifferia (micans), Gray, is a *Nanina* without the mucus-pore at the tail. Philippines.

VITRINA, Draparnaud. Glass-snail

Type, V. Draparnaldi, Pl. XII., Fig. 28.

Synonym, Helicolimax, Fer.

Shell imperforate, very thin, depressed; spire short, last whor 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.

Distribution, 87 species. Most abundant in north part of the Old World.

Sub-genera. Daudebardia, Hartm. (Helicophanta, Fér.) V. brevipes, Pl. XII., Fig. 29.

Shell perforated, horizontally involute; aperture oblique, ample. 8 species. Central Europe.

Simpulopsis (sulculosa), Beck.

Shell succinea-shaped. 5 species. Brazil.

SUCCINEA, Draparnaud, Amber-snail.

Type, S. putris, Pl. XII., Fig. 23.

Synonyms, 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.

Distribution, 155 species. World-wide.

Fossil, 7 species. Eocene. Britain.

Sub-genus. *Omalonyx,* D'Orbigny. 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.

Distribution, 2 species. Bolivia, Juan Fernandez.

Bulimus, Scopoli.

Etymology? *Boulimos,* extreme hunger (in allusion to its voracity !).

Synonym, 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 six 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. 44, Fig. 31.)

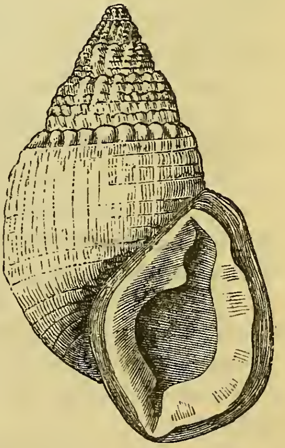


Fig. 123.

Sections. *Odontostomus* (gargantuus), Beck, aperture toothed. 13 species. Brazil.

Pachyotis, Beck (Caprella, Guild.), Fig. 123.*

Partula, Fér. P. faba, Pl. XII., Fig. 13, *Tahiti.* 26 species. Asiatic, Australian, and Pacific Islands, South America. The animal is ovoviviparous.

Gibbus (*Lyonnetianus*) Montf.

Shell hump-backed. Mauritius, 2 species.

Bulimulus, Leach. B. decollatus, Pl. XII., Figs. 11 and 12.

Shell small, lip acute. Above 300 species. England, 3 species.

* Fig. 123. *Bulimus auris-vulpina,* Chemn. The great extinct land-snail of St. Helena; from a specimen presented by Chas. Darwin, Esq. See "Journal of a Voyage round the World."

Zua, Leach. Z. lubrica, Pl. XII., Fig. 14

Shell polished, columella slightly truncated. 6 species.

Azeca, Leach. A. tridens, Pl. XII., Fig. 15.

Shell polished, peristome thickened and toothed. 4 living species.

Distribution, 1,120 species. Universally distributed.

Fossil, 30 species. Eocene—. Europe, St. Helena, Australia, West Indies.

B. Guadalupensis occurs in modern limestone, with human remains.

Achatina, Lamarck. Agate-shell.

Type, A. variegata, Pl. XII., Fig. 22.

Synonyms, Cochlitoma, Fér. Columna, Perry. Subulina (octona), Beck. Liguus (virgineus), Montf. Cionella (acicula), Jeffreys.

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 eight inches; their eggs exceed an inch in length, and have a calcareous shell.

Distribution, 370 species. Europe, Africa, Asia, and tropical America.

Fossil, 19 species. Eocene—. Europe and 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; vibracula much shorter, also deflected; lips elongated, tentacular. Frequents low and moist situations; in confinement one refused vegetable food, but ate another snail. (Say.) 186 species. West Indies, Central America, Mexico, Florida.

Fossil. Eocene—. *Glandina costellata*. Isle of Wight. (F. Edwards.)

Achatinella (vulpina), Sw. (Helicteres, Fér.) Columella twisted into a strong, tooth-like fold. Sandwich Islands 25, Mariannes 2, Ceylon 1.

Pupa, Lamarck. Chrysalis-shell.

Type, P. uva. Pl. XII., Fig. 16.

Synonym, 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.

Distribution, 236 species. Greenland, Europe, Africa, India, Pacific Islands, North and South America.

Fossil, 40 species. Carb. America. (Dawson.) 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 species. Old World.

Spiraxis, C. B. Adams, 1850.

Type, Achatina anomala, Pfeiffer.

Shell ovate-oblong, fusiform, or cylindrical; last whorl attenuated; aperture narrow, right margin usually inflected, columella more or less contorted, base scarcely truncated, furnished with a deeply-entering callous lamina.

Distribution, 30 species. West Indies, Mexico, Juan Fernandez.

Stenogyra, Shuttleworth, 1854. *Shell* elongated, turreted, many-whorled, semi-transparent, and blunt at the apex; peristome simple; shell frequently decollated.

Animal somewhat like Bulimus; middle rachidian teeth small.

Distribution, 50 species. Tropical America.

Cylindrélla, L. Pfeiffer. Cylinder-snail.

Type, C. cylindrus, Pl. XII., Fig. 20.†

Synonyms, Brachypus, Guild. Siphonostoma, Sw

Shell cylindrical or pupiform, sometimes sinistral, many-whorled, apex of the adult truncated, aperture round, peristome continuous, expanded.

Animal similar to *clausilia*; foot short, oral tentacles minute.

Distribution, 143 species. West Indies, Mexico, Texas, South America.

Balèa, Prideaux

Type, B. perversa. Pl. XII., Fig. 21.

Synonym, Fusulus, Fitz.

* Dr. Pfeiffer terms those teeth *parietal* which are situated on the body-whorl, those on the outer lip *palatal*, and on the inner lip *columellar*.

† The figure is taken from a specimen in Mr. Cuming's cabinet, in which the empty apex, usually decollated, remains attached to the adult shell.

Shell slender, usually sinistral, fusiform, multispiral, aperture ovate; peristome acute, margins unequal, wall of the aperture with one single plait; columella simple.

Animal snail-like; teeth 20.20; rows 130. (Thomson.)

Distribution, 8 species. Norway, Hungary, New Granada, Tristan d'Acunha. The British species is found, very rarely, in Porto Santo, only on the highest peak, at an elevation of 1,665 feet. (Wollaston.)

Fossil, 1 species. Eocene.

Sub-genus. *Megaspira* (elatior), Lea, Pl. XII., Fig. 18.

Shell dextral, with the columella transversely plaited.

Distribution, 1 species. Brazil.

Fossil, 1 species. Eocene—. Rheims.

Tornatellina, Beck.

Etymology, diminutive (or patronymic termination) of *tornatella*.

Type, T. bilamellata, Ant.

Synonyms, Strobilus, Anton. Elasmatina, Petit.

Shell imperforate, ovate or elongated; aperture semi-lunar, margins unequal, disunited; columella twisted, truncated; inner lip 1-plaited.

Distribution, 27 species. Cuba, South America, Juan Fernandez, Pacific Islands, New Zealand.

Paxillus, A. Adams.

Type, P. adversus, Ad. Borneo.

Shell small, pupiform, sinistral, rimate; spire pointed; aperture semi-ovate, ascending on the body-whorl; inner lip spreading, 1-plaited, outer lip expanded, notched in front.

Clausilia, Draparnaud.

Etymology, Diminutive of *clausum*, a closed place.

Synonym, Cochlodina, Fér.

Example, C. plicatula, Draparnaud (=C. Rolphii, Leach), Pl. XII., Fig. 19.

Shell fusiform, sinistral; aperture elliptical or pyriform, contracted by lamellæ, and closed when adult by a movable 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.

Distribution, 386 species. Europe, Asia, Africa, and South America.

Fossil, 20 species. Eocene—. Britain and France. Coal-strata, Nova 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, shield-shaped; respiratory and excretory orifices on the right side.

Fig. 124. *Limax Sowerbii, Fér.* Brit.

Limax, L. Slug.

Type L. maximus. Pl. XII., Fig. 25. (L. cinereus, Müller.)

Shell internal, oblong, flat, or slightly concave beneath, nucleus posterior; margin membranous; epidermis distinct.

Animal, foot pointed and keeled behind; mantle shield-shaped 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. 124. 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.

Distribution, 51 species. Europe, Canaries, Sandwich Islands, Australia.

Fossil, Eocene—. Britain. The *Ancylus? latus*, Edw., of the Isle of 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.

ANADENUS, Heynemann, 1863.

Shell round, calcareous, nucleus posterior; mantle large and rough; respiratory orifice on the right side and near the middle of the mantle; generative orifice distant from it behind the right tentacle. Dorsal surface not ridgel; tail without a mucus-gland, and pointed.

Distribution, 2 species. Himalayas.

INCILARIA, Benson.

Type I. bilineata, Cantor, Chusan.

Synonym? 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. Longitude 1½ inches. 6 species. North America, China.

Philomycus (Raf.) Fér. = Tebennophorus, Binney, 1842, Boston Society's Journal (Helix Carolinensis, Bosc) is also a slug with a long mantle.

ARION, Férussac. Land-sole.

Type, A. empiricorum, Fér.

Synonym, Limacella, Brard.

Shell oval, concave; or represented by numerous irregular calcareous 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 devour 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 fifteen days. (Bouchard.)

Distribution, 20 species. Europe. Norway, Britain, Spain, South Africa.

Fossil. Newer Pliocene, Maidstone. (Morris.)

Plectrophorus (*corninus*, Bosc) Fér. 5 species. Teneriffe; represented as having a small conical shell on the tail; probably an erroneous observation.

PARMACELLA, Cuvier.

Type, P. Olivieri, Cuvier.

Etymology, *parma*, a small shield.

Synonym? 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. XII., Fig. 27, is patelliform, with an exposed papillary spire.

Distribution, 7 species. South Europe, Canary Islands, North India.

JANELLA, Gray, 1850 (not Grat. 1826).

Synonym, Athoracophorus (!), Gould.

Type, Limax bitentaculatus, Quoy. Elongate, limaciform, covered by a mantle with free margins; back grooved; tentacles 2, retractile, rising within the edge of the mantle; respiratory orifice to the right of the dorsal groove, reproductive orifice below it and beneath the mantle.

Distribution, New Zealand, on leaves.

ANEITEA, Gray, 1860.

Mantle small and triangular, tooth strap with a single median tooth.

Distribution, 1 species. A. Macdonaldii. New Hebrides, New Caledonia.

PARMARION, Fischer. 1855.

Shell shallow, partly external; mantle large, with a free margin anteriorly, but covered by the shell posteriorly; generative orifice behind the right tentacle.

Distribution, 4 species. India.

TRIBONIOPHORUS, Humbert, 1863.

Mantle small, triangular, back with an almost imperceptible furrow; teeth with wavy edges.

Distribution, 3 species. New South Wales.

VIQUESNELIA, Deshayes, 1857.

Shell internal, rudimentary, oval, suborbicular, slightly concave below, and thickened at the edges; summit sub-central.

Fig. 125. *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 two 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. 126.†

During winter and dry weather the Testacella forms a sort of cocoon in the ground by the exudation of its mucus. If this cell is broken, the animal may be seen completely shrouded in its thin opaque white mantle, which rapidly contracts until it extends but a little way beyond the margin of the shell. Fig, 127 represents *T. Maugei* (lately

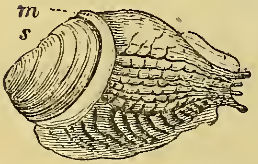


Fig. 127. *Testacella.*

* 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.

† Part of the lingual membrane of *T. haliotoides*, from a preparation by Fisher Cocken, Esq., of Botesdale. The dentition resembles that of *Ianthina.*

found by Mr. Cunnington, in fields near Devizes), just disturbed from its sleep; *s*, the shell; *m*, the contracted mantle.

Distribution, 3 species. South Europe, Canary Islands, Britain (introduced).

Fossil, 2 species. Tertiary.

FAMILY III.—ONCIDIADÆ.

Animal, slug-like, destitute of any shell, completely covered by a coriaceous mantle; tentacles cylindrical, retractile, with eyes at their extremeties; foot much narrower than the mantle.

ONCIDIUM, Buchanan.

Type, O. Typhæ, Buch.

Etymology, 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.

Distribution, 16 species. Britain, Mediterranean, 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 on the coast of Cornwall, congregated in little groups, about a foot or two from the margin 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 they 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

* This is a convenient mode of stating the number of lin ual 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 numb r of rows of teeth on the dental membrane is known, it may be added below, thus—*Peronia Mauritiana*, $\frac{80 \cdot 1 \cdot 80}{68}$

beneath the mantle; foot oval, much smaller than the mantle; length $3\frac{1}{2}$ inches. Coast of Chili. (Requires confirmation.)

Vaginulus, Férussac.

Type, V. Taunaisii, Férussac.

Synonym, Veronicella, Bl.

Animal elongated, slug-like, entirely covered by a 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.

Distribution, 20 species. West Indies, South 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 æstivate in the mud.

The fresh-water snails (and also *Neritina*) can lower themselves from aquatic plants by a mucous thread, *and re-ascend by the same;* a *Physa* can be lifted out of the water by its thread.

Limnæa,* Lamarck. Pond-snail.

Etymology, *Limnaios*, marshy.

Type, L. stagnalis, Fig. 128. Pl. XII., Fig. 30.

Shell spiral, more or less elongated, thin, translucent; body-whorl 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.

* Adjectives employed as names for shells should have the feminine termination.

L. peregra feeds on the green fresh-water algae; *L. stagnalis* prefers animal substances.

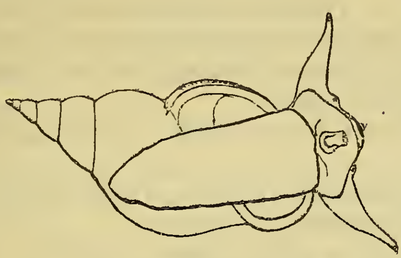


Fig. 128. *L. stagnalis.*

Distribution, 90 species. Europe, Madeira, India, China, North America.

Fossil, 70 species. Wealden—. Britain, 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. 5 species. Europe; Philippines

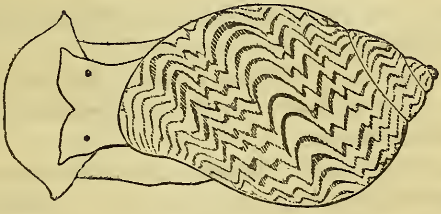


Fig. 129. *C. pulchra.*

CHILINIA, Gray. Chilian-snail.

Example, C. pulchra, D'Orbigny, Fig. 129

Synonym, Dombeya, D'Orbigny.

Shell oval, thin, ornamented with dark spots or wavy bands; columella thickened, with one or two strong prominent folds.

Distribution, 18 species. South America; in clear running streams.

Fossil, 1 species. Miocene, Rio Negro, Patagonia. (D'Orb.)

PHYSA, Draparnaud.

Type, P. fontinalis, Pl. XII., Fig. 32.

Etymology, *Physa*, a pouch.

Synonyms, 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, South Africa, has the base of the columella truncated.

Camptoceras (terebras), Benson, India, has the whorls disunited, and the peristome continuous.

Distribution, 20 species. North America, Europe, South Africa, India, Philippines.

Fossil, 43 species. Wealden—. Britain, France. The largest living species (*P. Maugeræ*, Ecuador?) is 15 lines in length. A fossil species found at Grignon measures 26 lines, and another equally large occurs in India.

Ancylus, Geoffroy. River-limpet.

Etymology, *Ancylus* (agkulos) a small round shield.

Type, A. fluviatilis, Müller. 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.

Distribution, 49 species. North and South America, Europe Madeira. On stones and aquatic plants in running streams.

Fossil, 8 species. Eocene, Belgium.

Sub-genera. *Velletia* (oblonga, Lightfoot), Gray. (Acroloxus, Beck.)

Shell and *Animal* dextral; lingual teeth 40, in 75 rows. 3 species. West Indies, Europe.

Fossil, 2 species. Eocene. Britain, France.

Latia, neritoides, Gray; shell limpet-like, interior with a transverse plate, turned up and notched on one side. 2 species. New Zealand.

Planorbis, Müller.

Synonym, "Coret," Adans.

Type, P. corneus, Pl. XII., Fig. 34.

Shell discoidal, dextral, many-whorled; 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. 130*). *P contortus*, a minute species, has above 6,000 teeth. (Cocken.) *P. corneus* secretes a purple fluid. (Lister.) *P. lacustris* (Segmentina, Fleming) has the whorls contracted internally by periodic septa, 3 in a whorl, with triradiate openings. *P. armigenus* (Planorbula, Haldeman) has 5 teeth in the aperture which nearly close the passage.

Fig. 130.

Distribution, 145 species. North America, Europe, India, China.

Fossil, 69 species. Wealden—. Britain, France.

Gundlachia, ancyliformis, Pfeiffer, 1850. Fresh waters. Cuba. *Shell* thin, obliquely conic; apex inclined posteriorly; base closed for two-thirds by a flat, horizontal plate; aperture semicircular.

Family V.—Auriculidæ.

Shell spiral, covered with horny epidermis, spire short, body-whorl 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 (Lovén); another species examined by Mr. Wilton has 11 large laterals and about 100 smaller (*uncini*) on each side, gradually diminishing towards the edge (Fig. 131): *c*, central teeth; *l*, laterals.

Fig. 131.

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*.

* *P. marginatus*, var. Rochdale, communicated by J. S. Gaskoin, Esq.

AURICULA, Lamarck.

Type, A. Judæ. Pl. XII., Fig. 35.

Etymology, *Auricula*, a little ear.

Synonyms, 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.

Distribution, 94 species. Philippines, Celebes, Feejees, Australia, Peru.

Fossil, 28 species. ? Neocomian—. France.

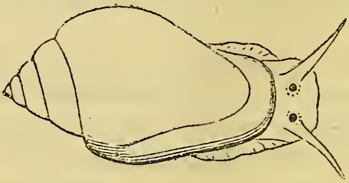


Fig. 132. *A. auris-felis.* (From Eyd. and Soul.)

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, Montfort).

Shell oval, compressed ; spire pointed, many-whorled, with lateral varices ; aperture toothed on both sides.

Distribution, 34 species. India, Borneo, Celebes, Pacific Islands. Inhabits moist spots in woods near the sea, and is wholly terrestrial, feeding on decayed vegetables. (Adams.) 1 Tertiary species.

Pedipes (afra), Adans.

Shell ovate, spirally striated, aperture denticulated on both sides ; the animal loops in walking, like *truncatella*.

Distribution, West Indies, Africa, Philippines, Pacific Islands. Under stones on the sea-shore.

Fossil, 5 species. Eocene—. Britain, France.

CONOVULUS, Lamarck.

Type, C. coniformis, Brug. Pl. XII., Fig. 37. (= Voluta coffea, L. ?)

Synonyms, Melampus, Montfort. Rhodostoma, Sw.

Shell obtusely cone-shaped, smooth; spire short, flat-whorled; 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.

Distribution, 56 species. West 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. Britain, France.

CARYCHIUM, Müller.

Type, C. minimum, Pl. XII., Fig. 39.

Synonym, Auricella, Hartm.

Shell minute, oblong, finely striated transversely; aperture oval, toothed, margin thickened, united by callus.

Animal, with 2 blunt, cylindrical tentacles; eyes black, sessile, near together, behind the tentacles.

Distribution, 9 species. Europe; North America. At the roots of grass in damp places, especially near the sea.

Fossil, 3 species. Miocene—. Europe.

The genus *Siphonaria*, described at p. 281, 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.

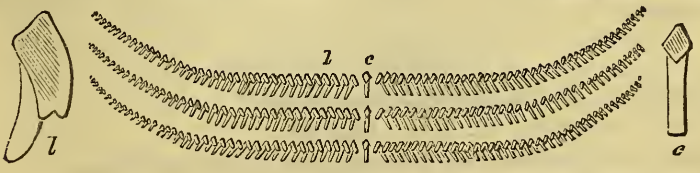


Fig. 133.*

SECTION B.—OPERCULATA.†

The Operculated land-snails are exceedingly like periwinkles

* *Siphonaria* species from the Cape; three rows of teeth, *c* central, *l* laterals, from a preparation by J. W. Wilton, Esq., of Gloucester.

† *Phanera-pneumona* (open-lunged), Gray. The account of this group is chiefly taken from the catalogue prepared by my friend Dr. Baird.

(*littorinæ*), 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.

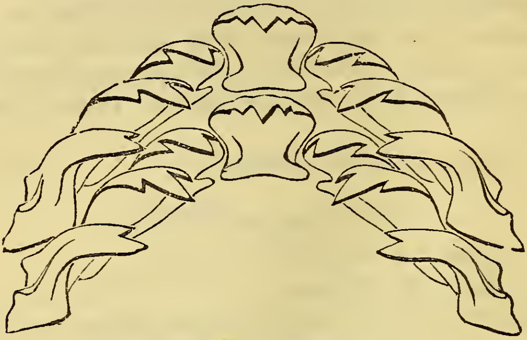


Fig. 134. Lingual teeth of *Cyclophorus*.†

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.

Etymology, *Cyclos*, circle, *stoma*, mouth.

Type, C. elegans, Pl. XII., Fig. 40.

Synonym, 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.

* The tentacles of the *helicidæ* are retractile by inversion (p. 18), those of the *cyclostomidæ* are contractile only.

† *C. aquilum*, *Sby*. (original). From a specimen gathered by J. W. Laidlay, Esq., on the steps of the great idol-temple of Moulmein, Birmah.

Animal with clavate tentacles; sole of the foot divided by a longitudinal groove, the side 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. 135. *Cyclostoma elegans*, from Charlton, Kent.

Distribution, above 160 species. South Europe; Africa, Madagascar. The only British species, *C. elegans*, is found on calcareous soils; it ranges to the Canaries and Algeria, and occurs fossil in the newer Tertiaries. Nearly half the species have the whorls 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, 40 species. Eocene, Europe.

Sub-genera. *Otopoma*, foliaceum, Gray. *Shell* sub-globose, umbilicated; peristome with an ear-like process covering part of the perforation. *Distribution*, 15 species. Arabia, Madagascar, China, New Ireland.

Choanopoma, lincina, Pfeiffer. *Shell* often a little decollated; peristome usually double, the outer edge angularly expanded. *Lincina* (labeo), Br., has the last whorl produced. *Jamaicia* (anomala), C. B. Adams, has the operculum convex. *Distribution*, 70 species. West 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." *Distribution*, about 70 species. West Indies; Tropical America, 8 species.

Realia, hieroglyphica, Gray. = Hydrocæna (part) Parreyss, Omphalotropis, Pfr. Liarea (Egea), Gray. Bourciera, helicinæformis, Pfr. *Shell* turreted or turbinate, perforated; peristome simple, straight or expanded; operculum pauci-spiral, horny. *Distribution*, 17 species. Canaries, ? Mauritius, Pacific Islands. (Ecuador, Bourciera.)

Pomatias, maculatum, Studer. *Shell* slender, transversely striated; peristome reflected; operculum cartilaginous, concamerated within. *Distribution*, 18 species. South Europe; Corfu, India.

Adamsiella (mirabilis) Pfeiffer, 1851 = Choanopoma, Pfr. (part) 1847. "Operculum thin, rather cartilaginous." *Distribution*, 12 species. Jamaica, Demerara. Named after the late Professor C. B. Adams, of Amherst, Massachusetts.

Cyclotopsis, Blanford. Asia.

? Ferussina, Grateloup.

Etymology, named in honour of Baron Ferussac.

Type, F. anastomæformis, Gr.

Synonym, Strophostoma, Desh.

Shell rounded, depressed, umbilicated; whorls transversely striated above, spirally keeled below; aperture turned obliquely upwards, peristome simple. Operculum. ?

Fossil, 5 species. Miocene—. Dax; Turin.

Cyclophorus, Montfort.

Etymology, *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-whorled.

Animal with long, slender pointed tentacles; foot broadly expanded, not grooved.

Distribution, about 150 species. India, Philippines, New Zealand, Pacific Islands, Tropical America. *C. gibbus*, Fér. (Alycaeus, Gray), has the last whorl 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; operculum sub-cartilaginous, spirally lamellated. *Distribution*, 16 species. India, Ceylon, Birmah, Borneo ?

Cyclotus (fuscescens), Guilding (Aperostoma, Troschel). *Shell* depressed, widely umbilicated; operculum shelly, whorls numerous, with raised margins. *Distribution*, 44 species. West Indies, Tropical America, India, Asiatic Islands. *Fossil*, Eocene, Isle of Wight. (F. Edwards).

Leptopoma (perlucidum), Pfeiffer. *Shell* turbinated, peristome simple, reflected; operculum membranous. *Distribution*, 20 species. Philippines, India, New Guinea, New Zealand, Pacific Islands.

*Lomastoma** (cylindraceum), Guild. (Farcimen, Troschel.) *Shell* oblong or pupa-shaped, scarcely perforated, aperture circular; operculum thin, horny, many-whorled, flat. *Distribution*, 19 species. West Indies, Tropical America, Canaries, India, Mauritius. *Fossil*, Eocene—. Paris and Isle of Wight. (E. Forbes.)

Craspedopoma (lucidum), Pfr. *Shell* turbinate, rimate, a little contracted near the aperture; operculum round, horny, many-whorled. *Distribution*, 3 species. Madeira, Palma. *Fossil*, Eocene—. Isle of Wight, Madeira.

Cataulus (tortuosus), Pfr. *Shell* pupa-shaped, with the base keeled, producing a channel in the front of the aperture; operculum circular, horny, the whorls easily separable. *Distribution*, 6 species. Ceylon.

Diplommatina (folliculus), Benson. *Shell* minute (1 species sinistral), conical, with costulated whorls; peristome double; operculum horny, multi-spiral. *Distribution*, 3 species. India.

Opisthophorus, Benson, 1855. O. biciliatus, Mouss. *Shell* like *Pterocyclos;* operculum double, margin grooved, interior concamerated. *Distribution*, 4 species. Singapore, Borneo, Java.

Hybocystis, Benson, 1859. *Shell* distortedly ovate; aperture circular, interior peristome deeply notched. Operculum shelly, thick, multi-spiral.

Pupina, Vignard.

Type, P. bicanaliculata, Sby. Pl. XII., Fig. 42. Australian Islands.

Shell sub-cylindrical, usually polished; aperture circular, peristome thickened, notched in front and at the suture; operculum membranous, narrow-whorled. *P. grandis*, Forbes, has a dull epidermis.

Distribution, 17 species. Philippines, New Guinea, New Ireland, Louisiades.

Sub-genus, Rhegostoma (nunezii), Hasselt. Aperture with a narrow channel in the middle of the columellar side. 6 species. Philippines, Nicobar. In *R. Lubricum* (Callia, Gray) the sinus is obsolete. *R. pupiniforme* (Pupinella, Gray) is perforated, and has a dull epidermis.

* Abridged from *Megaloma-stoma;* Swainson, who judiciously curtailed several preposterously long names, allowed this to remain.

Helicina, Lamarck.

Type, H. Neritella, Lam.

Synonyms, Oligyra, Say. Pachytoma, Sw. Ampultina, Bl. Pitonillus, Montfort.

Shell globose, depressed or keeled, callous beneath; aperture squarish or semi-lunar; columella flattened; peristome simple, expanded; operculum shelly or membranous, squarish or semi-ovate, lamellar.

Animal like *Cyclophorus;* lingual teeth 3.1.3. (Gray.)

Distribution, 162 species. West Indies, Tropical America, Pacific Islands, Australian Islands, Philippines.

Sub-genera. Lucidella (aureola), Gray. Peristome more or less toothed internally. 8 species. West Indies, Tropical America.

Trochatella (pulchella), Sw. *Shell* not callous beneath; peristome simple, expanded. West Indies 20 species, 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; operculum shelly, semi-ovate, with a tooth-like process adapted to the slit in the peristome. *Distribution*, 17 species. Cuba, Jamaica, and Hayti.

Stoastoma, C. B. Adams.

Etymology, *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; operculum shelly, lamellar.

Distribution, 19 species. Jamaica. *S. succineum* (Electrina, Gray) has smooth whorls. I. Opara, Polynesia. 60 new species have been added by the Hon. E. Chitty, who divides them among several new genera.

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.

Synonym, Acme and Acmaea, Hartmann.*

Shell minute, slender, nearly imperforate; peristome slightly thickened, margins sub-parallel, joined by a thin callus; operculum hyaline.

Distribution, 7 species. Britain, Germany, France; Vanicoro (on leaves). *A. fusca* is found in low, marshy situations, at the roots of grass; it occurs fossil in the Newer Pliocene of Essex. (J. Brown.)

Geomelania, Pfeiffer.

Type, G. Jamaicensis, Pfeiffer.

Etymology, *Ge*, the ground (*i.e.* terrestrial).

Shell imperforate, turreted; aperture entire, effused; peristome simple, expanded; margins joined, basal produced into a tongue-shaped process; operculum oval, pellucid, whorls few, rapidly enlarging.

Distribution, 21 species. Jamaica.

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 papillæ, which are said to be 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 membrame is broad and short, with many similar teeth in each row.

The lingual dentition is extremely varied in the *Bullidæ*. In

* 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.

Philine aperta there is no central tooth; and the laterals, which increase rapidly in size backwards, have a finely denticulated membranous inner edge.

In *Tornatella* and *Bulla* (physis) the rachis is unarmed, and the lateral teeth are numerous and similar; in *Acera*, *Cylichna*, and *Amphisphyra* there is a minute central tooth.

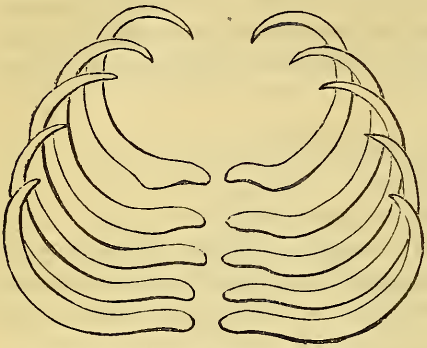


Fig. 136. *Philine aperta.* (Wilton.)

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 characterise 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. Considerable additions, however, have been made to our knowledge on this subject by the researches of Kelaart in Ceylon and A. Adams in the Chinese seas. 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;

* 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-branchs* also; no object being gained by the multiplication of descriptive epithets.

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.

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.

Synonyms, Actæon, Montf. (not Oken), Dactylus (solidulus), Schum. ? Monoptygma (elegans), Lea.

Shell solid, ovate, with a conical, many-whorled spire;

Fig. 137.

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 near their inner bases; foot oblong, lateral lobes slightly reflected on the shell. Lingual teeth 12.12, similar, with long simple hooks.

Distribution, 16 species. United States, Britain, Senegal, Red Sea, Philippines, Japan, Peru. *T. tornatilis* inhabits deep water—60 fathoms. (Forbes.)

Fossil, 70 species. Trias—Lias—. North America, Europe, South 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, whorls with acute margins. Bath Oolite, Britain.

Acteonina, D'Orbigny. Tornatellæ "without columella plaits," 30 species. Carb.—Portlandian (including *Cylindrites*).

Acteonella, D'Orbigny. 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. *Distribution*, 18 species. Chalk; Britain, France.

Acteon Cabanetiana, D'Orbigny. (*Itieria*, Matheron, 1842), Coral-rag, France, belongs to the genus *Nerinæa* (D'Orbigny), p. 244.

Cinulia, Gray.

Type, C. avellana, Pl. XIV., Fig. 4.

Synonyms, Avellana and Ringinella, D'Orbigny.

Shell globular, thick, spirally grooved 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, 21 species. Neocomian—Chalk. Britain, France.

Ringicula, v. p. 222, Pl. V., Fig. 21.

Globiconcha, D'Orbigny.

Type, G. rotundata, D'Orbigny.

Fossil, 6 species. Chalk. France.

Shell ventricose, smooth, aperture crescent-shaped, simple, not toothed or thickened on the columellar side.

Varigera, D'Orbigny. 1850.*

Type, V. Guerangi, D'Orbigny.

Fossil, 8 species. Neoc:—. Chalk. France.

Shell like *Globiconcha*, but with lateral varices.

Tylostoma, Sharp. 1849.

Type, T. Torrubiæ, Sharp.

Etymology, *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 whorl) thickened inside and expanded, rising slightly; inner lip callous, spread over body-whorl.

Distribution, 4 species. L. Cretaceous rocks, Portugal.

* 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.

? PTERODONTA, D'Orbigny.

Type, P. inflata, D'Orbigny.

Fossil, 8 species. 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 channeled, 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.

Distribution, 24 species. West Indies, United States, Mediterranean, Philippines, China, Australia. On sandy bottoms, ranging to 35 fathoms. (Adams.)

Fossil, 13 species. Tertiary.

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. *Distribution*, 12 species. Britain, Mediterranean, Asia. *Fossil*, Pliocene—. Suffolk.

FAMILY II.—BULLIDÆ.

Shell globular or cylindrical, convoluted, thin, often punctate-striated; 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 calcareous plates. Sexes united.

* 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.*)

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.

Synonym, 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.

Distribution, 50 species. In all temperate and tropical seas, especially on sandy bottoms, ranging from low water to 25 or 30 fathoms.

Fossil, 70 species. Oolite—. South America, United States, 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 (Glauconella, Gray; Smaragdinella, A. Adams), Bulla viridis, Rang. Pl. XIV., Fig. 8. *Shell* oval, widely open, showing the rudimentary internal spire. *Animal* with a squarish, disk-like head, eyes sessile in the centre; mantle not investing; a posterior lobe; lateral lobes enveloping.

ACERA, Müller.

Type, A. bullata, Pl. XIV., Fig. 9.

Etymology, *Akeros*, hornless.

Shell thin, flexible, globosely-cylindrical, spire truncated, whorls channeled; aperture long, expanded and deeply sinuated in front, outer margin disunited at the suture; columella open, exposing the whorls.

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.

Distribution, 7 species. Greenland, Britain, Mediterranean, Zanzibar, India, New Zealand.

A. bullata is found amongst weed, in 1—15 fathoms water. (Forbes.)

Cylichna, Lovén.

Type, C. cylindracea, Pl. XIV., Fig. 10.

Synonym, 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.

Distribution, 40 species. United States, Greenland, Britain, Red Sea, Australia.

Fossil, Tertiary—. Britain.

? Kleinella, A. Adams.

Shell thin, dotted, striated, columella smooth, spire obtuse.

Distribution, 1 species. Japan.

Amphisphyra, Lovén.

Type, A. pellucida, Johnst. (*Amphi-sphyra*, double hammer)

Synonyms, Utriculus (part), Brown. Rhizorus, Montfort. 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 bilobed in front; foot oblong, truncated in front, notched behind; teeth 1.1.1, central quadrate, serrulate; laterals broad, hooked.

Distribution, 7 species. United States, Norway, Britain, Borneo, Mexico.

BUCCINULUS, Blanchard.

Shell thick; columella with two plaits; aperture small, entire in front.

Distribution, 10 species. South Seas.

APLUSTRUM, Schumacher.

Type, Bulla aplustre, Pl. XIV., Fig. 11.

Etymology, *aplustre*, a ship's flag.

Synonyms, 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.

Distribution, 10 species. United States, West Indies, Mauritius, Ceylon, China, Australia.

SCAPHANDER, Montfort.

Type, S. lignarius, Pl. XIV., Fig. 12.

Etymology, *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 with two large trigonal plates and a small narrow transverse plate (Fig. 17). It feeds on *Dentalium entale*.

Distribution, 13 species. United States, Norway, Britain, Mediterranean on sandy ground; 50 fathoms.

Fossil, 8 species. Eocene—. Britain, France.

PHILINE (Ascanius, 1762).

Type, B. aperta, Pl. XIV., Fig. 13.

Synonym. Bullæa. Lamarck.

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 two or four series of sickle-shaped *uncini;* gizzard with three longitudinal shelly plates. Egg

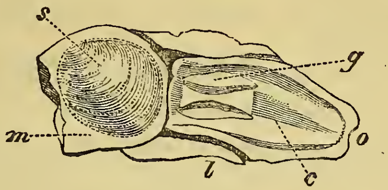


Fig. 138. *Philine aperta.**

capsules ovate, in single series on a long spiral thread; fry with a ciliated head-veil and an operculated, spiral shell. (Lovén.)

Distribution, 16 species. West Indies, Greenland, Norway, Britain, Mediterranean, Corea, Borneo.

Fossil, 7 species. 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.

Etymology, diminutive of *Doris*.

Synonym, Acera, Cuvier. Eidothea, Risso.

Type, D. membranaceum, Meck. Mediterranean.

Distribution, 3 species. South Europe.

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) Mediterranean.

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

* From a specimen dredged at Folkestone; *o*, mouth; *c*, head, or cephalic disc, *l*, side-lobes of the foot; *m*, mantle. The shell *s*, and gizzard *g*, are indistinctly seen through the translucent integuments.

gill, excretory opening behind it. Longitude 1, latitude 2 inches. 2 species.

PHYSEMA, A. Adams.

Shell glassy, globular, contracted in the middle and drawn out to a point in front.

Distribution, 1 species. West coast of North America.

Sormetus Adansonii, Bl., is described as semi-cylindrical, with sides grooved, head indistinct; shell unguiform, thin, and transparent.

Atlas (*Peronii*, Bl.), Lesueur. Head with two 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.

Synonym, 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 four tentacles, dorsal pair ear-like with eyes at anterior lateral bases; mouth proboscidiform, 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.

Distribution, 42 species. West Indies, Norway, Britain, Mediterranean, 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 ornament with filaments. 9 species. East Indies.

Dolabella, Lamarck.

Type, D. Rumphii, Pl. XIV., Fig. 15.

Etymology, *dolabella*, a small hatchet.

Shell hard, calcareous, 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.

Distribution, 12 species. Mediterranean, Mauritius, Ceylon, Society Islands, Sandwich Islands.

Stylocheilus, Gould, 1841.

Synonym, Aplysia longicauda Q. and G.

Animal limaciform, cirrigerous, dilated at the sides, attenuated behind; neck distinct; tentacles 4, long, linear, papillose, far apart; lips dilated laterally into tentacular processes.

Distribution, 3 species. New Guinea, on *Fuci*.

Dolabrifera, Grube.

Shell trapezoidal; side-lobes not used for swimming.

Distribution, 4 species. Indian Ocean, West America.

Siphonopyge, Brown.

Shell truncated in front; foot-lobes spread out for swimming; posterior part extended beyond the siphon.

Distribution, 6 species. West America, Chinese Sea.

Notarchus, Cuvier.

Type, N. Cuvieri, Bl.

Etymology, *notos*, the back, *archos*, vent.

Synonym, Busiris (griseus), Risso, ? Bursatella (Leachii), Bl.

* *Aplysia* (from *a* and *pluo*) un-washable: the *Aplysia* of the Greek fishermen were sponges unfit for washing.

Animal shell-less, ornamented with filaments, sometimes dendritic, foot narrow, lateral crests united, leaving only a narrow branchial slit; gills not covered by an opercular mantle lobe.

Distribution, 7 species. Mediterranean, Red Sea.

ICARUS, Forbes, 1843.

Type, I. Gravesii, F.

Synonym, *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 two 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.

Distribution, 4 species. Atlantic; South Europe.

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.

Example, P. membranaceus, Pl. XIV., Fig. 17.

Etymology, *pleura*, side, *branchia*, gill.

Synonyms, Berthella (plumula), Bl. Oscanius (membr.), Gray.

Shell internal, large, oblong, flexible, slightly convex. lamellar, with a posterior, sub-spiral 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 two grooved tentacles, eyes at their outer bases; mouth armed with horny jaws and covered by a broad veil with tentacular lobes.

Distribution, 22 species. South America, Norway, Britain, Mediterranean, Red Sea, Ceylon.

Sub-genus? *Pleurobranchæa*, Meckel; P. Meckellii, Leve, Mediterranean. *Synonym*, Pleurobranchidium (maculatum), Quoy, South Australia. Mantle-margin very narrow, not concealing the gill; dorsal tentacles ear-like, oral veil tentaculiform.

Posterobranchæa, D'Orbigny.

Type, P. maculata, D'Orbigny. Coast of Chili.

Animal shell-less; oval, depressed, covered by a mantle broader than the foot; foot oblong, bilobed behind; branchial plume on the left side, projecting posteriorly; reproductive orifice in front of gill, excretory behind; proboscis covered by a broad bilobed veil; no dorsal tentacles.

Runcina, (Forbes) Hancock.

Type, R. Hancocki, Forbes.

Synonym, ? 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.

Distribution on *Confervæ* near high-water mark, Torbay.

Neda, H. and A. Adams.

Animal shell-less; mouth terminating a proboscis, which is long and thin; oral veil half-moon shaped, with two lateral recurved tentacles.

Distribution, 1 species. South Europe.

Susaria, Grübe.

Shell small; mantle tuberculated, extending well over both head and foot; notched in front.

Distribution, 1 species. South Europe.

Umbrella, Chemnitz. Chinese-umbrella shell.

Type, U. umbellata, Pl. XIV., Fig. 18.

Synonym, 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. It has a minute sinistral nucleus.

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.

Distribution, 6 species. Canaries, Mediterranean, India, China, Sandwich Islands.

Fossil, 4 species. Oolite—. United States, Sicily, Asia.

Tylodina, Rafinesque.

Type, T. punctulata, Raf. (= citrina, Joannis). 3 species. Mediterranean, Norway.

Fossil, 1 species. Tertiary.

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, Cuvier.

Etymology, 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.

Distribution, 5 species. Mediterranean, Red Sea, India.

Fryeria, Grube.

Excretory orifice on the side of the foot under the mantle, which is leathery and warty; 6 gills entire length of both sides.

Distribution, 1 species. South Sea, East Africa.

Hypobranchiæa, A. Adams.

Mantle cuticular; gills limited to the hinder part of the body; excretory orifices at the side, under the mantle.

Distribution, 1 species. Japan.

Diphyllidia, Cuvier.

Type, D. Brugmansii, Cuvier.

Synonym, 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.

Distribution, 9 species. Norway, Britain (*D. lineata*, Otto), Mediterranean, India.

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 publications 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 calcareous 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

* According to Mr. Huxley, the "cloak" of the Dorids is not the equivalent of the *mantle*, but "has more relation to the *epipodium*"

mantle whatever. The eyes appear as minute black dots, immersed in the skin, behind the tentacles; they are well organised 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. 17); 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 fifth 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 third 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 nudibranchs 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.†

The digestive organs of the Nudibranchs present two remarkable modifications: in *Doris* and *Tritonia* the liver is compact

* The auditory capsules of other Mollusca (excepting the Nucleobranchs) 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 Mollusca was first clearly demonstrated by MM. Hancock and Embleton. The *excito-motory* system of the Mollusca corresponds with the *cerebro-spinal* system of the vertebrata.

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

Fig. 139. *Dendronotus arborescens.*

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 *Dorididæ* are distinguished by having a short and wide lingual membrane with numerous similar teeth; the Æolids have a narrow ribbon with a single series of larger teeth. In *Dendronotus* a large central tooth is flanked by a few small denticulated teeth. (Alder and Hancock, Pl. II., Fig. 8.)

The only Nudibranch with a solid upper jaw, is *Ægirus punctilucens* (A. and H., Pl. XVII., Fig. 15). In other instances the two halves are articulated and act as lateral jaws. In *Ægirus* the mouth is also furnished with membranous fringes (A. and H., Pl. XVII., Fig. 14). *Ancula cristata* has a formidable spinous collar (Pl. XVII., Fig. 7).

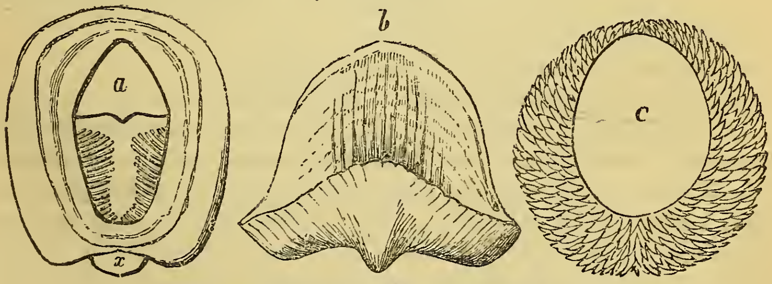


Fig. 140. *a*, Mouth of *Ægirus punctilucens.*
b, Horny upper mandible detached.
c, Prehensile collar of *Ancula.*
a, mantle; *x*, dental sac; *b*, insertion-plate of mandible; *c*, passage of mouth.

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 network 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 usually with numerous lateral teeth, rachis often edentulous; stomach simple; liver compact; skin strengthened with spicula, more or less definitely arranged.

DORIS, L.

Etymology, *doris*, a sea-nymph.

Example, D. Johnstoni, Pl. XIII., Fig. 1.

Synonyms, Dendrodoris, Eb. Hemidoris, Strp.

Animal oval, depressed; mantle large, simple, covering the head and foot; dorsal tentacles 2, clavate or conical, lamellated, retractile within 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. 41, Fig. 29).

* 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.

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'Orbigny, Rochelle; has the mantle more than usually strengthened with calcareous spicula.

Distribution, 100 species.

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 fathoms. They occur in all seas, from Norway to the Pacific.

Heptabranchus, A. Adams.

Mantle without a longitudinal ridge on the back; 7 gills arranged in a semicircle; oral tentacles star-shaped.

Hexabranchus, Ehrenberg.

Same as last, but with 6 gills arranged in a cross on the hinder part of the body; oral tentacles notched.

Atagema, Grube.

Mantle with longitudinal ridge on the back; tentacles clavate, retractile; gills very small.

Distribution, 1 species. New Zealand.

Actinocyclus, Ehrenberg.

Animal ovate; back naked; gills very plumose.

Distribution, 7 species. East Africa and South Europe.

Chromodoris.

Animal almost quadrangular; back naked; feathery gills arranged lineally.

Distribution, 1 species. East India.

Asteronotus, Ehrenberg.

Animal ovate: the apertures for the gills and tentacles almost closed.

Distribution, 2 species. East Africa and South Europe.

Glossodoris, Ehrenberg.

Synonym, Pterodoris, Eb.

Tentacles retractile; back covered with unequal cylindrical processes; a thread-like process on each side of the fore part of the foot.

Distribution, 7 species. East India and West America.

Goniodoris, Forbes.

Etymology, *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.
Distribution, 26 species. Norway, Britain (2 species), Mediterranean, China. Between tide-marks.

Triopa, Johnston.

Type, T. claviger, Pl. XIII., Fig. 3.
Synonym, 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.
Distribution, 3 species. Norway and Britain. Low water—20 fathoms.

Ægirus, Lovén.

Type, Æ. punctilucens, Pl. XIII., Fig. 4
Etymology, ? *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.
Distribution, 3 species. Norway, Britain (2 species), France. Littoral zone.

Thecacera, Fleming.

Etymology, *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.)
Distribution, Britain, 2 species. Length, $\frac{1}{4}$—$\frac{1}{2}$ inch. Found at low water.

Polycera, Cuvier.

Etymology, *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.)

Distribution, Norway (8 species), Britain, 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.

Idalia, Leuckart.

Etymology, *Idalia*, Venus, from Mount Idalium, in Cyprus.

Synonyms, Euplocamus, Phil. Peplidium (Maderæ), Lowe.

Example, 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.

Distribution, 14 species. Norway, Britain (4 species), Mediterranean, Madeira, Japan.

Ancula, Lovén.

Synonym, 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.

Distribution, 2 species. Norway and Britain. Length, ½ inch.

Ceratosoma (Gray), A. Adams.

Etymology, *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.

Distribution, 2 species. Sooloo Sea. (A. Adams.)

Trevelyana, Kelaart. 1858.

Body without a cloak. Two dorsal tentacles, without sheaths; non-retractile. Mouth in front of head, without tentacles. Branchiæ in a circular disk on the back, non-retractile.

Distribution, 1 species (T. Ceylonica). Ceylon.

Crimora, A. and H.

Body limaciform. Cloak nearly obsolete, forming a veil with branched appendages over the head, and a papillated ridge on the sides of the back. Dorsal tentacles laminated, retractile within sheaths; oral tentacles tubercular. Branchiæ plumose, non-retractile. Lingual teeth 26.0.26.

Pelagella, Grube.

Animal oblong; tentacles sheathless; head-veil without processes; ridge along the middle of the back, and two lateral ones; 8 feathery gills arranged in a circle.

Distribution, 1 species. South Europe.

Gymnodoris, Steenstrup.

Animal oblong; tentacles sheathless; gills, with lateral processes, dendritic, 2 or more in number.

Distribution, 1 species. Japan.

Acanthodoris, Grube.

Animal oblong; tentacles sheathless; retractile within a cavity in the mantle; several fleshy processes on the back; 8 feathery non-retractile gills.

Distribution, 2 species. North Sea.

Casella, H. and A. Adams.

Tentacles retractile within sheaths; gills laminated, with 6 lobes.

Distribution, 1 species. East India.

Brachychlamis, Ehrenberg.

Mantle long, angular; tentacles in front of the edge of mantle.

Distribution, 1 species. East Africa.

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.

Example, 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.

Distribution, 13 species. Norway and Britain. Under stones at low water,—25 fathoms. *T. Hombergii*, Cuvier, found on the scallop-banks, attains a length exceeding 6 inches.

SCYLLÆA, L.

Type, S. pelagica, Pl. XIII., Fig. 8.

Etymology, *scyllaea*, a sea-nymph.

Animal elongated, compressed; foot long, narrow, and channeled, 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.

Distribution, 7 species. Atlantic, South Britain, Mediterranean. On floating sea-weed.

Nerea (punctata), Lesson, New Guinea; 10 lines long, with ear-shaped tentacles, and 3 pairs of dorsal lobes.

TETHYS, L.

Etymology, *tethys*, the sea (personified).

Synonym, 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.

Distribution, 1 species. Mediterranean. Attains a foot in length, and feeds on other molluscs and crustaceans. (Cuvier.)

? BORNELLA (Gray), A. Adams.

Type, A. Adamsii, Gray. Length, 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.

Distribution, 3 species. Straits of Sunda, on floating weed; Borneo.

* This observation deserves further inquiry.

? DENDRONOTUS, A. and H.*

Etymology, *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.
Distribution, 3 species. Norway and Britain. On sea-weed and corallines; low water—coralline zone.

? DOTO, Oken.

Etymology, *doto*, a sea-nymph.
Example, D. coronata, Pl. XIII., Fig. 11.
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.
Distribution, 4 species. Norway and Britain. On corallines in deep water—50 fathoms.

GELLINA, Gray.

Head simple; papillæ or gills smooth.
Distribution, 1 species. North Sea.

? MELIBŒA, Rang.

Type, M. rosea, Rang; on floating weed, off the Cape.
Animal elongated, with a narrow, channeled 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.
Distribution, 3 species. South Sea and South Africa.

? LOMANOTUS, Verany.

Example, L. marmoratus, Pl. XIII., Fig. 12.
Synonym, Eumenis, A. and H.

* 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 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.

Distribution, 3 species. Britain and Mediterranean. On corallines.

Family VIII.—Æolidæ.

Animal with papillose gills (?), arranged along the sides of the back; tentacles sheathless, 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.

Synonyms, Psiloceros, Menke. Eubranchus, Forbes. Amphorina, Quatref.

Type, Æ. papillosa, L.

Etymology, *Æolis*, daughter of Æolus.

Animal ovate; dorsal tentacles smooth, oval, slender; papillæ 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, Cuvier. (Phyllodesmium, Ehr.) Body slender; dorsal tentacles laminated, buccal long; papillæ clustered; spawn multi-spiral. *Example*, E. Coronata, Pl. XIII., Fig. 13 (also Fig. 11, p. 17).

Cavolina, Brug. (Montagua, Flem.), C. peregrina. Body lanceolate; tentacles smooth or wrinkled; papillæ in transverse, rather distant rows; spawn of 1 or 2 coils.

Facelina, Grübe. Like Flabellina, but with the foot small, and the two front angular portions drawn out to a point.

Distribution, 5 species. Sitka, North Sea.

Coryphella, Landsborough. Like Cavolina, but with papillæ arranged in groups. 4 species.

Tergipes, Cuvier, T. lacinulata. Body linear; tentacles smooth; papillæ in a single row on each side; spawn kidney-shaped.

Distribution, Norway, Britain (33 species). United States, Mediterranean, South 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.

Etymology, *glaucus*, a sea-deity.

Synonyms, Laniogerus, Bl. Pleuropus, Raf.

Example, G. Atlanticus, Pl. XIII., Fig. 14.

Animal elongated, slender; foot linear, channeled; 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 papillæ; sexual orifice beneath first dextral papilla, vent behind second papilla; spawn in a close spiral coil.

Distribution, 7 species. 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.

Synonym, 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.

Distribution, 3 species. Falmouth. Under stones at low water. (Dr. Cocks.)

Embletonia, A. and H.

Etymology, dedicated to Dr. Embleton, of Newcastle.

Synonyms, Pterochilus, A. and H. ? Clœlia (formosa), Lovén.

Type, E. pulchra, Pl. XIII., Fig. 15.

Animal slender; tentacles 2, simple; head produced into a flat lobe on each side; papillæ simple, sub-cylindrical, in a single row down each side of the back.

Distribution, 4 species. Scotland (2 species). In the littoral and laminarian zones.

Calliopæa, (bellula), D'Orbigny. Brest; has 2 rows of papillæ down each side of the back; cephalic lobes subulate; vent dextral. Lon. 3 lines.

Calma, Alder and Hancock.

Animal sharply angular in front; foot broad; papillæ simple and supported on cylindrical bases; tentacles small.
Distribution, 1 species. North Sea.

Favorinus, Grübe.

Animal with slender cephalic tentacles knobbed at the extremity; oral tentacles 2 pair; papillæ arranged in several oblique rows.
Distribution, 1 species. North Sea.

Galvina, Alder and Hancock.

Animal with papillæ in transverse rows; oral tentacles short and tapering; rounded in front.
Distribution, 2 species. North Sea.

Cuthonia, Alder and Hancock.

Animal with head naked and expanded; papillæ clavate and arranged in thick-set rows.
Distribution, 1 species. North Sea.

Filurus, Dekker.

Foot stunted; body slender; tentacles 2; mouth on a loose fringe of skin with 2 small oral feelers; papillæ in 2 long rows down the back. 1 species.

Proctonotus, A. and H.

Type, P. mucroniferus, Pl. XIII., Fig. 16. Dublin, shallow water.
Synonyms, 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 semi-lunar veil; mouth with horny jaws; papillæ on ridges down the sides of the back and round the head in front; vent dorsal.
Distribution, 3 species. North Atlantic.

Antiopa, A. and H.

Type, A. splendida, A. and H.
Synonym, 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; papillæ 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. ?

Distribution, 3 species. Britain, Mediterranean.

Hermæa, Lovén.

Type, H. bifida, Pl. XIII., Fig. 17. Norway, Britain.

Animal elongated, tentacles folded longitudinally; papillæ numerous, arranged down the sides of the back; sexual orifice below right tentacles; vent dorsal, or sub-lateral, anterior.

Alderia, Allman.

Etymology, named after Joshua Alder, one of the authors of the "Monograph on the British Nudibranchiate Mollusca."

Type, A. modesta, Pl. XIII., Fig. 18. 3 species. Norway, South Ireland, and South Wales.

Animal oblong, without tentacles; head lobed at the sides; papillæ arranged down the sides of the back; vent dorsal, posterior.

? *Stiliger* (ornatus), Ehrenberg; Red Sea. Vent dorsal, anterior.

Chioræra, Gould, 1855.

Animal oblong; head large, pedunculated and provided with oral cirri; papillæ foliaceous and arranged in two lateral rows; generative organs on the right side. C. leonina, Puget Sound.

Family IX.—Phyllirhoidæ.

Animal pelagic, foot-less (*apodal*), compressed, swimming freely with a fin-like tail; tentacles 2, dorsal; lingual teeth in a single series; stomach furnished with elongated cœca; orifices on the right side; sexes united.

Phyllirhoe, Péron and Lesueur.

Etymology, *phyllon*, a leaf, *rhoë*, the wave.

Synonym, Eurydice, Esch.

Type, P. bucephala, Péron.

Distribution, 6 species. Mediterranean, 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.
Synonym, Actæon, Oken.
Animal elliptical, depressed, with wing-like lateral expansions; tentacles simple, with sessile eyes behind them; foot narrow.
Distribution, 8 species. Britain, Mediterranean. 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.

Example, A. corrugata, Pl. XIII., Fig. 20. British Channel.
Animal minute, leech-like; head obtuse, with lateral crests proceeding from two short conical tentacles, behind which are the eyes. 2 species.

CENIA, Alder and Hancock.

Type, C. Cocksii, Pl. XIII., Fig. 21.
Etymology, *cenia*, Falmouth.
Synonym? Fucola (rubra) (Quoy).

* 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).

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.
Synonyms, Chalidis, Qu. Pontolimax, Cr.
Animal minute, leech-like; head truncated in front, with arched lateral ridges on which are the eyes; foot linear.
Distribution, 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.

RHODOPE, Kölliker, 1847.

Example, R. Veranii.
Animal minute, similar to *Limapontia*? worm-shaped, rather convex above, flat beneath; without mantle, gills, or tentacles. Upon algæ, Messina.

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 affinities 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 molluscs; 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 *nucleobranchs* 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

* So called because the respiratory and digestive organs form a sort of *nucleus* on the posterior part of the back. See Fig. 141, *s*, *b*, and Pl. XIV., Fig. 24.

foot (*pro-podium*), which is very distinct in *Natica* (p. 235), and in *Harpa* and *Oliva;* but is only marked by a groove in *Paludina* and *Dolium* (Fig. 87). 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. 76).

The abdomen, or visceral mass, is small, whilst the anterior part of the body (or *cephalo-thorax*, M. Edwards) 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 nucleobranchs, and especially those without shells, "afford the most complete ocular demonstration of the truth of Milne Edwards's 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 larvæ are furnished with a shell, and with ciliated *vela*. (Gegenbaur.)

The nucleobranchs 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

* We can only call to mind one other example of a segmented organ in the *mollusca*, viz., the penniform styles of *Teredo bipalmulata*.

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 organised; 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; gill 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. Mediterranean.

Synonym, 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'Orbigny, 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.)

Distribution, 14 species. Atlantic, Mediterranean, Pacific.

Sub-genus. Firoloides, Lesueur. (*Cerophora*, D'Orbigny). 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. *Distribution*, 6 species. Atlantic; Mediterranean.

* The genus *Sagitta*, Q. and G., sometimes referred to this family, is an articulate animal. (Huxley.)

CARINARIA, Lamarck.

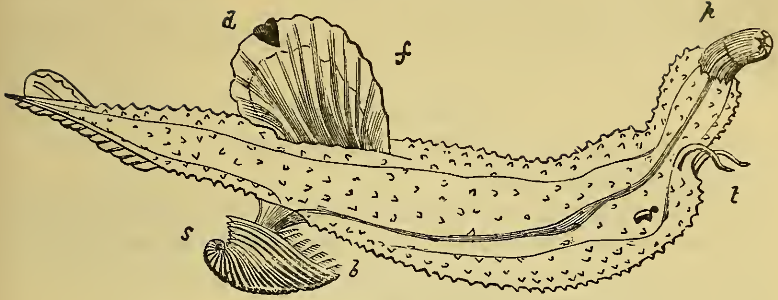


Fig. 141.*

Etymology, *carina*, a keel (or keeled vessel).

Type, C. cymbium, Desh. = C. cristatus, L., Fig. 141, 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.

Distribution, 8 species. Mediterranean and warmer parts of the Atlantic and Indian Oceans. They feed on small *Acalephœ*, and probably on the *pteropoda;* Mr. Wilton found in the stomach of a Carinaria two fragments of quartz rock, weighing together nearly 3 grains.

Fossil, 1 species. Miocene. Turin.

CARDIAPODA, D'Orbigny.

Example, C. placenta, Pl. XIV., Fig. 20.

Etymology, *cardia*, heart, *pous*, foot.

Synonym, Carinaroides, Eyd. and Souleyet.

Animal like *Carinaria*.

Distribution, 5 species. 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

* Fig. 141. *p*, proboscis; *t*, tentacles; *b*, branchiæ; *s*, shell; *f*, foot; *d*, disc.

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., Figs. 21-23.

Synonym, *steira*, Esch.

Shell minute, glassy, compressed and prominently keeled; nucleus dextrally 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.

Distribution, 18 species. Warmer parts of the Atlantic, Canary Islands.

Sub-genus. Oxygyrus, Benson. *Synonyms*, Ladas, Cantraine; Helico-phlegma, D'Orbigny. 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 whorl, near the aperture, and keel cartilaginous; no apertural slit; operculum trigonal, lamellar. 4 species. Atlantic, Mediterranean.

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. 182); that of Atlanta (Fig. 22) is the only example of a *dextral* operculum to a dextral shell (p. 207).

PORCELLIA, Léveille.

Example, P. Puzosi, Pl. XIV., Fig. 29.

Shell discoidal, many-whorled; whorls keeled or coronated; nucleus spiral; aperture with a narrow dorsal slit.

Fossil, 10 species. Upper Silurian — Trias. Britain, Belgium.

BELLEROPHON, Montfort.

Example, B. bi-carinatus, Lév. Pl. XIV., Fig. 27.

Synonym, Euphemus, M'Coy.

Shell symmetrically convoluted, globular, or discoidal, strong, few-whorled; whorls often sculptured; dorsally keeled; aperture sinuated and deeply notched on the dorsal side.

Fossil, 128 species. Lower Silurian—Carb. North America, Europe, Australia, India. The name *Bucania* was given by Hall to the species with exposed whorls; 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'Orbigny (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.

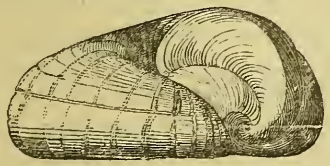
Type, C. ornatus, Pl. XIV., Fig. 30.

Etymology, *kurtos*, curved, *lithos*, stone.

Shell thin, symmetrical, horn-shaped or discoidal, with whorls more or less separate, keeled, and sculptured.

Fossil, 13 species. Lower Silurian—Carb. North America, Europe.

? *Ecculiomphalus* (Bucklandi), Portlock, Pl. XIV., Fig. 31. Lower Silurian, Britain, United States. *Shell* thin, curved, or discoidal with few widely separate whorls, slightly unsymmetrical, keeled.



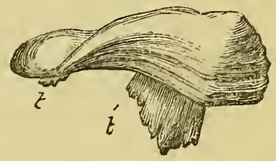


Fig. 142. *Maclurea Logani* (Salter), *L. Silurian*, Canada.

? Maclurea, Lesueur.

Named after William Maclure, the first American geologist.

Shell discoidal, few-whorled, 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 whorls; operculum sinistrally sub-spiral, solid with two internal projections (*t t*), one of them beneath the nucleus, very thick and rugose.

Fossil, 5 species. Lower Silurian. North America; Scotland (Ayrshire, M'Coy).

This singular shell abounds in the "Chazy" limestone of the United 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 Sir W. E. Logan, of the Geological Survey, 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. 267) is not supported by the evidence of Sir W. 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 organisation 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 *opisthobranchiate*, 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 or 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*, 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

* 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.)

as a distinct group; not indeed of equal value with the *Gastero-poda*, 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 *Hyalœa* 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 enclosed 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.

Hyalea, Lamarck

Etymology, *hyalĕos*, glassy.

Synonym, Cavolina, Gioeni, not Brug.

Type, H. tridentata, Fig. 143. 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.

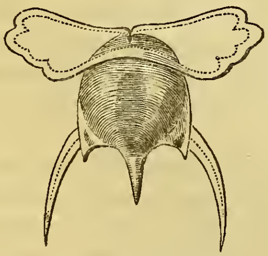


Fig. 143. H. tridentata.

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.

Distribution, 19 species. Atlantic, Mediterranean, Indian Ocean.

Fossil, 5 species. Miocene—. Sicily, Turin, Dax.

* *Theke*, a case, *soma*, a body; several of the genera have no shells.

Cleodora, Peron and Lesueur.

Synonyms, Clio, L. (part) not Müller. Balantium, Leach MS.

Type, C. pyramidata, Pl. XIV., Fig. 33.

Shell pyramidal, three-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 gills, 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.

Distribution, 12 species. Atlantic, Mediterranean, Indian Ocean, Pacific, Cape Horn.

Fossil, 4 species. Miocene—. Britain. (*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.

Distribution, 6 species (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.

Distribution, 4 species. Atlantic, India, Australia.

Fossil, 1 species. (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*, 4 species. Miocene. Bordeaux, Turin.

Theca, Morris. 1845.

Type, T. lanceolata.

* Under the name of "triptère," MM. Quoy and Gaimard described the fragment of a pterop d, since ascertained to have been a *Cuvieria*.

Synonyms, Creseis, Forbes.* Pugiunculus, Barr.

Shell straight, conical, tapering to a point, back flattened, aperture trigonal. Length, 1-8 inches.

Fossil, 40 species. Palæozoic. North America, Britain, New South Wales. ? Permian.

PTEROTHECA, Salter.

Type, P. transversa, Portlock. 3 species, Lower Silurian; Ireland, Wales, Canada.

Shell bi-lobed, transversely oval, with a dorsal keel projecting slightly at each end; ventral plate small triangular.

? CONULARIA, Miller.

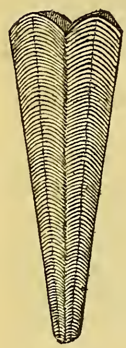


Fig 144.†

Etymology, *conulus*, a little cone.

Type, C. quadrisulcata, Fig. 144.

Shell four-sided, straight, and tapering, the angles grooved, sides striated transversely, apex partitioned off.

Fossil, 40 species. Silurian—Carb. North 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.‡

Etymology, *Eurybia*, a sea-nymph.

Synonym, Theceurybia, Bronn.

Example, 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 enclosed 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*.

Distribution, 4 species. Atlantic and Pacific.

Sub-genus. *Psyche*, Rang. (Halopsyche, Bronn.) P. globulosa,

* *Creseis Sedgwicki*, Forbes, is an orthoceras with very thin septa, belonging to the same group with (*Conularia*) *teres*, Sby. *Tentaculites*, Schl. is annellidous. (Salter.)

† Carboniferous limestone, Brit. Belgium.

‡ This name had been previously employed for four different genera of plants and animals.

Pl. XIV., Fig., 38. *Animal* globular, with two simple oval fins. *Distribution*, 1 species. Off Newfoundland

CYMBULIA, Peron and Lesueur.

Etymology, 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.

Distribution, 3 species. Atlantic, Mediterranean, Indian 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.

Distribution, 3 species. Mediterranean, Australia.

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

Etymology, *limacina*, snail-like.

Synonym, Spiratella, Bl.

Example, L. antarctica (drawn by Dr. Joseph Hooker), Pl. XIV., Fig. 41.

Shell sub-globose, sinistrally spiral, umbilicated; whorls transversely striated; umbilicus margined; no operculum.

Animal with expanded fins, notched on their ventral margins; operculum lobe divided; lingual teeth 1.1.1.

Distribution, 2 species. Arctic and Antarctic Seas; gregarious.

SPIRIALIS, Eydoux and Souleyet.

Example, S. bulimoides, Pl. XIV., Fig. 42.

Synonyms, Heterofusus, Fleming. Heliconoides, D'Orbigny. Peracle, Forbes. Scaea, Ph.

Shell minute, hyaline, sinistrally spiral, globose or turreted, 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.

Distribution, 12 species. Greenland and Norway to Cape Horn, Indian Ocean, Pacific.

? CHELETROPIS, Forbes.

Etymology, *chele*, a claw, and *tropis*, a keel.

Synonym, Sinusigera, D'Orbigny.

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 gregarious in the open sea.

The species comprised in this and the following genus are young gasteropods. (See pp. 212, 225.)

Distribution, 2 species. South America and South-east Australia.

Another minute spiral shell 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; operculum 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.*

Distribution, 3 species. Taken in the towing-net off Cape Byron, East coast of Australia, 15 miles from shore, floating, and apparently gregarious. (J. Macgillivray.) Mindoro, North Atlantic. (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.

Etymology, *Clio*, a sea-nymph.

Synonym, 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 the ends of its fins almost in contact, first above and then below. (Scoresby.)

Distribution, 4 species. Arctic and Antarctic Seas, Norway, India.

Sub-genus? *Cliodita* (fusiformis), Quoy and Gaimard. Head supported on a narrow neck; tentacles indistinct. 4 species. Cape, Amboyna.

Pneumodermon, Cuvier.

Etymology, *Pneumon*, lung (or gill), *derma*, skin.

Type, P. violaceum, Pl. XIV., Fig. 47.

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 mollusc (*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.)

Distribution, 4 species. Atlantic, India, Pacific Ocean.

Sub-genus? *Spongiobranchœa*, D'Orbigny. S. Australis, Pl. XIV., Fig. 46. Gill (?) forming a spongy ring at the end of the body; tentacles each with 6 rather large suckers. *Distribution*, 2 species. South Atlantic (Fry of *Pneumodermon*?). *Trichocyclus*, Eschscholtz, T. Dumerilii, Pl. XIV., Fig. 48. *Animal* without acetabuliferous tentacles? mouth probosidiform; front of the head surrounded with a circle of cilia, and two others round the body.

? Pelagia, Quoy and Gaimard.

Etymology, *Pelagus*, the deep sea (not = *Pelagia*, Peron and Les.).

Type, P. alba, Pl. XIV., Fig. 49. Amboyna.

Animal fusiform, truncated in front, rough; neck slightly contracted; fins small, fan-shaped.

Cymodocea, D'Orbigny.

Etymology, *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.

Distribution, 1 species. Atlantic.

CHAPTER III.

CLASS IV.—BRACHIOPODA, Cuvier, 1805.

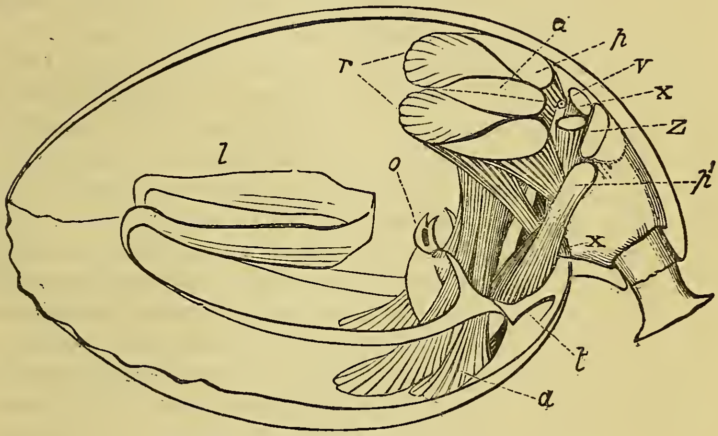
(= Order *Pallio-branchiata*, Blainville, Prodr. 1814.)

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 lamp-shell for the passage of the pedicle by which it is attached to submarine objects.*

* 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 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. It is sometimes perforated, as in the Terebratulidæ. 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 genera have no 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. 145. 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.

This and several other points of difference seem to show the propriety of adopting the proposal made by Deshayes in 1836 of dividing the Brachiopods into two great groups, the one having articulated, the other non-articulated valves. In the first, moreover, the valves are opened by muscles acting on the cardinal process of the dorsal valve, while in the latter the valves are opened by the pressure of the fluid in the perivisceral cavity. This difference is accompanied by a striking variation in the

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 $\frac{1}{8}$ of an inch, except by applying force.

† *Waldheimia Australis*, Quoy. $\frac{2}{1}$. From a drawing by Albany Hancock, Esq.

arrangement of the muscles. The articulated group possess an anal aperture; the unarticulated none. (Hancock.)*

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 Terebratulidæ and the other Brachiopods having articulated valves the muscular system consists of 3 pairs of muscles which act directly on the valves, and of 3 pairs which connect the shell, and adjust it with respect to the peduncle. In the unarticulated Brachiopods, such as Lingula, the muscles are more complicated than in the former group; three pairs of protractor muscles keep the valves together, and thus compensate for the absence of the hinge and condyles, which help to form this function in the articulated group; they are so arranged as to co-operate in preventing any displacement of the valves in any direction. Hence the term sliding-muscles which they have received is inappropriate, since they prevent any sliding action. In the Lamellibranchs the sliding of the valves is admirably guarded against by means of hinges with teeth and sockets; in Brachiopods the same end is apparently obtained by means of muscles. It has, therefore, been proposed to substitute the term *adjustor* for *protractor*, and *retractor* for *sliding* as applied to these muscles. The following table shows the names in general use, and those proposed by Mr. Hancock:—

Names in use.	Names proposed. Unarticulated brachiopods.	Homologous muscles in articulated brachiopods.
Ant. retractors.	Ant. occlusors.	Ant. occlusors.
Ant. adductors.	Post. ,,	Post. occlusors.
Post. ,,	Divaricators.	Accessory divaricators.

* Philosophical Transactions. 1858.

† The muscular system of *Terebratula* presents a considerable amount of resemblance to that of *Modiola* (Fig. 214); the anterior and posterior pedal muscles may be compared to the dorsal and ventral pedicle muscles.

Names in use.	Names proposed. Unarticulated brachiopods.	Homologous muscles in articulated brachiopods.
Cent. protractors.	Cent. adjustors.	Vent. adjustors.
Extr. „	Extr. „	
Post. retractors.	Post. „	Dorsal „
Capsular.	Peduncular.	Peduncular.
	Ant. parietals.	
	Post parietals.	

The muscles are remarkably glistening and tendinous, except at their expanded ends, which are soft and fleshy. They are, with few exceptions, non-striated. In the posterior adductors of *Waldheimia* transverse striations are well displayed. 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.* There may be considerable changes in arrangement of muscles without any important change in the internal structure. Thus in *Waldheimia cranium* there are six muscular impressions in the dorsal valve; in *W. australis* there are only four, the other two muscles being attached to the hinge-plate, not to the valve. The valve and hinge-plate are never found together, and it is, therefore, probable that in the fossil species, the shells of which are found without hinge-plates, the muscles may have been arranged as in *W. cranium*.

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 (p. 5) 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. 18, 21, and Fig. 208, *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 unlikely, since in many genera they are supported by a brittle skeleton of shell, while the

* Professor 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. 176, 181).

food is obtained by means of currents created by cilia. *Lingula* may have the power of slightly extending the arms. The internal skeleton consists of two spiral processes in the *Spiriferidæ* (Fig. 168), 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 calcareous 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 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. 202). In *Orbicula* it is reflected ventrally, and passes straight to the right, ending as in *Lingula.* In *Terebratula*, *Rhynchonella*, and probably all the articulated 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. 145, v.)†

The circulatory system is far less complex than was formerly supposed, and does not differ greatly from the same system in the Tunicata. The heart is placed on the dorsal surface of the stomach, and consists of a simple, unilocular, pyriform vesicle without any auricle. From it the blood is propelled through

* *Spirifera rostrata* and *Terebratula pectunculoides*, in the British Museum.

† 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 these 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. Mr. Hancock has carefully dissected several species of these genera without detecting any anal aperture. Filling the intestines with injections was tried, but no outlet could be discovered.

four channels to the organs of reproduction and to the mantle; and its flow is probably assisted by a number of subsidiary pulsatile vesicles situated on the main arterial trunks. It then courses through the plexus of lacunes in the pallial sinuses and lobes; turns back through the lacunes of the parietes into the system of visceral lacunes. It probably enters the liver, and ultimately finds its way back into the heart through the branchio-systemic vein. There is, however, another and more important blood current, which traverses the whole length of the brachial canal, and penetrates to the extremities of the cirri, before it joins the current returning from the visceral lacunes and flows with it into the branchio-systemic vein. The blood which has passed through the brachial canal is far more highly oxygenated than the blood which has flowed through the pallial membranes. There seems to be strong evidence that the so-called arms are really the gills or respiratory organs of the mollusc. They also serve to bring food to the creature's mouth by the means before noticed. The mantle is an accessory breathing-organ. It attains its highest development as such in *Lingula*, but even in this genus the brachial apparatus performs the chief part in oxygenating the blood.

There is another system of canals which take their rise from the visceral cavity. What its function is has not been determined; it is not the blood system as was formerly imagined, and has no connection with it. The perivisceral cavity and the visceral lacunes which diverge from it may, it is thought, be homologous to the water-vascular system in Polyzoa, the function of which is probably to evacuate the effete nitrogenised products which have been eliminated from the blood. Consequently it would perform the offices both of the kidney and the renal organs.

The generative organs occupy the great pallial sinuses, and probably both sexes are combined in one individual. In the articulated Brachiopods the ovaries and testes are placed in the mantle; but in *Lingula* and *Discina* they occur in the perivisceral chamber. The ova escape into the oviducts (regarded by Cuvier and others as hearts), which open externally, and have nothing to do with the vascular system. In *Rhynchonella* there are four oviducts, but in most, if not all the other Brachiopods, there are only two. In Terebratulidæ they are divided into two portions, called the auricle and ventricle by Professor Owen. Mature eggs have been found in large numbers in the perivisceral chamber and in the oviducts. 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.

As yet we know little 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 nervous system exhibits a state of development but little superior to what is found in Ascidians. No special organs of sense have been detected. The red spots in the mantle, supposed by some to be rudimentary eyes and ears, are probably the glands situated at the base of the setæ.

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 calcareous 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, Professor King, and more recently by Dr. Carpenter; according to this 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. 146). This structure is found only in the *Rhynchonellidæ;* but in most — perhaps all the other *Brachiopoda**—the shell is traversed by canals from one surface 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 aborescent. 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. Mr. Hancock's researches would tend to show that these conclusions are generally correct, but not entirely so. "When the shell is dissolved

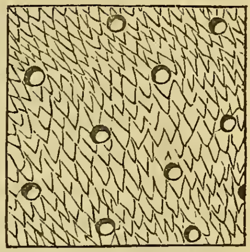


Fig. 146. *Terebratula.*

* 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 specimens in a state fit for microscopic examination.

† Called the "lining membrane of the shell," by Dr. Carpenter. (Davidson Intr. Mon. Brach.) M. Queckett 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.

in acid the free border [of the mantle] which projects beyond the marginal fold, and which is applied to the extreme edge of the shell, can be examined with advantage. The pallial cœca are then completely exposed appended to the membrane in various stages of development, and the spaces between them are found studded all over with rather large, clear, oval, cell-like spots, which are arranged with considerable regularity in rows, so that those in the approximate rows alternate. These spots apparently correspond to the bases of the prismatic columns of the shell; and if it be allowed that they represent spaces in which calcareous granules had been accumulated, it is easy to understand how the fibrous or columnar structure is formed. A succession of layers of such accumulated granules deposited one after the other would result in the peculiar shell formation of the Brachiopoda." The extremities of the prisms are not visible on the external surface, but in the young individual of some species, as *Terebratula caput-serpentis*, there is a thin layer of calcareous matter, which seems to show that in some Brachiopods the shell is composed of two layers of shell, having a different structure, as in the case of the *Conchifera*.

Of all mollusca 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 84 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 1,800 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 of specific development in the Silurian age.* Some species (like *Atrypa reticularis*) 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

* The number of Silurian species amounts to 690; but these were not all living *at one time*, they were obtained from a whole series of deposits, representing a succession of periods.

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 valves; oral arms united to each other by a membrane, variously folded; sometimes spiral at their extremities.

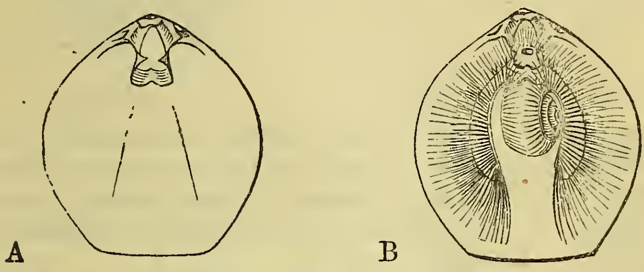


Fig. 147. *Terebratula vitrea*, Born.

Terebratula, (Llhwyd.) Brug. Lamp-shell.

Etymology, diminutive of *terebratus*, perforated.

Synonyms, Lampas, Humph. Gryphus, Muhlfeldt. Epithyris, Phil.

Types, T. maxillata, Pl. XV., Fig. 1. (= Ter. minor-subrubra, Llhwyd. Anomia terebratula, L.) T. vitrea, Fig. 147.

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. 147, A).

Animal attached by a pedicle; brachial disk tri-lobed, centre lobe elongated and spirally convoluted (Fig. 147, 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.

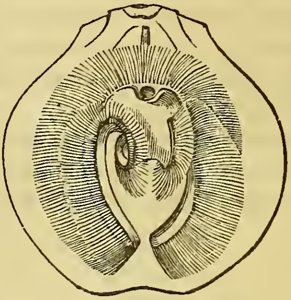
* The author has to acknowledge his obligation to Mr. Davidson for the use of the notes, drawings, and specimens, assembled during the preparation of his great work on the "British Fossil Brachiopoda," printed for the Palæontographical Society; to which work the student is referred for more copious descriptions and illustrations.

Distribution, 3 species. Mediterranean 90—250 fathoms on nullipore mud. (Forbes.) Vigo Bay; Falkland Islands.

Fossil, 126 species. Devonian—. World-wide.

Sub-genera. Terebratulina (caput-serpentis), D'Orbigny. (Pl. XV., Fig. 3.) Fig. 148. *Shell* finely striated, auriculate,

Fig. 148. Dorsal valve.



Animal, $\frac{2}{1}$.

deltidium usually rudimental; foramen incomplete; loop short, rendered annular in the adult by the union of the oral processes. *Distribution*, 6 species. United States, Norway, Cape, Japan. 10—120 fathoms. *Fossil*, 22 species. Oxfordian—. United States. Europe.

Waldheimia (australis), King. Pl. XV., Fig. 4 (p. 5, Figs. 5, 6), Figs. 145, 149, 150.

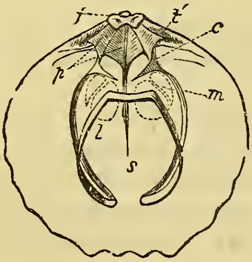


Fig. 149. Dorsal valve.

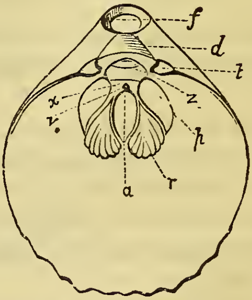


Fig. 150. Ventral valve.

Fig. 149. *j*, cardinal process; *t′*, dental sockets; *p*, hinge-plate; *s*, septum; *c*, crura of the loop; *l*, reflected portion of the loop; *m*, quadruple abductor-impression.

Fig. 150. *f*, foramen; *d*, deltidium; *t*, teeth; *a*, single abductor 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. *Distribution*, 9 species. Norway, Java, Australia, California, Cape Horn. Low water — 100 fathoms. *Fossil*, 90 species. Carb—. South 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.*

Meganteris, Suess, 1856. Terebratula Archiaci, Vern. *Devonian*, Asturias. *Shell* with a long, reflected, internal *loop.*

TEREBRATELLA, D'Orbigny.

Type, T. dorsata, Gmel. (= Magellanica, Chemn.) Pl. XV., Fig. 7. Fig. 151.

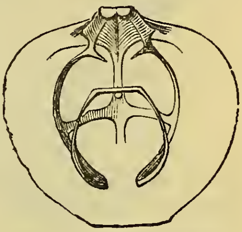


Fig. 151. *Terebratella.*

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 obselete in *Morrisia* and *T. Cumingii. Distribution*, excluding sub-genera, 25 species. Cape Horn, Valparaiso (90 fathoms), New Zealand, Japan, Ochotsk, Spitzbergen, Labrador. *Fossil*, 16 species. Lias—. United States, Europe. In *T. crenulata* and *Evansii* (Fig. 152) the dorsal septum sometimes projects so far as to touch the opposite valve, but in other examples it remains undeveloped. (Davidson.)

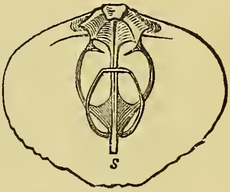


Fig. 152. *Ter. Evansii*, Dav.

Sub-genera. Trigonosemus (elegans), König. *Synonyms*, Delthyridæa (pectiniformis), M'Coy. Fissirostra, D'Orbigny. *Example*, 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. *Distribution*, 5 species. Chalk, Europe.

Lyra (Meadi), Cumberland, Min. Con. 1816. Pl. XV., Fig. 6. *Synonyms*, Terebrirostra, D'Orbigny. Rhynchora, Dalman.*

* 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 British Museum. 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.

Shell ornamented with rounded ribs; beak very long, divided lengthwise internally by the dental plates; loop doubly attached? *Distribution*, 4 species cretaceous. Europe. Three species of similar form are found in the Trias of St. Cassian.

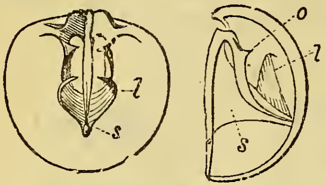


Fig. 153. *M. Pumila.* $\frac{2}{1}$

Magas (pumila), Sby. Fig. 153. *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*). 3 species. U. Green-sand—Chalk. Europe. *Distribution*, 2 species. New Zealand; Canaries. The recent *Ter. Cumingii*, of New Zealand, resembles *Bouchardia* externally, but has the diverging processes of the loop as in *Magas*.

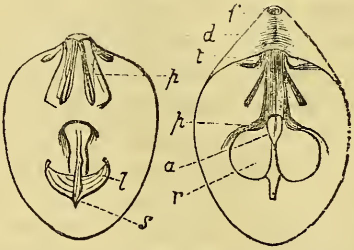
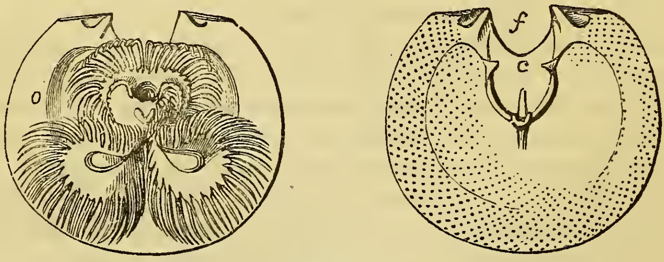


Fig. 154. *B. Tulipa*, Bl.*

Bouchardia (tulipa), Davidson, Fig. 154. Beak prominent, with a minute apical foramen (*f*); deltidium blended with the



Animal. $\frac{10}{1}$ Fig. 155. Dorsal valve.†

shell (*d*); apophysis anchor-shaped, the septum (*s*) being fur-

* 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. 155. *c*, loop; *f*, pedicle notch; *o*, the ovaries. From the originals in Mr. Davidson's collection; magnified ten diameters.

nished with two short lamellæ. *Distribution*, 3 species. Brazil, 13 fathoms. New Zealand, South Australia.

Morrisia (anomioides, Scacchi), Davidson. Fig. 155. *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. *Distribution*, 3 species. Mediterranean. 95 fathoms. (Forbes.) *Fossil*, 4 species. Chalk—. Europe.

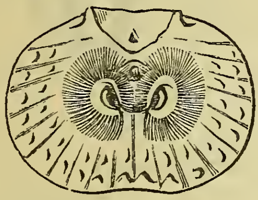


Fig. 156. Dorsal valve with animal. $\frac{2}{1}$

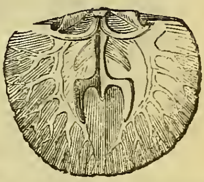
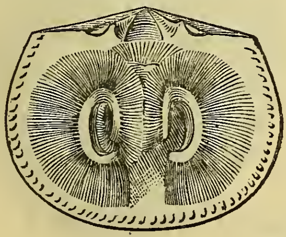
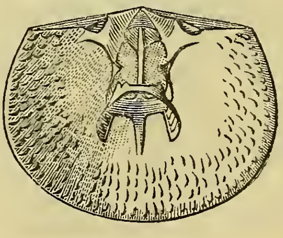


Fig. 157. Dorsal valve.

Kraussia (rubra), Dav. Cape. Fig. 157. K. Lamarckiana, Dav. Australia. Fig. 156. *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. 158. *Animal* with rather small oral arms, the spiral lobe very diminutive. *Distribution*, 6 species. South Africa, Sydney, New Zealand; low water to 120 fathoms.



Animal.



Dorsal valve.

Fig. 158.

? *Megerlia* (truncata), King, 1850. Pl. XV., Fig. 9. Fig. 158. *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. *Distribution*, 3 species. Mediterranean, Philippines. These species belong to the same natural group with *Kraussia*. *Fossil*, 7 species. Chalk—.

? *Kingena* (lima), Dav. Cretaceous, Europe, Guadaloupe. Valves spinulose; loop trebly attached.

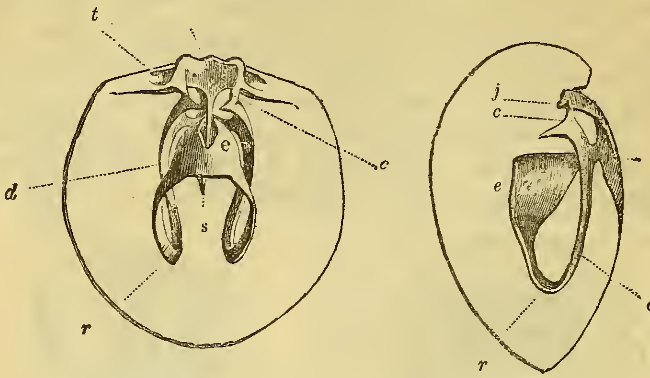


Fig. 159. *Ter.* (*Kingena*) *lima*, (after Davidson.)
t, dental sockets; *j*, cardinal process; *c*, crura; *d*, diverging processes of loop, *r*, reflected portion; *e*, third attachment of loop; *s*, dorsal septum.

? *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.

Zellania (Davidsoni), Moore, 1855. (*Etymology*, *Zella*, a lady's name?) *Shell* minute, orthi-form; texture fibrous; hinge-area short, foramen angular, encroaching on both valves; interior of dorsal valve as in *Thecidium*, with a single central septum and broad margin. *Fossil.* Lias—Great Oolite. 3 species. Britain.

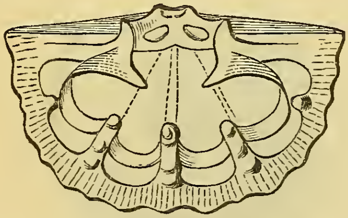


Fig. 160. *Argiope decollata.* $\frac{4}{1}$

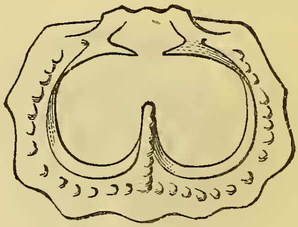


Fig. 161. *A. Neapolitana*, Sc.* $\frac{8}{1}$

ARGIOPE, Eudes Deslongchamps.

Etymology, *Argiope*, a nymph.

Synonym, Megathyris, D'Orbigny.

Type, A. decollata, Pl. XV., Fig. 10. Fig. 160, 162.

Shell minute, transversely oblong or semi-ovate, smooth or

* Interior of dorsal valves magnified, from the originals in Coll. Davidson.

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

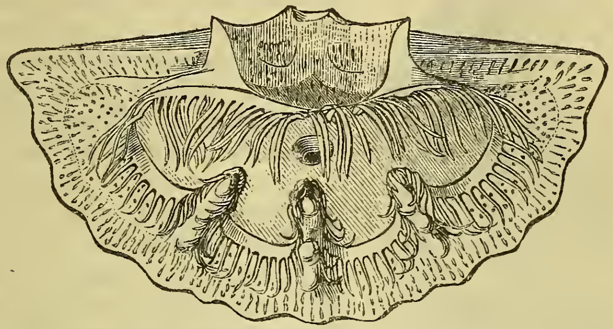


Fig. 162. *A. decollata*, $\frac{40}{1}$; dorsal valve with the animal, from a specimen dredged by Professor Forbes in the Ægean. The oral aperture is seen in the centre of the disk.

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.

Distribution, 5 species. North Britain, Madeira, Canaries, Mediterranean. 30—105 fathoms.

Fossil, 19 species. Oolite—. Europe.

Fig. 163. *T. radians.*

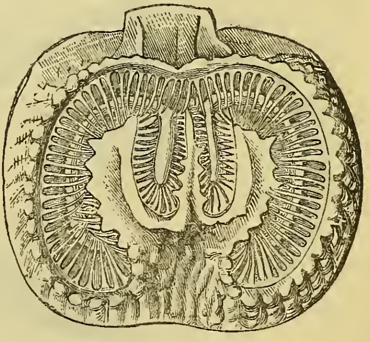


Fig. 164. *T. Mediterraneum.** $\frac{4}{1}$

THECIDIUM, Defrance.

Etymology, *Thekidion*, a small pouch.

Type, T. radians, Pl. XV., Fig. 11.

Shell small, thick, punctate, attached by the beak; hinge-

* Dorsal valve with the animal, magnified. Coll. Davidson.

area (*h*) flat; deltidium (*d*) triangular, indistinct; *dorsal valve* (Fig. 163) 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. 165) 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.

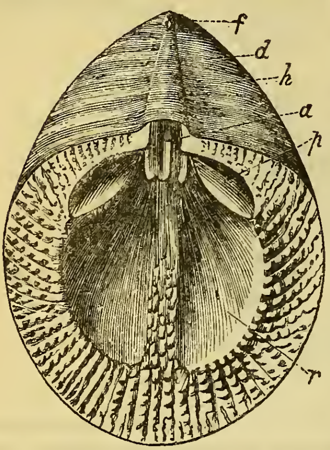
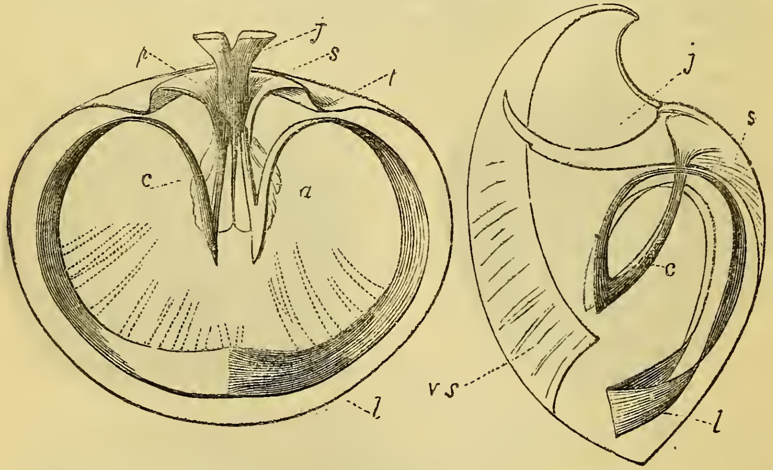


Fig. 165. T. radians. $\frac{4}{1}$.

Animal (Fig. 164) 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.

T. radians is the only unattached species, it is supposed to be fixed by a pedicle when young. (D'Orbigny.)



Dorsal valve. Fig. 166. Profile.*

a, adductor; *c*, crura; *l*, loop: *j*, cardinal process; *p*, hinge-plate; *s*, dorsal septum; *v s*, ventral septum; *t*, dental sockets.

T. hieroglyphicum, Pl. XV., Fig. 12, has a very complicated

* The loop (which was discovered by Professor King) has a distinct suture in the

interior; whilst in several others there are but two brachial lobes. The Liassic species form the subject of a monograph by M. Eudes Deslongchamps; they are often minute, and attached in numbers to sea-urchins, corals, and terebratulæ.

Distribution, 1 species. Mediterranean.

Fossil, 34 species. Trias—. Europe.

? Stringocephalus, Defrance.

Etymology, *Strinx* (*stringos*), an owl, *cephale*, the head.*

Type, S. Burtini, Pl. XV., Fig. 13. Figs. 166, 167. 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*.

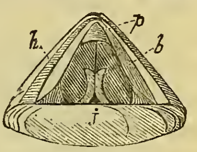


Fig. 167.†

Family II.—Spiriferidæ.

Shell furnished internally with two calcareous 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 immovably; the spiral lamellæ are sometimes spinulose, indicating the existence of rigid cirri, especially on the front of the whorls; valves articulated by teeth and sockets.

Spirifera, Sowerby.

Type, S. striata, Sby., Fig. 168.

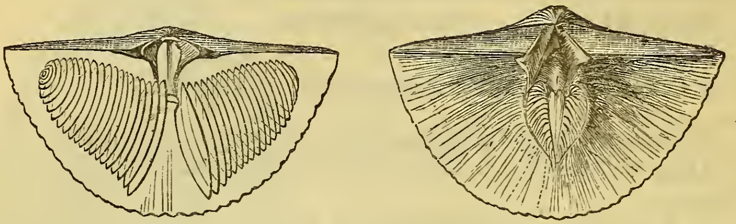
Synonyms, Trigonotreta. König. Choristites, Fischer. Delthyris, Dalman. Martinia, &c., M'Coy.

middle; the dotted lines proceeding from its inner edge are added from a drawing by M. Suess, and represent what he regards as shelly processes for supporting a membranous disk. They may be portions of spirals, whose outer whorls are confluent.

* Internal casts of *Productus giganteus* are called "owl-heads" by quarrymen in the North of England. (Sowerby.)

† Fig. 167. Young shell, magnified four diameters; *h*, hinge area; *b*, deltidium; *p*, pseudo-deltidium.

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



Dorsal valve. Fig. 168. Ventral valve.

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.

Distribution, 220 species. Lower Silurian—Trias. Arctic America—Chili, Falkland Islands, Europe, China, Thibet, Australia, Tasmania. In China these and other fossils are used as medicine.

Sub-genera. Spiriferina, D'Orbigny. S. Walcotti, Pl. XV., Fig. 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. *Distribution*, 29 species. Carb.—Lower Oolites. Britain, France, Germany, South America.

Cyrtia, Dalman. C. exporrecta, Pl. XV., Fig. 15. *Shell* impunctate, pyramidal, beak prominent, area equiangular, deltidium with a small tubular foramen. *Fossil*, 10 species. Silurian—Trias. Europe. In *C. buchii*, *heteroclyta*, *calceola*, &c., the shell is punctate.

Suessia (imbricata), Eudes Deslongchamps, 1855. (Dedicated to M. Suess). *Shell* like *Spirifera;* texture fibrous; hinge area wide as the shell; foramen deltoid; large valve with two cardinal septa, and a prominent central septum, supporting a little plate; small valve with a tri-lobed cardinal process, and

* Professor King attributes this to metamorphism; *S. Demarlii*, Bouch., from the Devonian limestone, is punctate. (Carpenter.)

a broad 4-partite hinge-plate, with processes from the outer angles of the dental sockets; crura of the spires united by a transverse band supporting a small process. *Fossil*, 2 species. Upper Lias, Normandy.

ATHYRIS, M'Coy.

Etymology, *a*, without, *thuris*, a door* (i.e. deltidium).

Synonyms, Spirigera, D'Orbigny. Cleiothyris, King (not Phil.).

Types, A. concentrica, Buch. A. Roissyi, Figs. 169, 170. 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. 170†);

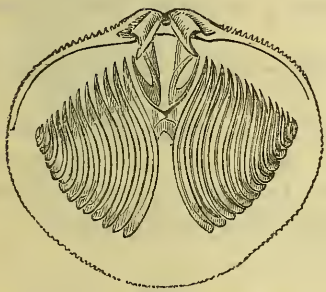


Fig. 169. Interior of dorsal valve.

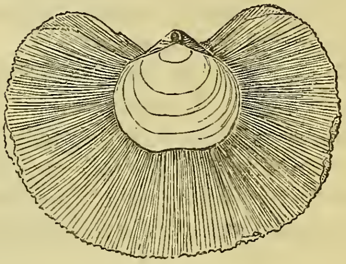


Fig. 170. Specimen with fringe.

hinge-line curved, area obsolete, foramen 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 70 species. Silurian—Lias. North and South America and Europe.

* Sometimes employed, *incorrectly*, in the sense of a door-*way* or for men.

† The spurious genus *Actinoconchus* (M'Coy) was founded on this character; similar expansions are formed by species of *Atrypa*, *Camarophoria*, and *Producta*.

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. 171); spiral arms have been observed in all the species.

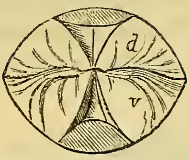


Fig. 171. Merista.

Retzia, King.

Dedicated to the distinguished Swedish naturalist, Retzius.

Type, Ter. Adrieni, Vern.

Example, R. serpentina, Carb. L., Belgium, Fig. 172.

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 50 species. Silurian—Trias. South America, United States, Europe.

Professor King first pointed out the existence of calcareous 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*.

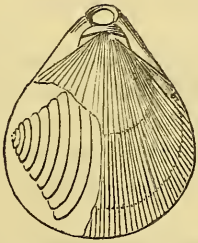


Fig. 172. *Retzia serpentina, D. K.*

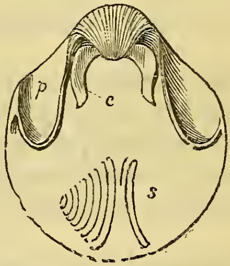


Fig. 173. *Uncites gryphus.*

Uncites, Defrance.

Type, U. gryphus, Pl. XV., Fig. 17. Fig. 173.

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.

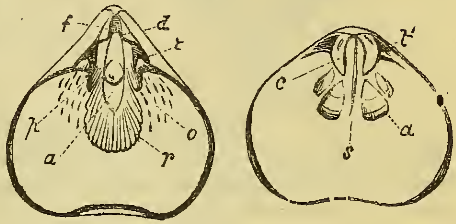
The large, concave deltidium of Uncites so much resembles the channel formed by the dental plates of *Pentamerus*, that

Dalman mistook the shell for a member of that genus. The discovery of internal spires, by Professor 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. 173, *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

Fig. 174. *R. nigricans.*



Ventral. Fig. 175. Dorsal.

Fig. 174. Dorsal valve with the animal; *a*, adductor muscles; *i*, intestine.

Fig. 175. 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.

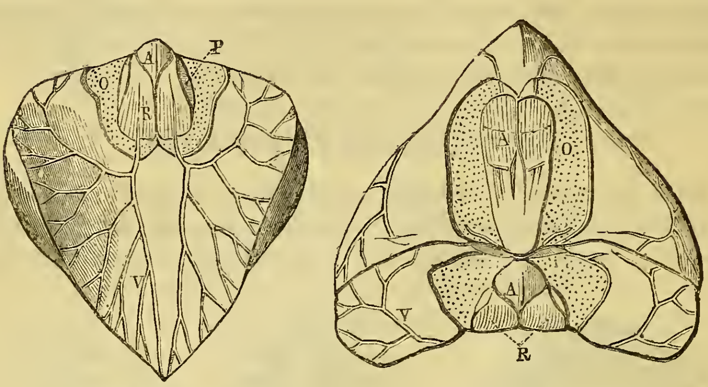
deltidium, sometimes concealed; hinge-teeth supported by dental plates; hinge-plate deeply divided, supporting oral lamellæ, rarely provided with spiral processes; muscular impressions grouped as in *Terebratula;* vascular impressions consisting of two principal trunks in each valve, narrow, dichotomising, 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.

Rhynchonella, Fischer.

Synonyms, Hypothyris, Phil. Hemithyris (psittacea), D'Orbigny. Acanthothyris (spinosa), D'Orbigny. 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. 176; nigricans, Fig. 174; psittacea, Fig. 175 (p. 5, Fig. 4).



Ventral aspect. Umbonal aspect.

Fig. 176. *Rh. acuminata*, internal casts.

Fig. 176. Umbonal aspect, with the dorsal valve above (Coll. Professor King). Ventral aspect (Coll. Professor Morris). A, adductor; R, cardinal; P, pedicle; V, vascular; O, ovarian impressions.

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.

Distribution, 4 species. *R. psittacea*, Labrador (low water ?), Hudson's Bay (100 fathoms), Melville Island, Sitka, Icy Sea. *R. nigricans*, New Zealand, 19 fathoms.

Fossil, 332 species. Lower Silurian—. North and South 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. *Distribution*, 8 species. Lower Silurian. Russia and Portugal.

Camarophoria, King. T. crumena, Martin (sp.). Figs. 177, 178. 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 species. Carb.—Permian (Magnesian limestone.) Germany and England.

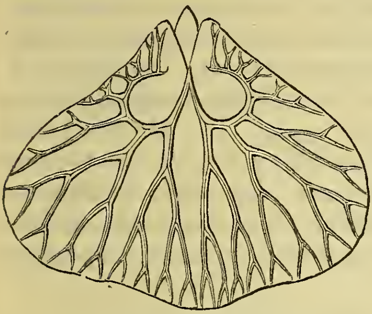


Fig. 177. Internal cast.*

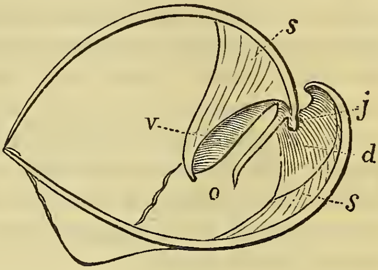


Fig. 178. Section.

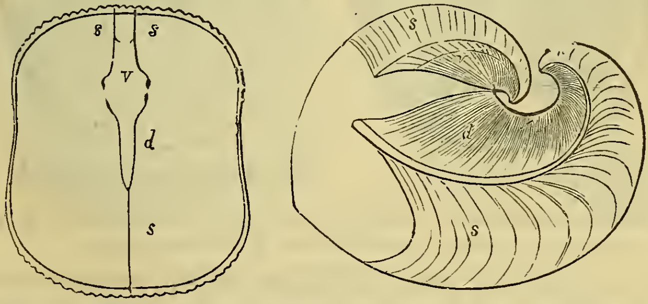
Pentamerus, Sowerby.

Etymology, *pentameres*, 5-partite.

Synonym, Gypidia (conchydium), Dalman.

Type, P. Knightii, Pl. XV., Fig. 22. Fig. 179.

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. Fig. 179. Transverse section.

longitudinal septa (*s s*) opposed to the plates of the other valve.

Oral lamellæ have been detected by Mr. Salter in *P. liratus*;

* Ventral side of cast, showing the V-shaped cavity of the dental plates, and the impressions of branchial veins, accompanied by arteries (after King).

in *P.* ? *brevirostris* (Devonian, Newton) the dorsal valve has a long trough-like process supported by a single low septum.

Fossil, 52 species. Upper Silurian — Devonian. Arctic America, United States, Europe.

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. 179, 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.

Synonyms, Cleiothyris, Phillips. Spirigerina, D'Orbigny.* Hipparionyx, Vanuxem.

Type, A. reticularis, Pl. XV., Fig. 21. Figs. 180, 181.

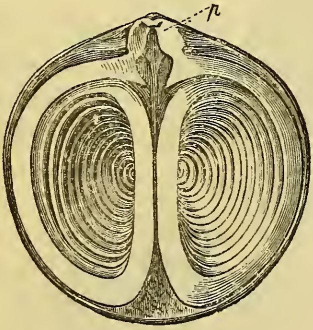


Fig. 180. Dorsal valve.

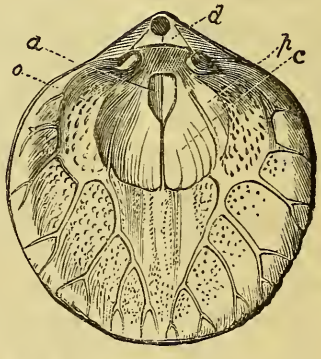


Fig. 181. Ventral valve; interiors.

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 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

* 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

directed towards the centre of the valve; teeth and impressions like *Rhynchonella*.

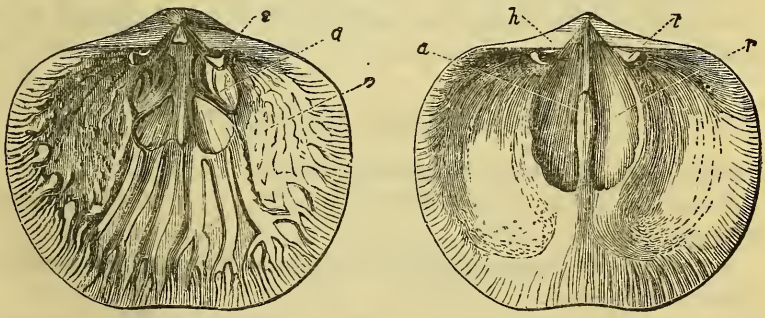
The shells of this genus differ from *Rhynchonella* chiefly in the calcification of the oral supports, a character of uncertain value.

Fossil, 21 species. Lower Silurian—Trias. America (Wellington Channel! Falkland Islands), Europe, Thibet.

Anoplotheca lamellosa, F. Sandberger, 1856, Devonian, Rhine, is a species of *Atrypa*.

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



Dorsal valve.† Ventral valve.

Fig. 182. *Orthis striatula.* Devonian, Eifel.

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.

* 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.

Orthis, Dalman.

Etymology, *orthos*, straight.
Type, O. rustica, Pl. XV., Fig. 23.
Synonyms, Dicœlosia (biloba), King. Platystrophia (biforata), King. Gonambonites (inflexa), Pander. Orthambonites (calligramma), Pander.

Shell transversely oblong, radiately striated or plaited, biconvex, hinge-line narrower than the shell, cardinal process simple, brachial processes tooth-like, prominent and curved.

Fossil, 154 species. Lower Silurian—Carb. Arctic America, United States, South America, Falkland Islands, Europe, Thibet.

? *Sub-genera.* *Orthisina*, D'Orbigny. O. anomala, Schl. Fig. 183. *Synonyms*, 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*, Lower Silurian, Europe.

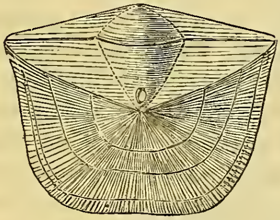


Fig. 183. *Orthisina.*

O. pelargonatus (Streptorhynchus, King), from the Magnesian limestone, *O. senilis*, Carb. limestone, and some Devonian species, have the beak twisted, as if it had been attached; there is no foramen.

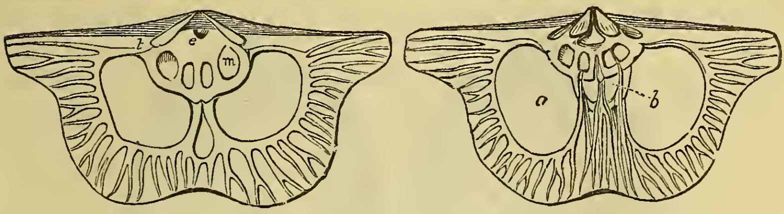
Strophomena, Blainville.*

Etymology, *strophos*, bent, *mene*, crescent
Examples, S. rhomboidalis, Pl. XV., Fig. 24. (=Productus depressus, Sby.)
Synonyms, Leptæna (rugosa), Dalman. Leptagonia, M'Coy. Enteletes, Fischer.

Shell semicircular, 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. 184, *e*); muscular depressions 4, central pair narrow, formed by the adductor; external pair (*m*) fan-like, left by the cardinal and pedicle muscles; *dorsal*

* 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.*

valve with a bi-lobed cardinal process, between the dental sockets, and four depressions for the adductor muscles.



Ventral valve. Fig. 184. Dorsal valve.

Interior of *S. rhomboidalis*, var. *analoga*, Carb. limestone (after King). *e*, foramen; *t*, teeth; *o*, ovarian spaces; *b*, brachial pits?

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 *Productus; S. rhomboidalis* occasionally exhibits traces of spiral arms, in the ventral valve. *S. latissima*, Bouch., has plain areas, like *Calceola*.

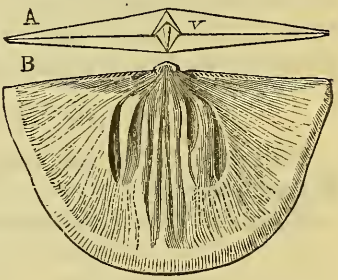


Fig. 185. *Leptæna*, $\frac{2}{1}$. A, hinge-areas; V, ventral; B, interior of dorsal valve.

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, 129 species. Lower Silurian—Carb. North 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. 185. (Plectambonites, Pander.) Valves regularly curved; dorsal concave, thickened, muscular impressions elongated. *Fossil*, 41 species. Lower Silurian—Lias. North America and 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.

Koninckia, Suess. Producta Leonhardi, Wissm. (*P. alpina*, Schl.), Fig. 186. 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 three diverging ridges. The small

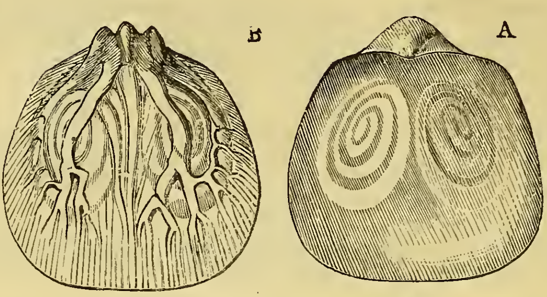


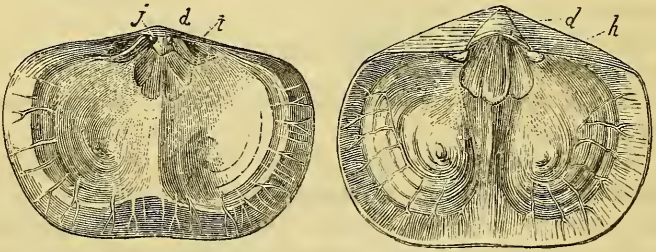
Fig. 186. *Productus? Leonhardi*, $\frac{2}{1}$.*

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. M. Suess, of Vienna, states that he has found traces of very slender spiral lamellæ occupying the furrows. This curious little shell most resembles the Triassic *Leptæna dubia* (Productus), Münster (= *Crania Murchisoni*, Klipst!).

DAVIDSONIA, Bouchard.

Dedicated to the author of the Monograph of British Fossil Brachiopoda.

Type, D. Verneuili, Bouchard. Fig. 187. Devonian, Eifel.



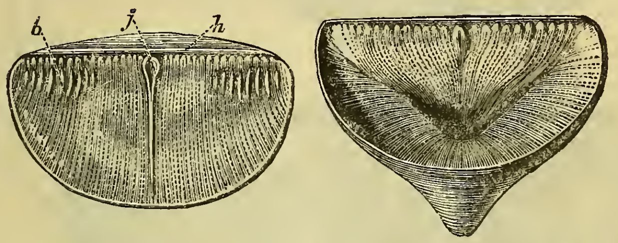
Dorsal valve. Fig. 187. Ventral valve. $\frac{2}{1}$

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,

* A, translucent specimen; B, interior of dorsal 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. 180), but destitute of calcified supports. The upper valve sometimes exhibits markings derived from the surface on which the shell has grown. The mantle-lobes seem to have continued depositing shell until the internal cavity was reduced to the smallest possible limit.

Fossil, 3 species. Devonian—Trias.



Dorsal valve Fig. 188. Ventral valve.

CALCEOLA, Lamarck.

Etymology, *calceola*, a slipper.

Type, C. sandalina, Pl. XV., Fig. 26. Fig. 188.

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, semicircular, 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, Britain.

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.

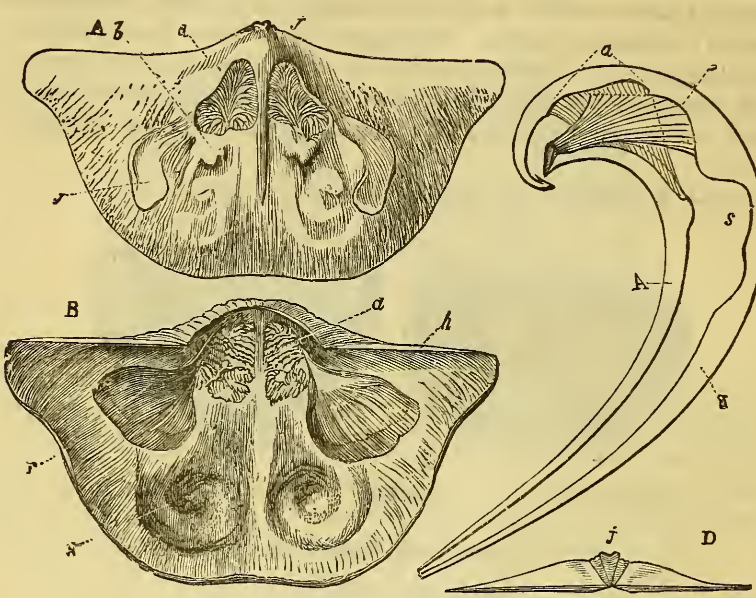


Fig. 189. *Productus giganteus*, ¼ Carb. limestone.

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.

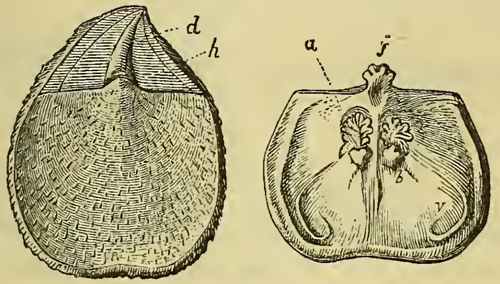
Productus, Sowerby.

Types, P. giganteus, Martin. =*Anomia producta*, Martin.

Examples, P. horridus, Pl. XV., Fig. 27. P. proboscideus, 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. striatus* is irregular in its growth, elongated and tapering towards the beak, and occurs in numbers packed closely together. *P. proboscideus* 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, 81 species. Devonian—Permian. North and South America, Europe, Spitzbergen, Thibet, Australia.



Exterior. Fig. 190. Interior.

Sub-genus. Aulosteges, Helmersen. A. Wangenheimii, Vern., Fig. 190. Permian, Russsia; Carb. *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 *Productus* (*longi-spinus*).

Strophalosia, King.

Example, S. Cancrini, De Vern., Fig. 191.

Synonym, 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 species. Devonian—Carb. Europe, Himalaya (Gerard).

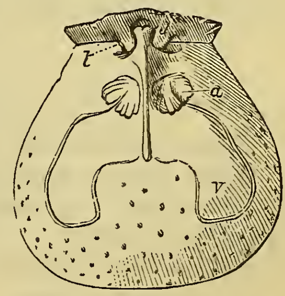


Fig. 191. *S. Cancrini.*

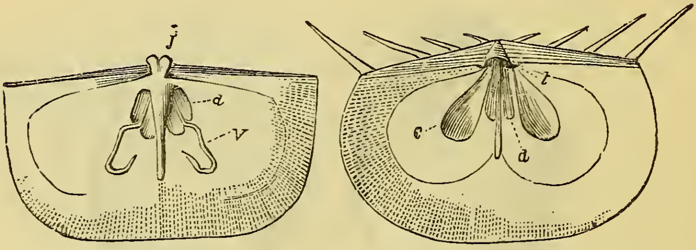
CHONETES, Fischer.

Example, C. striatella, Pl. XV., Fig. 29.

Etymology, *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, 47 species. Silurian—Carboniferous. Europe, North America, Falkland Islands.



Dorsal valve. Fig. 192. Ventral valve.*

FAMILY VI.—CRANIADÆ.

Shell orbicular, calcareous, 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. 195.)

CRANIA, Retzius.

Etymology, *kraneia*, capitate.

Type, Anomia craniolaris, L.

Examples, C. Ignabergensis, Pl. XV., Fig. 30. C. anomala, Figs. 193—195.

Synonyms, Criopus, Poli. Orbicula (anomala), Cuvier, = O. Norvegica, Lam.

* Interiors of two sp. of *Chonetes*, from Nehou and the Eifel, after Davidson: *a*, adductor; *c*, cardinals.

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

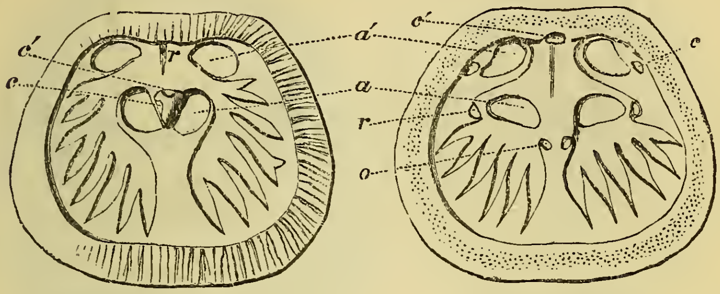


Fig. 193. Ventral valve. Fig. 194. Dorsal valve.

Crania anomala, Muller. $\frac{4}{1}$ Zetland.

a, anterior adductors; *a*′, posterior adductors; *c*, posterior adjustors; *c*′, cardinal muscle; *r*, *o*, central and external adjustors.

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 fathoms, *dead;* Forbes); the animal is orange-coloured, and its labial arms are thick, fringed with cirri, and disposed in a few horizontal gyrations (Fig. 195).

Distribution, 5 species. Spitzbergen, Britain, Mediterranean, India, New South Wales. —150 fathoms.

Fossil, 37 species. Lower 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 Lower 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.

* M. Quenstedt has placed the Oolitic Cranias in *Siphonaria!*

FAMILY VII.—DISCINIDÆ.

Shell attached by a pedicle, passing through a foramen in the ventral valve; valves not articulated; minutely punctate.

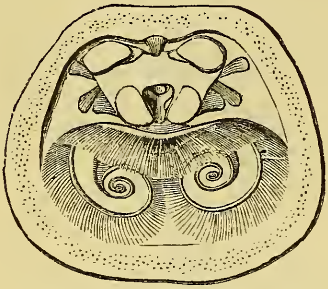


Fig. 195. *Crania.**

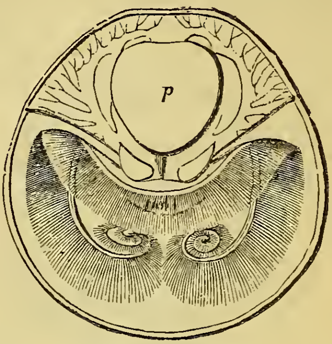


Fig. 196. *Discina.*†

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.

DISCINA, Lamarck.

Synonyms, Orbicula, Sby. (not Cuvier‡). Orbiculoidea (elliptica), D'Orbigny. Schizotreta, Kutorga.

Types, D. lamellosa, Pl. XV., Fig. 31. (=D. ostreoides, Lamarck.)

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

* 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.

‡ The *Orbicula* of Cuvier was the *Patella anomala*, Müll (= Crania), as pointed out by Dr. Fleming, in the "History of British Animals," 1828.

Crania; and three pair of adjustor muscles for keeping the valves opposed to each other. 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,

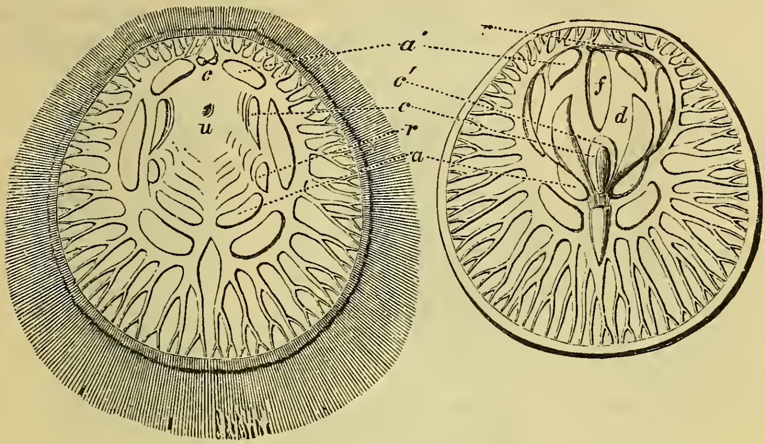


Fig. 197. Dorsal. Fig. 198. Ventral lobe.

Discina lamellosa, Brod. $\frac{2}{1}$

u, umbo; *f*, foramen; *d*, disk; *a*, anterior adductors; *a'*, posterior adductors; *c*, *c'*, central and posterior adjustors; *r*, external adjustors. The mantle-fringe is not represented in Fig. 198.

which are themselves setose like the bristles of certain annelides (*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.

Distribution, 10 species. West Africa, Malacca, Peru, and Panama.

Fossil, 64 species. Silurian—. Europe, United States, Falkland Islands.

In some species the valves are equally convex, and the foramen occupies the end of a narrow groove.

Sub-genus, *Trematis*, Sharpe. (=Orbicella, D'Orbigny.) *T. terminalis*, Emmons. Valves convex, superficially punctate; dorsal valve with a thickened hinge-margin (and three diverging plates, indicated on casts.—Sharpe). *Fossil*, 14 species, Lower and Upper Silurian. North America and Europe.

SIPHONOTRETA, Verneuil.

Etymology, *siphon*, a tube, *tretos*, perforated.

Types, S. unguiculata, Eichw., Figs. 199, 201. S. verrucosa, Fig. 200.

Shell oval, bi-convex, slightly beaked, conspicuously punctate, or spiny; beak perforated by a tubular foramen; hinge-margins

Fig. 199.

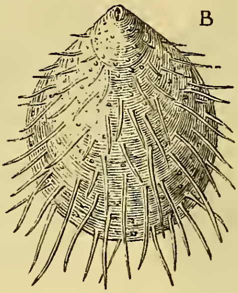


Fig. 200. Exterior.

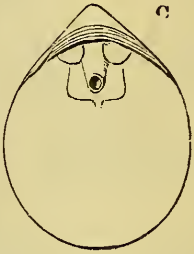


Fig. 201. Interior.

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, 9 species. Lower and Upper Silurian. Britain, Bohemia, Russia.

? *Acrotreta* (sub-conica), Kutorga. 3 species. Lower 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.

LINGULA, Bruguière.

Etymology, *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 occupy-

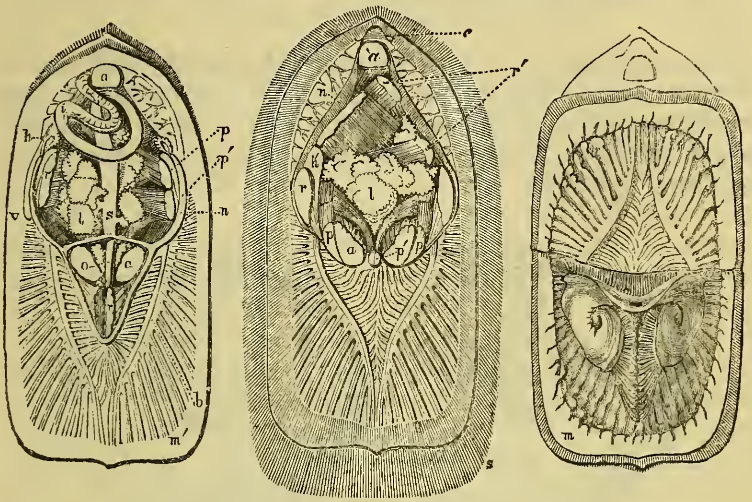


Fig. 202. Dorsal.* Fig. 203. Ventral. Fig. 204. Ventral.

Lingula anatina, Lam. (original). *Syn.* Patella unguis, L. (part.)

a a, anterior adductors; *a'*, posterior adductor; *p p*, external adjustors; *p' p'*, central adjustors; *r r*, anterior retractors (the anterior occlusors of Hancock); *r'r'r'*, posterior adjustors; *c*, capsule of pedicle; *n n*, visceral sheath; *o*, œsophagus; *s*, stomach, *l*, liver; *i*, intestine; *v*, vent; *b*, branchial vessels; *m'*, mantle margin; *m*, inner lamina of mantle margin retracted, showing bases of setæ; *s*, setæ.

ing the posterior half of the shell, and surrounded by a strong muscular sheath; pedicle elongated, thick; 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 whorls, 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

* In Fig. 202 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. 204 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. 202, 204.

alive. The shell is horny and flexible, and always of a greenish colour.

Distribution, 16 species. India, Philippines, Moluccas, Australia, Feejees, Sandwich Islands, West America.

Fossil, 91 species. Lower Silurian—. North 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*, Lower Silurian, Tremadoc, has a pedicle-groove like *Obolus*, Fig. 205. (Salter.)

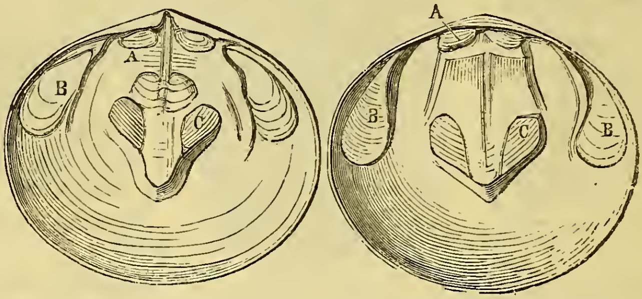


Fig. 205. Ventral valve. Fig. 206. Dorsal valve..
Obolus Davidsoni. (Salter.) Wenlock limestone, Dudley.
A, posterior adductors; B, adjustors; C, anterior adductors.
The *pedicle-scar* in the centre of Fig. 168 has no letter.

Obolus, Eichwald.

Synonyms, Ungula, Pander; Aulonotreta, Kutorga.

Etymology, *obolus*, a small Greek coin.

Type, O. Apollinis, Eichw.

Shell orbicular, calcareo-corneous, depressed, sub-equivalve, smooth; hinge-margin thickened inside, and slightly grooved in the ventral valve; posterior adductor impressions separate; anterior pair sub-central; impressions of adjustors lateral. Fig. 205, 206. (After Davidson.)

Fossil, 8 species. Lower and Upper Silurian. Sweden, Russia, England, United States.

CHAPTER IV.

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 seaweed 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 fossilised 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.

* 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.

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 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 calcareous rocks, and attack the hardest marble, and still harder shells. (Fig. 25, p. 34). 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

* See the admirable memoir by Mr. Albany Hancock, in the An. Nat. Hist. for October, 1848.

† 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.

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 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 shell-fish 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 shell-fish deepens or enlarges its burrow after attaining the full growth usual to its species (p. 35).

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 conve-

* 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. 32); 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 embedded 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.

† 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* fossilised 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.

niently examined in a bivalve with a closed mantle, like the great *Mya* (Fig. 207), 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

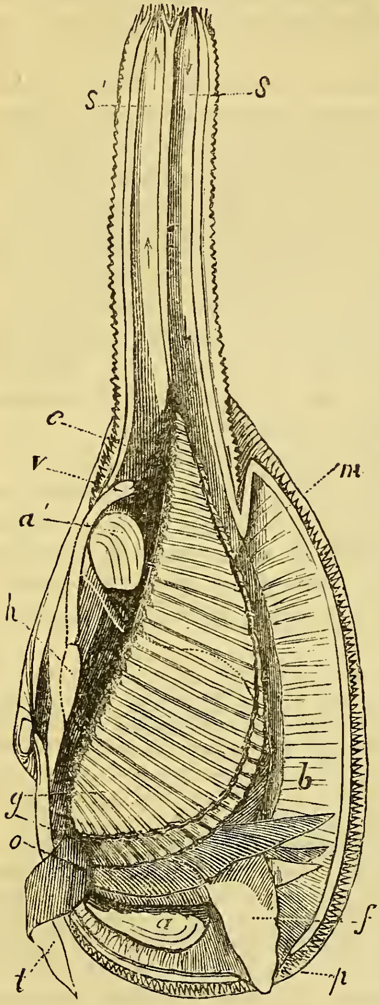


Fig. 207. *Mya arenaria.* †

* Alder and Hancock on the branchial currents of *Pholas* and *Mya*. An. Nat. Hist., Nov. 1851.

† *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.

and to the siphonal partition. Each gill is composed of two laminæ, divided internally into a series 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.)

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. 208 *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.

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. 208, *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.*

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

* Some other particulars respecting the organisation and development of bivalve shell-fish are given in Chapter I. For an account of their vascular system see Milne-Edwards, An. Sc. Nat. 1847, tom. viii. p. 77.

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. 29). 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. 224),

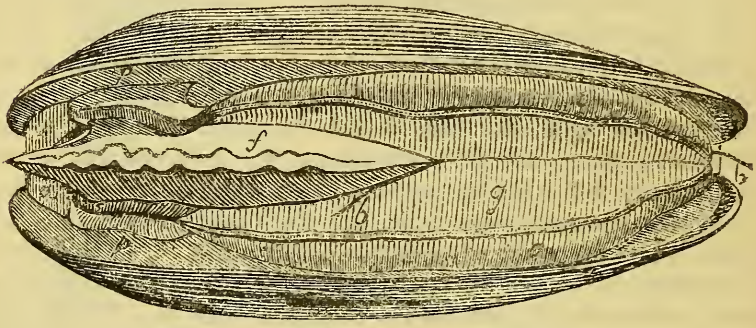


Fig. 208. River-mussel. (*Anodon cygneus* ♀) *

the resemblance to an operculated spiral univalve becomes very striking.

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.†

The *Conchifera* are mostly *equivalve*, the right and left valves

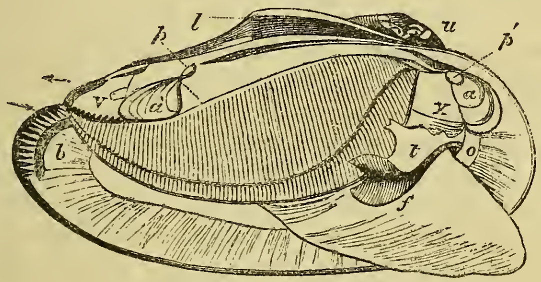
* The valves are forcibly opened and the foot (*f*) contracted; *a*, anterior adductor-muscle, much stretched; *p*, *p*, palpi; *g*, inner gills; *o*, *o*, outer gills distended with spawn; *b*, *b*, a bristle passed through one of the dorsal channels.

† 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.

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

Dorsal Margin.



Ventral margin or base.

Fig. 209. *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.

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 shown 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*, 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. 211, *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. 20) 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 process 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 cartilage from the ligament was peculiar to them. The cartilage-pit of many of the *Anatinidæ* is furnished internally with a movable 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. 33) which is organically connected with the margin of the mantle. It is developed to a remarkable extent in *Solemya* and *Glycimeris*

* 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" published by Longman and Co.

(Pl. XXII., Figs. 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* characterises 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 pp. 19, 20).

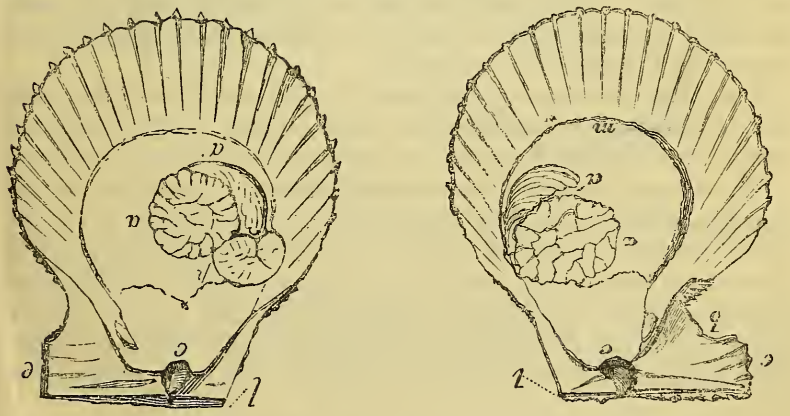


Fig. 210. Left valve. (*Pecten varius.*) Right valve.
a, a, adductor; *p*, pedal impression; *m*, pallial line; *l*, ligamental margin; *c, c*, cartilage; *e, e*, anterior ears; *b*, byssal sinus.

The *adductor impressions* are usually simple, although the

* 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.

muscles themselves may be composed of two elements,* as in *Cytherea chione* (Fig. 14, p. 20) and the common oyster. The impression of the posterior adductor in *Spondylus* is double (Pl. XVI., Fig. 15). In *Pecten varius* (Fig. 210, *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.

In the *left* valve of *Anomia* there are four distinct muscular impressions (Fig. 213). Of these, the small posterior spot alone is produced by the *adductor*, and corresponds with the solitary

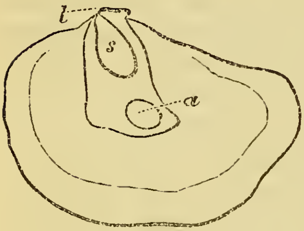


Fig. 211. Right valve.

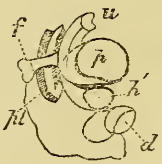


Fig. 212.

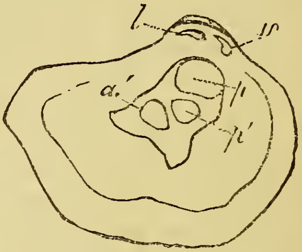


Fig. 213. Left valve.†

impression in the right valve. The adductor itself (Fig. 212, *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 disc (*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 *Müllería*.

The *dimyary* bivalves have a second adductor, near the anterior margin, which is small in *Mytilus* (Fig. 30), but large in *Pinna*. The *retractor* muscles of the foot (already alluded to at p. 20) have their fixed points near those of the adductors; the anterior pair are attached within the umbones (Fig. 214, *u u*), or nearer the adductor, as in *Astarte* and *Unio* (Fig. 209). The posterior pair (*p' p'*) are often close to the adductor, and leave no separate

* Compare the shell of *modiola*, Pl. XVII., Fig. 5, with the woodcut, Fig. 214.

† Fig. 211. Right valve of *Anomia ephippium*, L. *l*, ligamental process; *s*, sinus. Fig. 213. Left valve; *l*, ligament pit. Fig. 212. 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.

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., Figs. 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*,

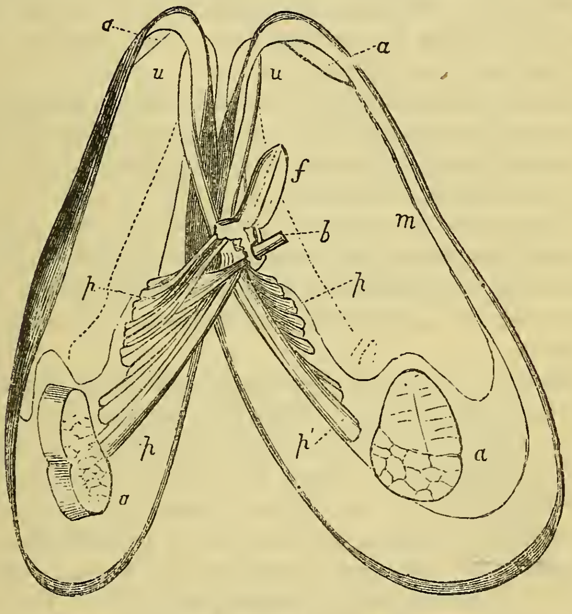


Fig. 214. Muscles of *Modiola*.*

Modiola, and *Dreissena* the byssal muscles are equal to the great adductors in size.

In a few rare instances the muscles are fixed to prominent *apophyses*. The *falciform processes* of *Pholas* and *Teredo* (Pl. XXIII., Figs. 19, 26) are developed for the attachment of the foot-muscle; the posterior muscular 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

* Fig. 214. 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.

less shell than the mantle, and their impressions deepen with age.

The *pallial line* (Fig. 214, *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. 20), only exists in those shells which have retractile siphons; its depth is an index to their length. The large combined siphons of *Mya* (Fig. 207) 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 older 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

* 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 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 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 organised, 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 distin-

* *Etudes Critiques sur les Mollusques Fossiles, par L. Agassiz, Neuchatel,* 1840.

guishing 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*.
6. Microscopic structure of the shell. (*v.* p. 31.)
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 organisation." (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.

* 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 *Lithodomus* and *Ungulina*—boring shells—have the foot like *Mytilus* and *Lucina*.

12. *Novaculina* is a river *Solen*, and *Scaphula* a fresh-water *Arca*.

FAMILY I.—OSTREIDÆ.

Shell inequivalve, slightly inequilateral, 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 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.

The union of the *Ostreidæ* and *Pectinidæ*, as proposed by the authors of the "History of British Mollusca," has not proved satisfactory. The genus *Ostrea* stands quite alone, and distinct from all the *Pectinidæ* in the structure of its gills, which are like those of *Avicula*, and by resting on its *left* valve. The shell also is more nacreous than that of the scallops

OSTREA, L.—OYSTER.

Synonyms, Amphidonta and Pycnodonta, Fischer. Peloris, Poli.

Type, O. edulis, L.

Example, 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 subnacreous, 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.*

Distribution, 70 species. Tropical and temperate seas. Norway, Black Sea, &c.

Fossil, 200 species. Carb. —. United 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

* The course of the alimentary canal in the common oyster is incorrectly represented by Poli, and copied in the Crochard ed. of Cuvier.

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 five or seven years, whilst the "sea-oysters" are full-grown in four years. Native oysters do not breed freely, and sometimes many die in the spawning season; they are also liable to be killed by frost. The season is from August 4 to May 12. From 20,000 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.

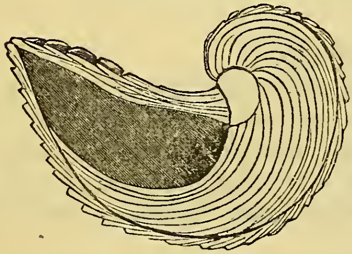


Fig. 215. *Gryphæa.*

"Green oysters" are those which have fed on *confervæ* in the tanks.

Sub-genera. Gryphæa, Lamarck. G. incurva, Sby. (section), Fig. 215. Free, or very slightly attached; left valve with a prominent, incurved umbo; right valve small, concave. *Fossil*, 30 species. Lias — Chalk. Europe, India.

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*, 46 species. L. Oolite — Chalk. United States; Europe.

Dimya (Deshayesana), Rouault, 1859. Mém. Soc. Géol. b. III. 471, t. 15. Fig. 3. *L. Eocene*, Paris. The figure is most like an oyster, and the "second adductor impression," on account of which it is named *Dimya*, is rather like the small anterior scar in *Pecten* (Fig. 210).

Anomia, L.

Etymology, *anomios*, unequal.

Example, A. Achæus, Pl. XVI., Fig. 3.

Synonyms, 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. 213, p. 402): 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, elongated; palpi 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.

Distribution, 20 species. North America, Britain, Black Sea, India, Australia, West America, Icy sea. Low water — 100 fathoms.

Fossil, 36 species. Oolite —. Chili, United States, Europe, India.

Sub-genera. Placunomia (Cumingii), Broderip. *Synonym*, 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. *Distribution*, 13 species. West Indies, Britain (*P. patelliformis*), New Zealand, California, Behring's Sea, Ochotsk. — 50 fathoms.

Limanomia (Grayana), Bouchard. Shell eared like *Lima*. *Fossil*, 4 species. Devonian; Boulonnais, China?

PLACUNA, Solander.—Window-Shell.

Etymology, *plakous*, a thin cake.

Example, P. sella, Pl. XVI., Fig. 5.

Shell suborbicular, 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 as 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.

*Placuna** is essentially like *Anomia*, having the generative system attached to the right mantle-lobe, and the ventricle exposed. The mantle-margin is cirrated, and furnished with a *curtain*, as in Pecten; the foot is tubular and extensile, but has no distinct muscles except the small one, whose existence in *P. placenta* (Pl. XVI., Fig. 6) we had predicated from examination of the shell.† The small muscular impressions before and in the rear of the adductor are produced by suspensors of the gills.

Distribution, 4 species. Scinde, North Australia, China.

Sub-genera. Carolia, Cantraine, 1835 (after Prince Charles Bonaparte). *Synonym*, 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. *Distribution*, 3 species. (British Museum), Tertiary, Egypt; America?

Placunopsis, Morris and Lycett. P. Jurensis, Rœmer. Suborbicular, 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 species. Lower Oolites, Europe.

Placenta, Retzius. Cartilage grooves slightly divergent, the posterior one the longer of the two; muscular impression sub-central.

* Original figures and descriptions will be found in the An. Nat. Hist. 1855, p. 22.

† This organ appears to represent the *byssal-sheath* of Anomia, rather than the foot, as there is no other opening for the passage of a byssus.

Pecten, O. F. Müller. Scallop.

Etymology, *pecten*, a comb.

Type, P. maximus (Janira, Schum.)

Synonyms, 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. 210).

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.

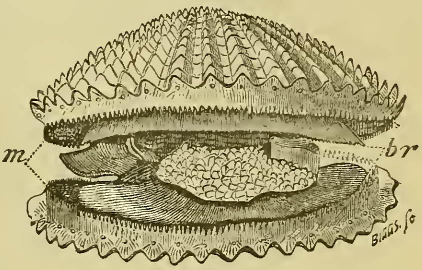


Fig. 216. *Pecten varius.**

The Scallop (*P. maximus*) and "quin" (*P. opercularis*) are esteemed delicacies; the latter covers extensive banks, especially on the north and west of Ireland, in 15 to 25 fathoms water. The scallop ranges from 3—40 fathoms; 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 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 Gennesaret into a Spanish warrior, they assigned him the scallop-shell for his "cognizance." (Moule's "Heraldry of Fish.")

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.)

Sub-genera, Neithea, Drouet, Vola, Klein. P. quinquecostatus and other fossil species 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.

Distribution, 2 species.

Fossil, Trias? Upper Greensand —, 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*.

Amusium, Klein. Shell nearly equivalved, gaping in front and behind; smooth outside, generally marked with radiating grooves inside.

Distribution, 176 species. World-wide; Nova-Zembla—Cape Horn; — 200 fathoms.

Fossil, 450 species (including Aviculo-pecten). Carb.—. World-wide.

Lima, Bruguiere.

Etymology, *lima*, a file.

Example, L. squamosa, Pl. XVI., Fig. 11. (Ostrea lima, L.)

Synonyms, Plagiostoma (Llhwyd), Sby. P. cardiiformis, 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-margins 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 species. Greenland—Britain. *Fossil*, Miocene—. Europe.

Limœa, Bronn. L. strigilata, Pl. XVI. Fig. 14.* Hinge minutely toothed.

Fossil, 4 species. Lias—Pliocene. The recent *Limœa* ? *Sarsii* (Lovén), Norway (=L. crassa of the Ægean ?) has the mantle-border plain. Some of the larger recent species have obscure lateral teeth.

Distribution, 20 species. Norway, Britain, West Indies, Canaries, India, Australia; 1—150 fathoms. The largest living species (*L. excavata*, Chemn.) is found on the coast of Norway.

Fossil, 200 species. Carb.? Trias—. United States, Europe, India. The so-called *Plagiostoma spinosum* is a *Spondylus*.

SPONDYLUS (Pliny) L. Thorny-oyster.

Type, S. gædaropus, L.

Example, S. princeps, Pl. XVI., Fig. 15

* After Bronn; the figure in Brocchi does not show the teeth.

Synonyms, Dianchora, Sby. Podopsis, Lam. Pachytes, Defr.

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 two 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 species (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 calcareous 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.)

Distribution, 68 species. West Indies, Canaries, Mediterranean, India, Torres Straits, Pacific, West America :—105 fathoms.

Fossil, 80 species. Carb—. Europe, United 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-embedded; Red Sea, Indian Ocean, Mauritius, Chinese Seas.

PLICATULA, Lamarck.

Etymology, *plicatus*, plaited.

Type, P. cristata, Pl. XVI., Fig. 17.

Shell irregular, attached by the umbo of the right valve valve smooth or plaited; hinge-area obscure; cartilage quite internal; hinge-teeth, two in each valve; adductor scar simple.

Animal resembles *spondylus*.

Distribution, 9 species. West Indies, India, Philippines, Australia, West America.

Fossil, 40 species. Trias—. United States, 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. 217), 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.

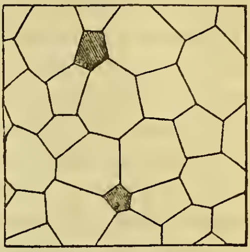


Fig. 217. *Pinna.**

Animal with the mantle-lobes free, their margins fringed; foot small, spinning a byssus; gills two 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.

Etymology, *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 one or two 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 four, posterior large in front of the adductor; adductor composed of two 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. (British Museum.)

* 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.

Distribution, 25 species. Mexico, South Britain, Mediterranean, India, Pacific :—20 fathoms.

Fossil, 300 species. Lower Silurian —. World-wide.

Sub-genera Maleagrina. Lam. Margaritophora, Muhlfeldt. 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 River, 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 Islands, of which about twenty tons are annually imported to Liverpool. 2. The black-lipped, from Manilla, of which thirty 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. 30, 31). Mr. Hope's pearl, said to be the largest known, measures 2 inches long, 4 round, and weighs 1,800 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 species. China, Australia.

Vulsella, Lam. V. lingulata, Pl. XVI., Fig. 21. *Synonym*, Reniella, Sw. Shell, oblong, striated, sub-equivalve; umbones straight, earless. Often found imbedded in living sponges. *Distribution*, 7 species. Red Sea, India, Australia, Tasmania. *Fossil*, 7 species. U. Chalk —. Britain, France.

Pteroperna, Lycett, 1852. P. costatula, Desl. *Shell* with a long posterior wing; hinge-line bordered by a groove; anterior teeth numerous, minute; posterior one or two, long, nearly parallel with the hinge-margin. *Fossil*, 3 species. Bath oolite; Britain, France.

? *Aucella* (Pallasii), 1846. Very inequivalve; left umbo prominent, earless; right valve small and flat, with a deep sinus beneath the small anterior ear. *Fossil*, 4 species, 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 species. Lower Silurian — Carb. United States, Europe.

? *Cardiola* (interrupta), Broderip, 1844. Equivalve, gibbose, obliquely oval, radiately ribbed; beaks prominent; hinge-area short and flat. *Fossil*, 17 species. Upper Silurian — Dev. United States, Europe.

? *Eurydesma* (cordata), Morris; Devonian? New South Wales. *Shell* equivalve, sub-orbicular, ventricose, very thick near the beaks; ligimental 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*, 32 species. Lower Silurian — Carb. United States, 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.

Synonym, ? *Halobia* (salinarum) Br. 1830. *Trias*, Hallstadt. Semi-oval, radiated, compressed, with a shallow sinus in front; hinge-line long and straight.

Posidonomya, Bronn.

Synonym, Posidonia, Br. 1838 (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 species. Lower Silurian — Trias. United States, 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). Lower Silurian — Carb. Spitzbergen — Australia.

GERVILLIA, Defrance.

Etymology, dedicated to M. Gerville, a French naturalist.

Example, 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, 37 species. Carb. — Chalk. Europe.

Sub-genus? *Bakewellia*, King. B. ceratophaga, Schl. *Fossil*, 5 species. Permian, Britain, Germany, Russia. *Shell* small, inequivalve, cartilage pits 2—5; hinge with anterior and posterior teeth; anterior muscular impression and pallial line distinct.

PERNA, Bruguiere.

Etymology, *perna*, a shell-fish (resembling a *gammon*), Pliny.

Synonyms, 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 species have the posterior side produced and wing-like. In some Tertiary Pernas the pearly layer is an inch thick.

Distribution, 18 species. Tropical seas; West Indies — India — West America.

Fossil, 30 species. Trias —. United States, Chili, Europe.

Sub-genera, *Crenatula*, Lamk. C. viridis, Pl. XVI., Fig. 24. *Shell* thin, oblong, compressed; byssal sinus obsolete; cartilage pits shallow, crescent-shaped. *Distribution*, 8 species, North Africa, Red Sea — China; in sponges. *Fossil*, 4 species.

Hypotrema, D'Orb, 1853. H. rupellensis (= ? Pulvinites Adansonii, Defrance, 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 twelve close-set transverse cartilage grooves.

Inoceramus, Sowerby (1814).

Etymology, *is* (inos), fibre, *keramos*, shell.

Example, I. sulcatus, Pl. XVII., Fig. 3.

Synonym, 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, 75 species. ? Silurian — Chalk. South America, United States, Europe, Algeria, Thibet.

Pinna, L.

Etymology, *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 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.

Distribution, 30 species. United States, Britain, Mediterranean, Australia, Pacific, Panama.

Fossil, 60 species. Devonian —. United States, Europe, South 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 half-way from the beak. Some fossil Pinnas crumble under the touch into their component fibres. The living species range from extreme low water to 60 fathoms; 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 shell-fish, 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 species. Oolitic strata of England and France. Fragments an inch or more in thickness are common in the Cotteswold-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 members 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.

Example, 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.

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 un-

* A thin layer of minute cells may frequently be detected immediately under the epidermis. (Carpenter.)

known 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 thirty or forty millions are collected yearly in the Firth of Forth alone. (Dr. Knapp.) Mussels produce small and inferior pearls. At Port Stanley, Falkland Islands, 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.

Distribution, 65 species. World-wide. Ochotsk, Behring's Sea, Russian Ice-meer; Black Sea, Cape Horn, Cape, New Zealand.

Fossil, 100 species. Silurian —. United States, Europe, South 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 two; pallial line simple.

Fossil, 6 species. Carb. — Permian. Europe. The ligamental area resembles that of the recent *Arca obliquata*, Chemn. India.

Modiola, Lam. Horse-mussel.

Etymology, *modiolus*, a small measure, or drinking-vessel.

Example, M. tulipa, Pl. XVII., Fig. 5. M. modiolus, p. 403, Fig. 214.

Shell oblong, inflated in front; umbones anterior, obtuse; hinge toothless; pedal impressions three 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 fathoms.

Distribution, 70 species, chiefly tropical; *M. modiolus*, Arctic seas — Britain.

Fossil, 150 species. Silurian? Lias —. United States, Europe, Thibet, South 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.* *Distribution*, 40 species. West Indies — New Zealand. *Fossil*, 35 species. Carb. —. Europe, United States. The "date-shell" bores into corals, shells (Fig. 25, p. 34), and the hardest limestone rocks; its burrows are shaped like the shell, and do not admit of free rotatory motion. The animal, which is eaten in the Mediterranean, is like a common mussel; in *L. patagonicus* the siphons are produced. Like other burrowing shell-fish, 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. *Distribution*, 24 species. Temperate and arctic seas; Nova Zembla, Ochotsk, Britain, New Zealand. Low water — 40 fathoms. Spinning a nest, or hiding amongst the roots of sea-weed and corallines. *M. marmorata*, Forbes, burrows in the test of *Ascidia*. *Fossil*, 12 species. Upper Greensand —. Europe.

Modiolarca (trapezina), Gray; Falkland Islands — 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.) 2 living species.

? *Mytilimeria* (Nuttallii), Conrad. *Shell* irregularly oval, thin, edentulous, gaping posteriorly; umbones sub-spiral; ligament short, semi-internal. *Distribution*, 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

* The outer shell-layer has a tubular structure; the tubes are excessively minute seldom branching, oblique and parallel. (Carpenter.)

large and oval. *Fossil*, 15 species. Silurian, United States, Europe.

? *Orthonotus* (pholadis), Conrad. Lower Silurian, New York. *Shell* elongated, margins parallel, umbones anterior, back plaited.*

Myrina, Adams. *Modiola pelagica*, has the mantle open; the shell is peculiar from the large size of the anterior muscular impression; and the subcentral umbones distinguish it from *Modiolarca*.

Hoplomytilus (crassus), Sdbgr. *Devonian*, Nassau. *Shell* with a muscular plate in the umbo, like *Septifer*. The *Mytilus squamosus*, Sby. Magnesian limestone, Brit., has a similar plate.

Hippomya. Salter.

Shell gibbous, with anterior inflated close beaks, a long cardinal edge; anterior edge short, rounded, and separated by a strong sinus from the inflated posterior ridge and slope.

Fossil, 1 species. Devonian.

Dreissena, Van Beneden.

Etymology, dedicated to Dreyssen, a Belgian physician.

Synonyms, 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 shells; 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.

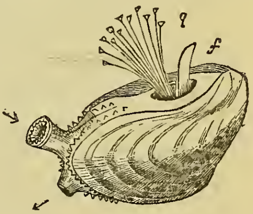


Fig. 218. *Dreissena*.

Animal with the mantle closed; byssal orifice small; and siphon very small, conical, plain, branchial prominent, fringed inside; palpi small, triangular; foot-muscles short and thick, close in front of the posterior adductor.

D. polymorpha is a native of the Aralo-Caspian rivers; in 1824 it was observed by Mr. J. Sowerby in the Surrey docks,

* 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 Islands, has the same long, straight back and plaited dorsal region.

to which it appears to have been brought with foreign timber, in the holds of vessels. It has since spread into the canals, docks, and rivers of many parts of England, France, and Belgium, and has been noticed in the iron water-pipes of London, incrusted with a ferruginous deposit. (Cunnington.)

Distribution, 15 species. Europe, America, Africa.

Fossil, 13 species. Eocene—. Britain, 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 subequal. 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.

Etymology, *arca*, a chest.

Type, A. Noæ, Pl. XVII., Fig. 12.

Synonyms, Barbatia, Gray; Anomalocardia, Klein; Scapharca, Gray; Scaphula, Benson.

Examples, 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 groved; 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 calcareous; 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 nder stones at low water in crevices of rocks, and the empty burrows of boring mollusks; they are often much worn and distorted. The genus *Palaarca* probably belongs here; we have not been able to ascertain the generic characters; but they may be found in the Memoirs of the Geol. Surv., Canada, Vol. III., under the head Cyrtodonta.

Distribution, 140 species. World wide, most abundant in warm seas; low water—230 fathoms (*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, 1,000 miles from the sea. A second species has been found in the river Tenasserim, Birmah. The hinge is edentulous in the centre, and the posterior teeth are laminar and branched; the elements of the posterior muscular impression are distinct.

Fossil, 400 species. Lower Silurian—. United States, Europe, South India.

Cucullæa, Lamarck.

Etymology, *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.

Distribution, 2 species. Mauritius, Nicobar, China.

Fossil, 240 species. Lower Silurian. North 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 *Cucullœa;* 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.

Parallelopipedum, Klein. The outermost hinge-teeth short, and perpendicular to the hinge-line; teeth developed along the whole length of the hinge.

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 subequal; 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.

Distribution, 58 species. West Indies, Britain, India, New Zealand, West America; ranging from 8 to 60, rarely 120 fathoms.

Fossil, 80 species. Neocomian—. United States, Europe South 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.

Synonym, Trigonocœlia, Nyst. Pectunculina, D'Orb.

Shell orbicular, convex, slightly oblique; ligamental area with a triangular cartilage-pit in the centre; hinge with 2 equal, curved series of transverse teeth.

Distribution, 4 species. Red Sea (Nyst.), Japan, Britain. Mr. M'Andrew has dredged *L. pygmæa*, living, on the coast of Finmark; it is a fossil of the *Pliocene* of England, Belgium, and Sicily.

Fossil, 36 species. Bath-oolite—. United States Europe.

NUCULA, Lam.

Etymology, diminutive of *nux*, a nut.

Example, 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 Professor 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*.

Distribution, 70 species. United States, Norway, Cape, Japan, Sitka, Chili. On coarse bottoms, from 5—100 fathoms.

Fossil, 177 species. Lower 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.

Synonym, Noetia, Gray.

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, Lower Silurian, Canada, is 3 inches long, and has the ligament preserved.

Fossil, 14 species. Lower Silurian—Chalk. North America. Europe.

Sub-genera. *Cucullella*, M'Coy. C. antiqua, Sby. Upper Silurian, Herefordshire. *Shell* elliptical, with a strong rib behind the anterior adductor impression.

Lunularca, Gray. Part anterior to the umbo toothless, with a lunule.

Leda, Schumacher.

Etymology, *Leda*, in Greek mythology, mother of Castor and Pollux.

Synonym, Lembulus (Leach) Risso.

Example, L. caudata, Pl. XVII., Fig. 20.

Shell resembling *Nucula;* oblong, rounded in front, produced and pointed 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,

* *N. donaciformis*, Parreyss, from the White Nile, is a crustacean! (Estheria.)

siphonal tubes (Forbes); gills narrow, plume-like, deeply laminated, attached throughout; mantle-margin with small ventral lobes forming by their apposition a third siphon.

Distribution, 80 species. Northern and Arctic Seas, 10—180 fathoms. Siberia, Melville Island, Massachusetts, Britain, Mediterranean, Cape, Japan, Australia.

Fossil, 190 species. United States, Europe, South India.

Sub-genus, *Yoldia*, Möller (dedicated to the Countess Yoldi).

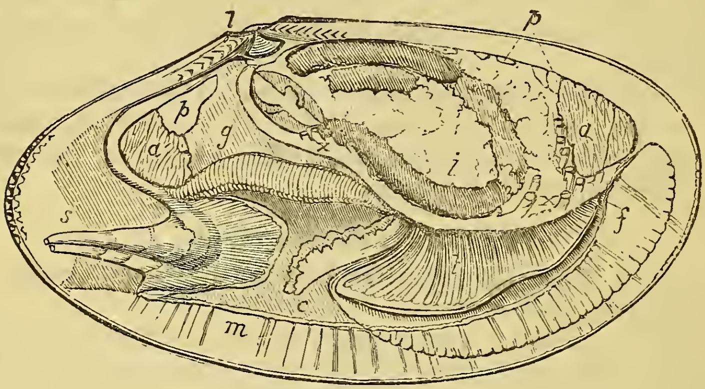


Fig. 219. *Yoldia* n. sp. $\frac{3}{1}$. Antarctic Expedition.

(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.

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. *Distribution*, Arctic and Antarctic Seas, Greenland, Massachusetts, Brazil, Norway, Kamtschatka. *Yoldia limatula* (Fig. 220) has been dredged, alive, by Mr. M'Andrew, on the coast of Finmark. It is also found in Portland Harbour, Massachusetts. The animal is very active, and leaps to an astonishing height, exceeding in this faculty the scollop-shells.

(Dr. Mighels.) *Fossil*, Pliocene—. (Crag and Glacial deposits.) England, Belgium.

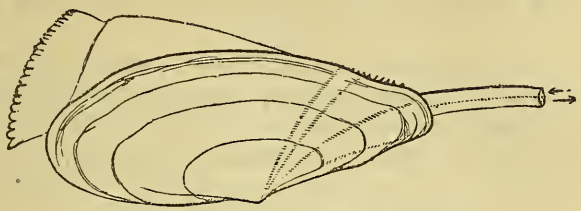


Fig. 220. *Yoldia limatula* (after Barrett).

SOLENELLA, Sowerby.

Type, S. Norrisii, Pl. XVII., Fig. 22. S. ornata, Fig. 23.

Synonyms, 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 appendiculated, convoluted, as long as the shell; gills narrow, posterior; foot deeply cleft; forming an oval disk, even-margined and striated across.

Distribution, 2 species. Valparaiso, New Zealand (shell like *S. ornata*).

Fossil, 1 species. Miocene. Point Desire, Patagonia.

? SOLEMYA, Lamarck.

Type, S. togata, Pl. XXII., Fig. 17.

Synonym, 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 shape, and cirrated; foot probosciform, 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.

Distribution, 4 species. United States, Canaries, West Africa (Gaboon River), Mediterranean, Australia, New Zealand. Burrowing in mud; 2 fathoms.

Fossil, 4 species. Carb. —. Britain, 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).

Etymology, *Trigonos*, three-angled.

Synonym, Lyriodon, G. Sowerby.

Example, T. Costata, Pl. XVII., Fig. 24. T. pectinata, Fig. 221.

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.

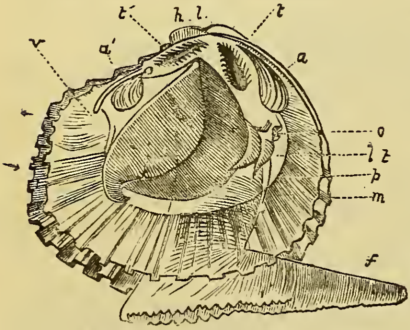


Fig. 221. *Trigonia pectinata.**

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 in-

* Fig. 221. 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; *h l*, ligament; *t*, *t'*, dental sockets; *o*, mouth; *l t*, labial tentacles or palpi; *p*, pallial line; *m*, margin; *f*, foot; *v*, cloaca.

terior 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.

Distribution, 3 species (or varieties?), Australia.

Fossil, 100 species. Trias — Chalk (not known in Tertiaries). Europe, United States, Chili, Algeria, Cape, South India.

MYOPHORIA, Bronn, 1830.

Type, M. vulgaris, Schl.

Synonym, 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, 16 species. Trias: Germany, Tyrol.

AXINUS, Sowerby, 1821.

Type, A. obscurus, Sowerby.

Synonym, 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 species. Upper Silurian — Muschelkalk. United States, Europe. *Mactra trigonia*, Goldf. *Isocardia axiniformis*. Ph. *Anatina attenuata* and *Dolabra securiformis*, M'Coy, probably belong to this genus. *Dolabra equilateralis*, *Amphidesma subtruncatum*, with many others from the Palæozoic rocks, may constitute a distinct genus, but their generic character has yet to be discovered.

CURTONOTUS. Salter.

Thickened hinge-plate, with a single strong triangular central

* See Plott's Oxfordshire, T. vii. Fig. 1.

‡ In the collection of the late Miss Benett of Warminster, now in Philadelphia.

tooth on each valve. Right valve plate with an obscure tooth behind the central one. Anterior muscular scar deep; pallial impression entire.

Fossil, 6 species. Devonian, Britain.

PSEUDAXINUS, Salter.

Type, P. (Anodontopsis) securiformis, M'Coy, and P. trigonus.

Shell thin, edentulous, convex with prominent umbones, and a strong posterior carinated edge; beaks anterior; no lunette.

LYRODESMA, Conrad, 1841.

Type, L. plana, New York.

Synonym, Actinodonta, Phil.

Shell trigonia-shaped, rather elongated, with a striated posterior area; hinge with several (5—9) radiating teeth, striated across; ligament external.

Fossil, 4 species. Lower Silurian: Canada, United States, Britain.

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 three, distinct, two 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 North America both species and individuals abound. All the remarkable generic forms are peculiar to South 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. 31). † This condition of the umbones is conspicuous in the great fossil *Uniones* of the Wealden, 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.

Unio, Retz. River-mussel.

Etymology, *unio*, a pearl (Pliny).

Example, 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. 209, p. 399.)

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, Baphia, Meusch.), 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 river Tay, where the mussels were collected by the peasantry before harvest time. The pearls

* In the synopsis at p. 406, 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.

‡ 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. Gaskin 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.

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 a hundred might contain a pearl, and one pearl in a hundred might be tolerably clear. (See p. 30).

Distribution, 420 species. North America, South America, Europe, Africa, Asia, Australia.

Fossil, 50 species. Wealden —. Europe, India.

Sub-genera, *Monocondylœa*, D'Orbigny. M. Paraguayana, Pl. XVIII., Fig. 2.

Shell with a single large, round, obtuse cardinal tooth in each valve; no lateral teeth.

Distribution, 6 species. South America.

Hyria, Lam. H. syrmatophora, Pl. XVIII., Fig. 3. *Synonyms*, Pachyodon and Prisodon, Schum. *Shell* Arca-shaped, hinge-line straight, with a dorsal wing on the posterior side; teeth elongated, transversely striated. *Distribution*, 4 species. S. America.

CASTALIA, Lamarck.

Type, C. ambigua, Pl. XVIII., Fig. 4.

Synonym, 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.

Distribution, 3 species. Rivers of South America, Guiana, Brazil.

ANODON, Cuvier. Swan-mussel.

Type, A. cygneus, Fig. 208, p. 398.

Etymology, *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 300,000 young shells. (Lea.) See p. 14.

Distribution, 100 species. North America, Europe, Siberia.

Fossil, 8 species. Eocene—. Europe.

M. D'Orbigny relates that he found great quantities of small Anodons (*Bysso-anodonta Paraniensis*, D'Orbigny) 4 lines in length, *attached by a byssus*, in the River Parana, above Corrientes.

Iridina, Lamarck.

Synonyms, Mutela, Scop. Spatha, Lea (including *Mycetopus*). Leila, Gray.

Type, I. exotica, Pl. XVIII., Fig. 5.

Etymology, *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.

Distribution, 9 species. Rivers of Africa, Nile, Senegal.

Mycetopus, D'Orbigny.

Etymology, *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.

Distribution, 3 species. River Parana, Corrientes; River 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.

Distribution, 4 species. River Nile, from first cataracts to Fazool;* River Senegal.

Mulleria, Férussac.

Dedicated to Otto Frid. Müller, author of the "Zoologia Danica."

Type, M. lobata, Fér., Fig. 222.

Synonym, Acostæa (Guaduasana), D'Orbigny.

* The "fresh-water oysters" discovered by Bruce.

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

Fig. 222. *Mulleria lobata*, Fér. (Original.)

impressions single, posterior. Fig. 222 represents the left, or attached valve, showing the single muscular impression, and projecting spur with the nucleus, consisting of *both* valves of the fry, united, and filled up with shell.*

Distribution, River 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.

* M. D'Orbigny very liberally placed his suite of specimens of this remarkable genus in the British Museum. Oct., 1854.

† The only specimen of Mülleria in England, prior to the acquisition of the D'Orbigny collection, was purchased many years ago by Mr. Thomas Norris of Bury, for £20.

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, sub-equal; foot very small; gills two on each side, very unequal, united posteriorly.

Chama (Pliny), L.

Example, C. macrophylla, Pl. XVIII., Figs. 8, 9.

Synonym, 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

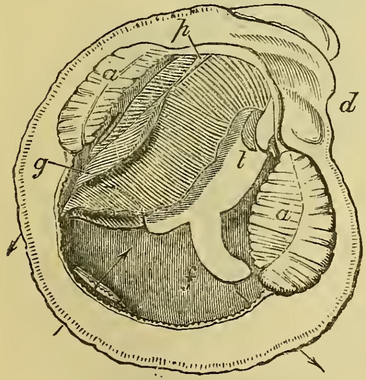


Fig. 223. Right side.

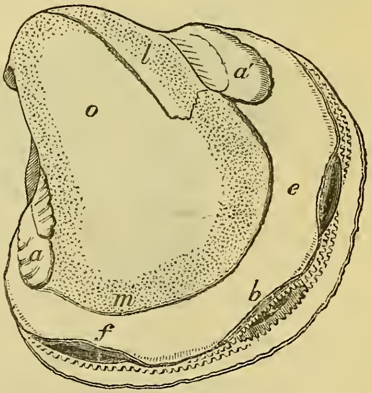


Fig. 224. Left side.

Fig. 223. Right side, with the umbonal portion of the mantle removed.
Fig. 224. 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 pallial line; lips simple, palpi small and curled; gills 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.

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. 224, *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.

Distribution, 50 species. Tropical seas, especially amongst coral reefs;—50 fathoms. West Indies, Canaries, Mediterranean, India, China.

Fossil, 40 species. Green-sand—. United States, Europe.

Sub-genus ? Monopleura; Matheron (= Dipilidia, Math.). *M. imbricata*, Math. Fig. 226. Neocomian, Southern France.

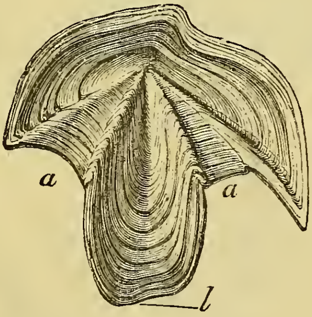


Fig. 225. *Bi-radiolites*, $\frac{3}{5}$.

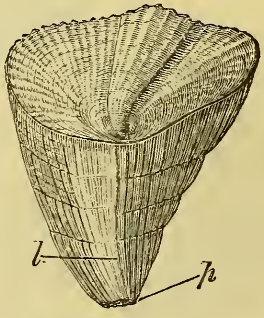


Fig 226. *Monopleura*, $\frac{1}{2}$.

p, point of attachment; *l*, ligamental groove; *a*, *a*, corresponding areas.

Shell attached by the *dextral* umbo; valves alike in structure and sculpturing; fived 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. *Fossil*, 10 species. 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.

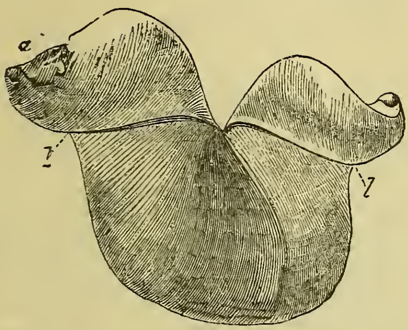
Diceras, Lamarck.

Type, D. arietinum, Pl. XVIII., Figs. 10 and 11, and Figs. 227 and 228.

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.

Distribution, 5 species. Middle oolite. Germany, Switzerland, France, Algeria.

Diceras differs from *Chama* in the great prominence of both its *umbones*, in having constantly two hinge-teeth in the right



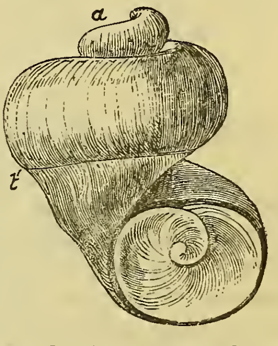


Fig. 227. *Diceras arietinum*, ½. Fig. 228. *Requienia ammonia*, ¼.
a, point of attachment; *l*, *l*, ligamental grooves; *t*, posterior adductor inflection.

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. 229, *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.

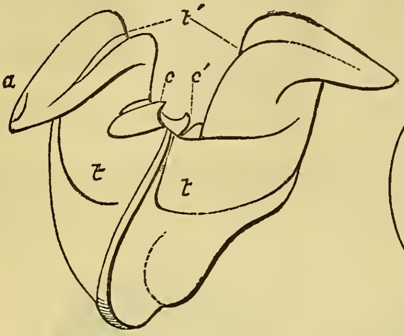
Requienia, Matheron,

Dedicated to M. Requien, author of a Catalogue of Corsican Mollusca.

Example, R. Lonsdalii, Pl. XVIII., Fig. 12 and Fig. 230. 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.*



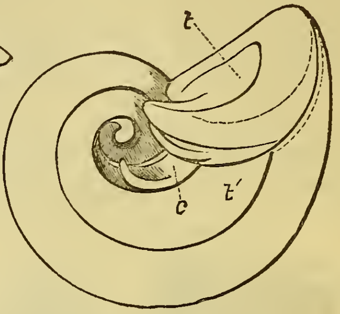


Fig. 229. *Diceras*, $\frac{1}{4}$. Fig. 230. *Requienia*, $\frac{1}{2}$.
Internal casts; *a*, point of attachment; *c*, *c′*, casts of dental pits; *t*, *t′*, furrows produced by spiral ridges. (Mus. Brit.)

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. 230, *c′*). The internal muscular ridges are produced by duplicatures of the shell-wall, and are indicated outside by grooves (Fig. 229, *t′*). In *R. subæqualis* and *Toucasiana* there is a second parallel ridge, as in Hippurites and *Caprotina.*

Fossil, 7 species. Neocomian — L. Chalk. Britain, 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, sub-marginal.

The shells of this extinct family are characteristic of the cretaceous strata, and abound in many parts of the Peninsula; the Alps, and Eastern 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. The structure of these shells has been fully described in the Quarterly Journal of the

Geological Society of London. In all the genera the shell consists of *three layers*, but the outermost, which is thin and compact, is often destroyed by the weathering of the specimens. The principal layer in the lower valve of the *Hippurite* is not really very different from the upper valve in structure; the laminæ are corrugated, leaving irregular pores, or tubes, parallel with the long axis of the shell, and often visible on the rim. The umbo of the upper valve of the *Radiolite* is marginal in the young shell. (Q. J. Geol. Soc., vol. xi. p. 40.)

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 three 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 Radiolite consists of prismatic cellular structure (Fig. 232); the prisms are perpendicular to the shell-laminæ, and often minutely subdivided. The cells appear to have been empty, like those of *Ostrea* (p. 407).† 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. 239), sometimes by mud or chalk, and very often it is only indicated by a vacuity between the outer shell and the internal mould (Fig. 244). The inner shell-layer

* 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 Annelids.
5. Mr. D. Sharpe refers *Hippurites* to the Balani; *Caprinella* to the Chamaceæ.
6. La Peyrouse 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.

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.*

The inner layer ceases at the pallial line, beyond which, on the rim of the shell, the cellular structure is often apparent;

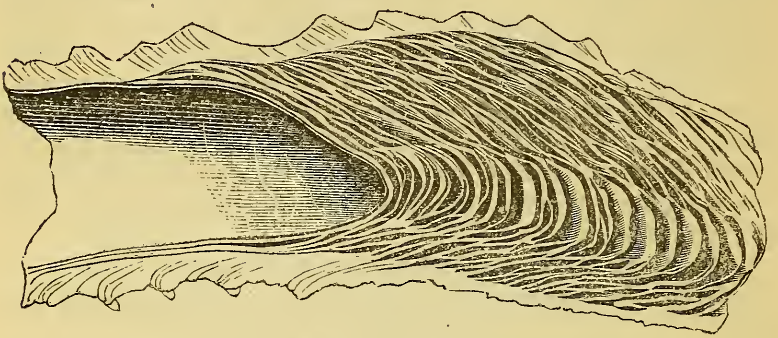


Fig. 231. Section of a fragment of *Ostrea Cornucopiæ.*

obscure bifurcating impressions radiate from the pallial line to the outer margin (Fig. 232, *v*, *v*).

These have been compared to the vascular impressions of

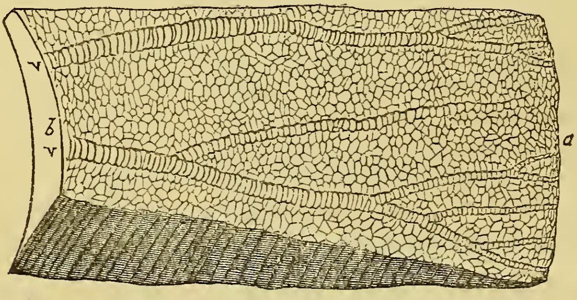


Fig. 232. Part of the rim of *Radiolites Mortoni*, Mantell.†

Crania (Figs. 193, 194), and constitute the only argument for supposing the *Rudistes* to have been *palliobranchiate;* but they

* 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. 246), which has lost its outer layer, might be mistaken for an *Ammonite*.

† 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.

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 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 bivalves, they opened to a very small extent.

HIPPURITES, Lamarck.

Name, adopted from old writers, "fossil *Hippuris*," or Horse-tail.

Types, *H. bi-oculatus*, Lamarck, and *H. cornu-vaccinum*, Fig. 237.

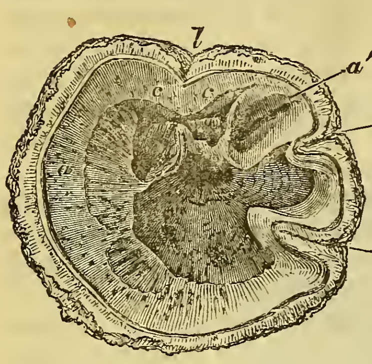
Shell very inequivalve, inversely conical, or elongated and cylindrical; *fixed valve* striated or smooth, with three parallel furrows (*l*, *m*, *n*) on the cardinal side, indicating duplicatures of the outer shell layer; internal margin slightly plaited; pallial line continuous; umbonal cavity moderately 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*)

* 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 *Rudistes* has a parallel in *Rhynchonella* and *Terebratula* (p. 360), and in the condition of the hepatic organ in *Tritonia* and *Dendronotus*.

‡ 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. 361).

small, very deep, bounded by the second duplicature (m); third duplicature (n) projecting into the umbonal cavity: *free valve*



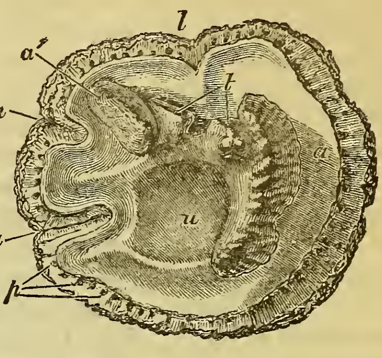
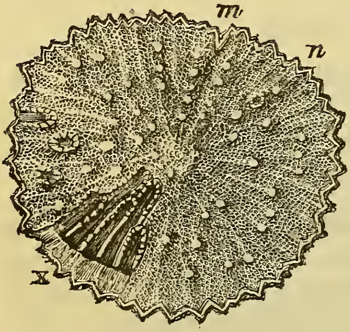


Fig. 233. Interior of lower valve, $\frac{1}{2}$. Fig. 234. Upper valve (restored).

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.

depressed. with a central umbo, and two grooves or pits cor-



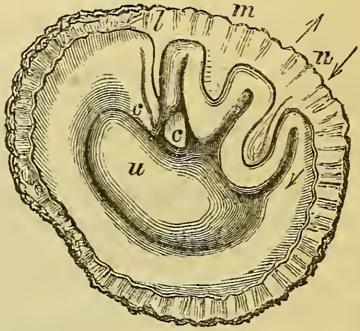


Fig. 235. *H. Toucasianus*, upper valve, $\frac{1}{2}$.† Fig. 236. Lower valve, with mould, $\frac{2}{3}$
l ligamental, m muscular, n siphonal inflections; x, fracture, showing canals; c, cartilage; u, left umbo; the arrows indicate the probable direction of the branchial currents.

responding to the posterior ridges in the lower valve; surface

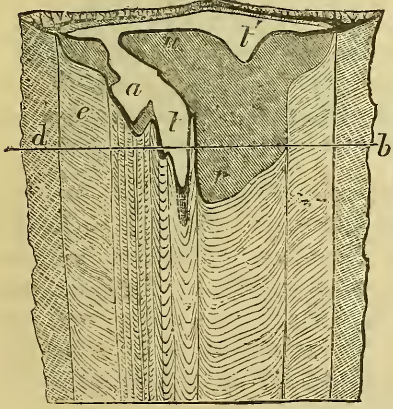
* From the original in the Brit. Mus. The inner layer of shell in this species has an irregularly cellular structure, to which its preservation is due.

† 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.

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, 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 farther removed from the side than in *H. bi-oculatus* and *radiosus* (Figs. 233, 234); 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



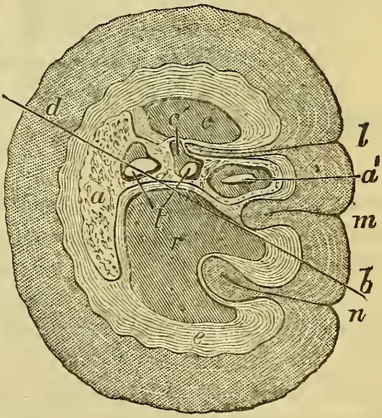
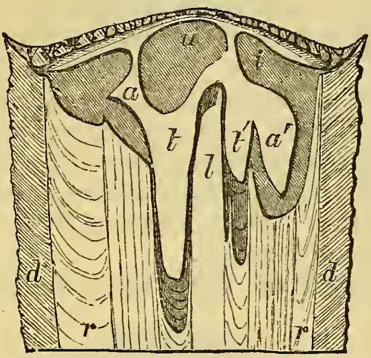


Fig. 237. Longitudinal section; upper half, ½. Fig. 238. Transverse section, ⅓.
Hippurites cornu-vaccinum, *Bronn*. Salzburg,

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. 237 is taken in the line d b of Fig. 238, cutting only the base of the posterior tooth (t'). Fig. 238 is from a larger specimen, at about the level d b of Fig. 237, cutting the point of the posterior apophysis (a'), and showing the peculiar shell-texture deposited by the anterior adductor (a).

attachment of the adductor muscles harmonises 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 of the teeth and adductors farther 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 *Chama*, the mantle-opening for that organ would have been completely obstructed by the adductor, but that the muscular support was hook-shaped (Fig. 239, *a*). The posterior adductor-process is similarly under-cut for the passage of the rectum, which in all bivalves emerges between the hinge



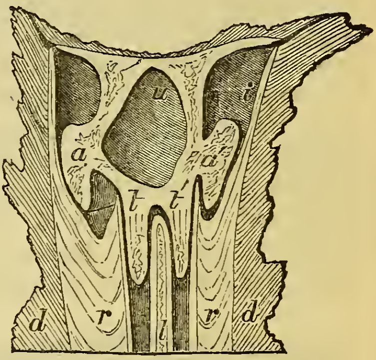


Fig. 239. *Hippurites cornu-vaccinum*. Fig. 240. *Radiolites cylindraceus*, ½. Longitudinal sections taken through the teeth (*t*, *t'*) and apophyses (*a*, *a'*).

d outer, *r* inner shell-layer; *l*, dental plate of lower valve; *u*, umbonal cavity of upper valves; *i*, intestinal channel. Originals in Brit. Mus.

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, 30 species. Chalk. Bohemia, Tyrol, France, Spain, Turkey, Syria, Algeria, Egypt.

RADIOLITES, Lamarck, 1801.

Etymology, *radius*, a ray.

Synonym, Sphærulites, De la Metherie, 1805.

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

Fig. 241. Interior of lower valve.

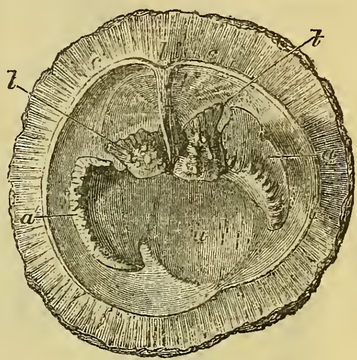
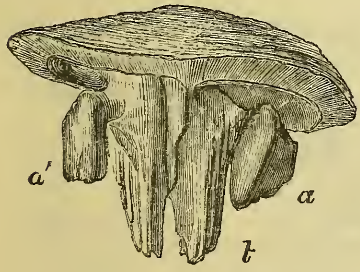


Fig. 242. Interior of upper valve.

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.

dental sockets and lateral muscular impressions; *upper valve* flat or conical, with a central umbo; outer layer thin, radiated;



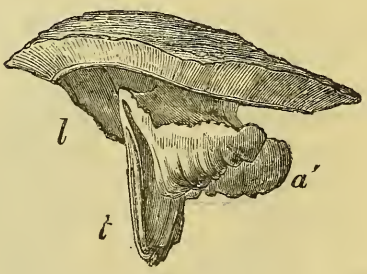


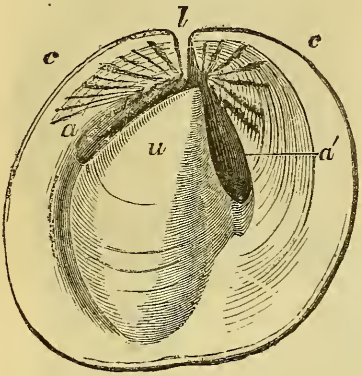
Fig. 243. Side views of the upper valve of *R. mammillaris*; *l*, ligamental inflection; *t*, teeth; *a*, *a'*, muscular processes.

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.

In aged examples of *R. calceoloides* the ligamental inflection is concealed, the cartilage pits partially filled up and smoothed,



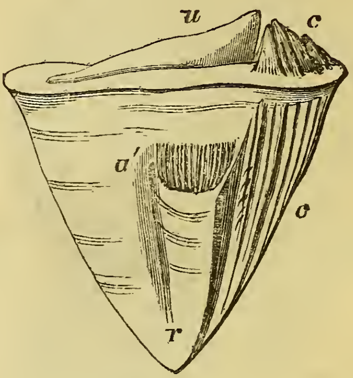


Fig. 244. Upper view. Fig. 245. Side view.

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.

and the teeth and apophyses so firmly wedged into their respective cavities, as to suggest the notion that the valves had become fixed about a quarter of an inch apart, and ceased to open and close at the will of the animal.

Fossil, 42 species. Neocomian—Chalk. Texas; Britain, France, Bohemia, Saxony, Portugal, Algeria, Egypt.

Sub-genus ? Bi-radiolites, D'Orbigny. R. canaliculatus (Fig. 225, 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 species. Chalk, France.

Caprinella, D'Orbigny.

Type, C. triangularis, Desm. (Fig. 246).

Synonym, Caprinula (Boissii), D'Orbigny.

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 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 two hinge teeth, the anterior

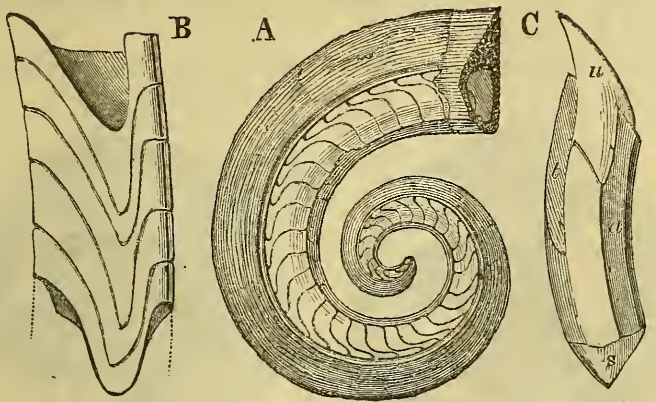
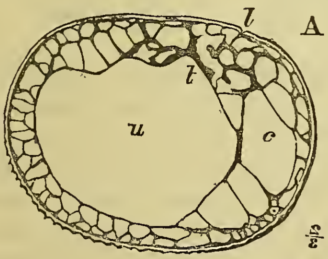


Fig. 246. *Caprinella triangularis*, Desm. U. Greensand, Rochelle, $\frac{2}{5}$. A, portion of the left valve, after D'Orbigny,* the shell-wall is removed by weathering, exposing the camerated interior. B, mould of five of the water-chambers. C, mould of the body-chamber; *u*, umbo of right valve; *s*, of left valve; *t*, dental groove; *a*, surface from which the posterior lobe has been detached. From the originals in the Brit. Mus., presented by S. P. Pratt, Esq.

supported by a plate which divides the umbonal cavity lengthwise.

In *C. triangularis* the umbonal cavity of the spiral valve is



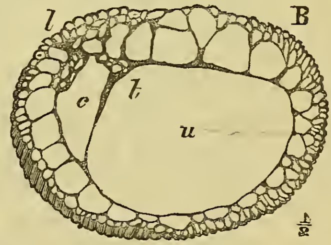


Fig. 247. Straight valve. Fig. 248. Spiral valve.
Transverse sections of *C. Boissii*, L. Chalk, Lisbon (Mr. Sharpe).
l, position of ligamental inflection; *t*, teeth; *c*, cartilage pits; *u*, umbonal cavity. Fig. 248 is from a weathered specimen, which has lost the outer layer. The tubes of the shell-wall are filled with limestone containing small shells.

partitioned off at regular intervals (Fig. 246, A); the length of the water chambers is sometimes $3\frac{1}{2}$ inches, and of the body-

* 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 Mr. Sharpe in Portugal, the umbo of the smaller valve is turned *away* with a sigmoid flexure. (Q. J. Geol. Soc. VI. pl. 18.)

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 species. Neocomian—Lower Chalk. France, Portugal, Texas.

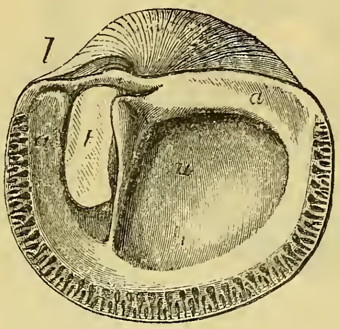


Fig. 249. *C. Aguilloni*, left valve.

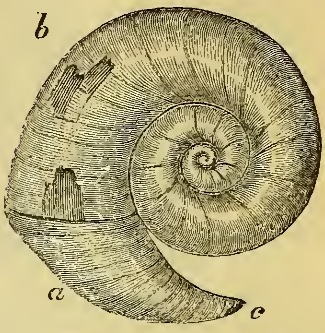


Fig. 250. *C. adversa* (after D'Orb.).

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'Orbigny.

Etymology, *caprina*, pertaining to a goat.

Synonym, Plagioptychus, Matheron.

Type, C. Aguilloni, C. D'Orbigny. Lower 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. 250) 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 the spire downwards. (Saemann.) The lower valve of *C. Coquandiana* is sub-spiral.

* These singular fossils were called *ichthyosarcolites* by Desmarest, from their resemblance to the flaky muscles of fishes.

Fossil, 10 species. Upper Greensand and Lower Chalk. Bohemia, France, Texas.

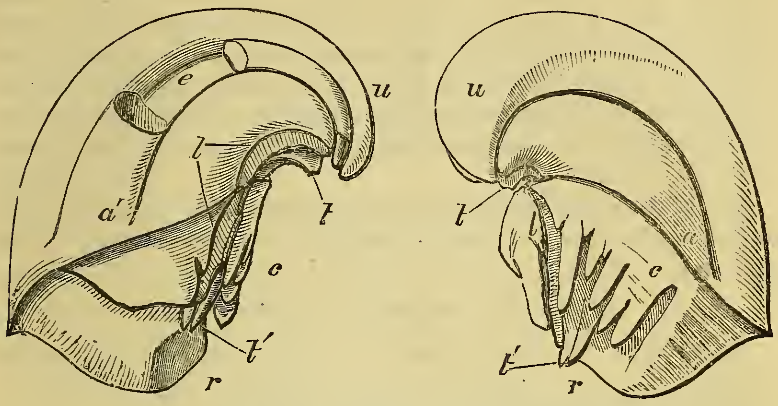


Fig. 251. Internal mould of *Caprotina quadripartita*, D'Orb., ½.
u, left umbo; *r*, right umbo; *l*, ligamental inflection; *c*, cartilage; *t*, *t'*, dental sockets *a*, *a'*, position of adductors; at *e*, a portion of the third lobe is broken away.* From a specimen collected by Mr. Pratt.

CAPROTINA, D'Orbigny.

Type, C. semistriata, Pl. XIX., Figs. 13 and 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. 251). *C. costata* is like a little Radiolite.

Fossil, 10 species. Upper Greensand, 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.

* 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. (Figs 244, 245, *c*, *c*.)

Animal attached by a byssus, or free; mantle-lobe extensively united; 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.

Etymology, *tri*, three, *dakno*, to bite; a kind of oyster. (Pliny.)

Example, T. squamosa, Pl. XVIII., Fig. 15.

Shell massive, trigonal, ornamented with radiating ribs and imbricating foliations; margins deeply indented; byssal sinus

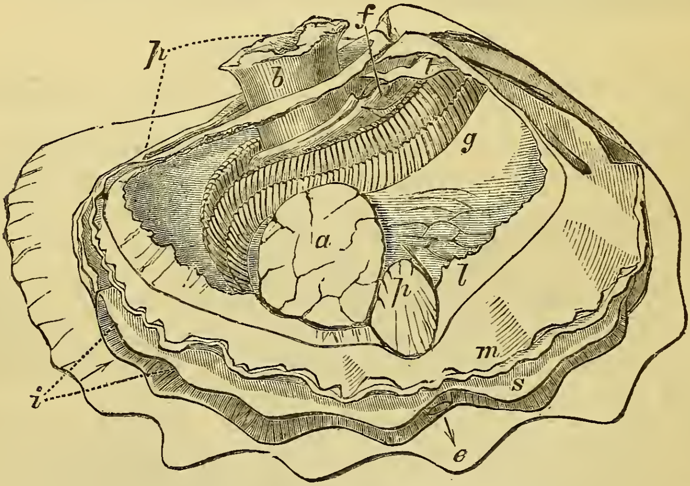


Fig. 252. *Tridacna Crocea*, Lam. (Original.)

a, the single adductor muscle; *p*, pedal muscle, and pedal opening in mantle; *f*, the small grooved foot; *b*, byssus: *t*, labial tentacles; *g*, gills; *l*, the broad pallial muscle; between *g* and *l* is the renal organ; *m*, the double mantle-margin; *s*, the siphonal border; *i*, inhalent orifice; *e*, valvular excurrent orifice. An. Nat. Hist. 1855, p. 190.

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 about 2 feet across, are used as *benitiers* in the Church of St. Sulpice, Paris. (Dillwyn.) Captain Cook states that the animal of this species sometimes weighs 20 lbs. and is good eating.*

Fig. 252 shows the animal of *Tridacna*, as seen on removing the left valve and part of the mantle within the pallial line.

Distribution, 7 species. 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 two 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 two, laterals 1.1 in each valve; ligament external, short and prominent; pallial line simple or slightly situated behind; muscular impressions sub-quadrate.

Animal with mantle open in front; siphons usually very short, cirrated externally; gills two on each side, thick, united posteriorly; palpi narrow and pointed; foot large, sickle-shaped.

CARDIUM, L. Cockle.

Etymology, *kardia*, the heart.

Synonym, 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.

Animal with the mantle-margins plaited; siphons clothed with tentacular filaments anal orifice with a tubular valve; branchial fringed; foot long, cylindrical, sickle-shaped, heeled.

The cockle (*C. edule*) frequents sandy bays, near low water; a small variety lives in the brackish waters of the river 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 Mediterranean, Black Sea, Caspian, and Aral. On the coast of Devon the large prickly cockle (*C. aculeatum*) is eaten.

* "We stayed 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.)

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.

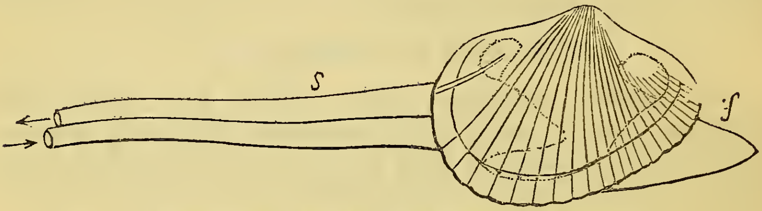


Fig. 253. *C. læviusculum*, Eichw. (after Middendorff).

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. *Distribution*, 8 species. Aral, Caspian, Azof, Black Sea, and the embouchures of the Wolga, Dniester, Dnieper, 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.

Distribution, 200 species. World-wide; from the sea-shore to 140 fathoms. Gregarious on sands and sandy mud.

Fossil, 330 species. Upper Silurian —. Patagonia — Southern 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.

Synonyms, Lychas, Stein. Pleurorhynchus, Ph. Lunulocardium, Münster.

Type, C. Hibernicum, Pl. XIX., Fig. 5. C. aliforme, Fig. 254.

Shell, equivalve trigonal, conical and gaping in front, truncated behind, with a long siphonal tube near the umbones; anterior

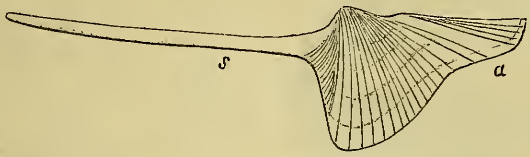


Fig. 254. *Conocardium aliforme*, Sby. Carb., Ireland. (Mus. Tennant.)

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. 253) 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 species. U. Silurian — Carb. North America, Europe.

Family XI.—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.

Fig. 255 represents the animal of a species of *Diplodonta*, from the Philippines, as seen on removing the left valve, and part of the mantle within the pallial line; *b-c*, the large pedal opening; the arrows indicate the small plain *incurrent* orifice, and the valvular *excurrent* orifice; *f*, the foot, contracted in spirit; *p p*, the large striated palpi; *l*, the liver; the outer gill has a simple margin, the inner is grooved and conducts to the mouth. This genus has higher claims than *Kellia* to be regarded as the type of a family.

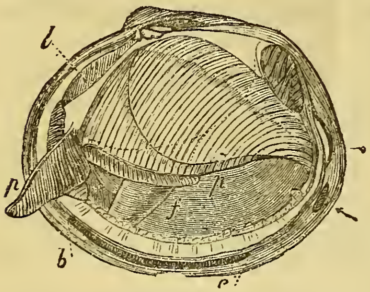


Fig. 255. *Diplodonta.*

LUCINA, Bruguière.

Etymology, *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.

Distribution, 70 species. West Indies, Norway, Black Sea, New Zealand; 120 fathoms.

Fossil, 250 species. U. Silurian —. United States — T. del Fuego; Europe — Southern India.

Sub-genera, *Cryptodon*, Turton. L. flexuosa, Pl. XIX., Fig. 7. *Synonyms*, Ptychina, Phil. Thyatira, Leach. Clausina (ferruginosa) Jeffr. *Shell* thin, edentulous; ligament quite internal, oblique. *Animal* with a long anal tube. *Distribution*, 5 species. Norway — New Zealand. *Fossil*, 2 species, Eocene —. United States, Europe.

Psathura, Deshayes. Anterior adductor scar long, narrow; hinge-teeth 2.2; umbones imperceptible.

Corbis, Cuvier.

Etymology, *corbis*, a basket.
Type, C. elegans. Pl. XIX., Fig. 8.
Synonyms, 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.
Distribution, 5 species. India, China, North Australia, Pacific.
Fossil, 80 species (including sub-genera). Lias —. United States, Europe.
In *C. dubia* (Semi-corbis) Desh., from the *Eocene*, Paris, the lateral teeth are obsolete.
Sub-genera. *Sphœra* (corrugata), Sby. *Shell* globular, concentrically furrowed and obscurely radiated; ligament prominent; margins crenulated; hinge-teeth 2.2, obscure; laterals obsolete. *Fossil*, Trias — Chalk. Europe.
Sportella, Deshayes. Like Sphæra, but with 2.1 hinge-teeth.
? *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 species? Lias — Portlandian. Europe.

? Tancredia, Lycett, 1850.

Dedicated to Sir Thomas Tancred, Bart., founder of the Cotteswold Naturalists' Club.
Example, T. extensa, L. Pl. XXI., Fig. 22.
Synonym, 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, 12 species. Lias — Bath Oolite. Britain, France.

Diplodonta, Bronn.

Etymology, *diplos*, twin, *odonta*, teetn.

Synonym, 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 two on each side, distinct, the outer oval, inner broadest in front, united behind; branchial orifice small, simple; anal larger, with a plain valve.

Distribution, 40 species. West Indies, Rio, Britain, Mediterranean, Red Sea, West Africa, India, Corea, Australia, California. D. diaphana (Felania, Recluz) burrows in sand.

Fossil, 30 species, Eocene —. United 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. *Distribution*, 2 species. Mediterranean. *Fossil*, 1 species. 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. *Distribution*, 3 species. Patagonia, Northern Europe. *Fossil*, 1 species. Tertiary, Europe.

Ungulina, Daudin.

Etymology, *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 two on each side, unequal, the external narrower, with a free dorsal border, inner widest in front.

Distribution, 4 species. Senegal, Philippines, excavating winding galleries in coral.

Kellia, Turton, 1822.

Etymology, named after Mr. O'Kelly, of Dublin.

Synonyms, 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 fathoms. *K. Laperousii* (Chironia), Desh. Pl. XIX., Fig. 11, was obtained, burrowing in sandstone, from deep water, at Monterey, California.

Distribution, 20 species. Norway—New Zealand—California.

Fossil, 20 species. Eocene—. United 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. *Distribution*, Greenland, Norway, Britain. In pools and crevices of rocks between tide-marks, and in the roots of seaweeds and corallines. Mr. Thompson obtained them from the stomachs of mullets taken on the north-east 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. *Distribution*, 8 species, New Ireland, Australia, Philippines. *Fossil*, 2 species, Eocene—, France, Java.

MONTACUTA, Turton.

Dedicated to Colonel 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 fathoms. *M. bidentata* burrows in the valves of dead oyster-shells.

Distribution, 3 species. United States, Norway, Britain, Ægean.

Fossil, 2 species. Pliocene—. Britain.

LEPTON, Turton.

Etymology, *lepton*, a minute piece of money (from *leptos*, thin).

Synonym ? Solecardia (eburnea), Conrad, Lower California.

Type, L. squamosum. Pl. XIX., Fig. 14. Fig. 256.

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.

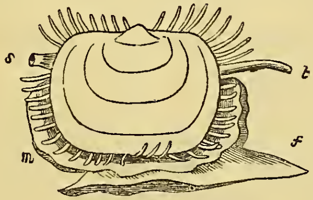


Fig. 256. *Lepton.*

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 two on each side, separate; foot (*f*) thick, tapering, heeled and grooved, forming a sole or creeping disk. (Alder.)

Sub-genus. Scintilla (Cumingi), Desh. 1856. Small shells resembling *Lepton*; minutely punctate; ligament internal, oblique; hinge-teeth 1. 2; posterior laterals 1. 2. *Distribution*, 37 species (?), Philippines, North Australia, Panama.

Distribution, 50 species. United States, Britain, Spain. Laminarian and Coralline Zones.

Fossil, 5 species. Pliocene—. United States, Britain.

Galeomma, Turton.

Synonyms, 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 one 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.)

Distribution, 14 species. Britain, Mediterranean, Mauritius, Pacific.

Fossil, 1 species. Pliocene—. Sicily.

Family XII.—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.

Etymology, *kuklas*, orbicular.

Type, C. Cornea. Pl. XIX., Fig. 17.

Synonyms, 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.

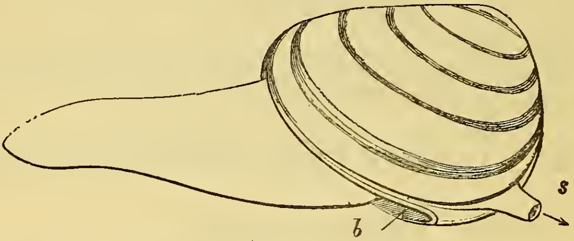


Fig. 257. *Pisidium amnicum*, $\frac{3}{1}$, with its foot protruded.

Sub-genera, *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.

Distribution, 60 species. United States, South America, Greenland, Norway, Sicily, Algeria, Cape, India, Caspian, Britain.

Fossil, 38 species. Wealden—. Europe.

CYRENA, Lamarck.

Etymology, *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.

Sub-genera, *Corbicula*, Muhlf. *C. consobrina*, Pl. XIX., Fig. 21. *Shell* orbicular, concentrically furrowed, epidermis polished; lateral teeth elongated, striated across.

Batissa, Gray. Anterior lateral teeth short; under ones long.
Velorita, Gray. Anterior laterals thick and triangular.

Distribution, 130 species. Tropical America (eastern), Egypt, India, China, Australia, Pacific Islands. 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, 105 species. Wealden—. Europe, United States.

? Cyrenoides, Joannis.

Synonym, 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.

Distribution, 4 species. River Senegal. The marine species are *Diplodontæ*.

Fossil, 1 species. Europe.

Family XIII.—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.

Etymology, *Kuprinos* (from *Kupris*), related to Venus.
Type, C. Islandica, Pl. XIX., Fig. 22.

* Associated with the bones of *Elephas meridionalis*, *Rhinoceros leptorhinus*, *Mastodon Arvernensis*, *Hippopotamus major*, &c.

Synonym, 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 second and third in *Venus* and *Cytherea;* the second tooth of the left valve is consequently obsolete.

Distribution, *C. Islandica* ranges from Greenland and the United States to the Icy Sea, Norway, and England; in 5—80 fathoms water. It occurs fossil in Sicily and Piedmont, but not alive in the Mediterranean.

Fossil, 90 species. (D'Orbigny.) Muschelkalk —. Europe.

Circe, Schumacher.

Etymology, in Greek mythology a celebrated enchantress.

Example, C. corrugata, Pl. XX., Fig. 2.

Synonym, Paphia (undulata), Lamarck.*

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 fathoms. (Forbes.)

Distribution, 40 species. Australia, India, Red Sea, Canaries, Britain.

Astarte, Sowerby, 1816.

Synonym, Crassina, Lamarck. Tridonta, Schum. Goodallia, Turton.

Example, A. sulcata, Pl. XX., Fig. 1. A. borealis, Fig. 258. (*Astarte*, the Syrian Venus.)

Shell sub-orbicular, compressed, thick, smooth or concen-

* 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.

trically 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.

The animal of *Astarte borealis* is shown in Fig. 258; mantle-margins free, plain, slightly cirrated in the branchial region; united posteriorly by the branchial septum, forming a single excurrent orifice; pedal muscles (p p'), distinct from adductors; gills flat, finely striated, destitute of internal partitions; outer

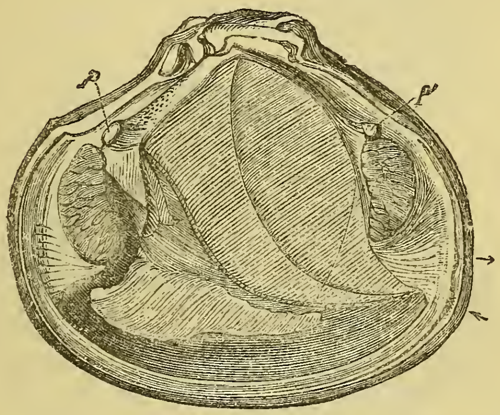


Fig. 258. *Astarte borealis*, var. semi-sulcata, Leach, $\frac{3}{2}$. Wellington Channel.

gill narrow, elliptical, with a simple margin; inner gill grooved, conducting to the mouth.

Distribution, 20 species. Behring's Straits, Wellington Channel, Kara Sea, Ochotsk, United States, Norway, Britain, Canaries, Ægean (30—112 fathoms).

Fossil, 285 species. Carb. —. North and South America, Europe, Thibet.

? *Digitaria*, Wood; Tellina digitaria, Lower Mediterranean. *Fossil*, Pliocene, Britain.

GOULDIA, C. B. Adams.

Shell minute, triangular, furrowed· hinge like *Astarte*, with lateral teeth; pallial line simple.

Distribution, 7 species. Panama, West Indies.

Crassatella, Lamarck.

Synonyms, Ptychomya, Ag. Paphia (Lamarck, part) Roissy.
Type, C. ponderosa, Pl. XXI., Fig. 4. C. pulchra, Fig. 259.
Etymology, *crassus*, thick.

Shell solid, ventricose, attenuated behind, smooth or concentrically furrowed; lunule distinct; ligament internal; margin smooth or denticulated; 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.

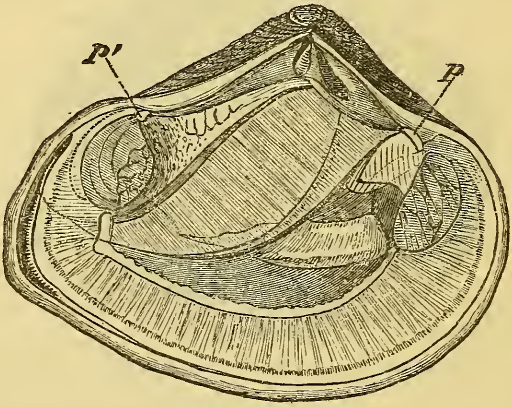


Fig. 259. *Crassatella pulchra.* Sandy Cape, J. B. Jukes.
Animal as seen on the removal of *right* valve, and portion of the mantle.

In *Crassatella pulchra* the animal is like *Astarte*; foot linguiform, slightly grooved; palpi short and broad, few-plaited; outer gill narrower in front.

Distribution, 34 species. Australia, New Zealand, Philippines, India, West Africa, Canaries, Brazil.

Fossil, 64 species. Neocomian —. Patagonia, United States, Europe.

Isocardia, Lamarck. Heart-cockle.

Etymology, *isos*, like, *cardia*, the heart.
Type, I. cor. Pl. XX., Fig. 3.

Synonyms, 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.

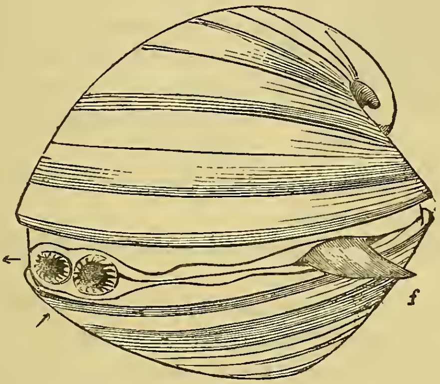


Fig. 260 *Isocardia cor.*

The heart-cockle burrows in sand, by means of its foot (*f*), leaving only the siphonal openings exposed. (Bulwer.)

Distribution, 5 species. Britain, Mediterranean, China, Japan.

Fossil, 90 species. Trias —. United States, Europe, South 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, Lamarck.

Example, C. obesa, Pl. XX., Fig. 4. C. rostrata, Fig. 261.

Synonyms, 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.

Animal of *Cypricardia rostrata*, Lamarck, Philippines (Fig. 300), with mantle-lobes united, and covered with wrinkled epidermis; siphonal orifices fringed; gills deeply plicated, anterior part of the outer gill *united to the inner;* dorsal border narrow, plaited; adductor muscles of two elements,

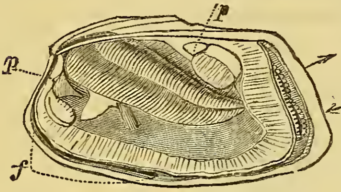


Fig. 261. *Cypricardia.*

Distribution, 13 species. Red Sea, India, and Australia. In crevices of rock and coral.

Fossil, 60 species. Lower Silurian —. North America and Europe.

? *Sub-genera. Coralliophaga*, Bl. C. coralliophaga, Lamarck. *Shell* long, cylindrical, thin, slightly gaping behind; hinge-teeth 2.2, and a laminar posterior tooth; pallial line with a wide and shallow sinus. *Distribution*, 5 species. Mediterranean, 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; South Sea.

? *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. 422), but they bear no resemblance to *Sanguinolaria.*

Goniophora, Phillips, 1848. Cypricardia cymbæformis, Sby. Upper Silurian, Britain (*Mytilidæ?*).

Pleurophorus, King, 1848.

Type, P. costatus, Brown. Permian, England. (Pal. Trans., 1850. Pl. XV., Figs. 13—20.)

Synonyms ? 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.

? *Sub-genus. Redonia*, Rouault, Bull Soc. Geol., 8, 362. *Shell* oval, tumid; hinge with cardinal and posterior teeth; anterior adductor bounded by a ridge. *Fossil*, Lower Silurian, Brittany, Portugal. (Sharpe.)

Fossil, 5 species. Lower Silurian—Trias. United States, Europe, New South Wales, Tasmania.

? CARDILIA, Deshayes.

Type, C. semisulcata, Pl. XVIII., Fig. 18.

Synonym, Hemicyclonosta, Deshayes.

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.

Distribution, 2 species. Chinese Sea, Moluccas.

Fossil, 2 species. 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 species. Upper Silurian—Devonian. United States, Europe.

Sub-genera. ? *Goldfussia* (nautiloides), Castlenau. Umbones spiral; anterior side concentrically furrowed; posterior side with two oblique ridges. *Fossil*, Silurian, United States.

Megaloma (Canadensis), Hall, 1852. Upper Silurian, Canada. Umbones very thick, hinge-teeth rugged, almost obliterated with age; posterior lateral teeth 1.1; no muscular ridges.

PACHYDOMUS (Morris), J. Sowerby.

Etymology, pachus, thick, *domos*, house.

Synonyms, Astartila, Dana. ? Cleobis (grandis), Dana. ? Pyramus (ellipticus), D. =Notomya, M'Coy.

Type, P. globosus (Megadesmus), J. Sowerby, 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 species. Devonian? New South Wales, Tasmania.

PACHYRISMA, Morris and Lycett.

Etymology, *pachus*, thick, *ereisma*, support.

Type, P. grande, Morris and Lycett. 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.

Example, 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 species. Trias—Chalk. Europe.

CARDINIA, Agassiz.

Etymology, *cardo-inis*, a hinge.

Type, C. Listeri, Pl. XIX., Fig. 23.

Synonyms, Thalassides, Berger, 1833 (no description). Sinemuria, Christol. Pachyodon, Stutch. (not Meyer nor Schum). Pronoe, Agassiz.

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, 71 species. Silurian—Inferior Oolite. Europe; along with *marine* shells.

Sub-genus? *Anthracosia*, King, 1844; Unio sub-constrictus, Sowerby. (Carbonicola, M'Coy, 1856.) Upper Silurian—Carb. 40 species. 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 species. Permian—Miocene. (D'Orb.) Europe.

Sub-genus. ? *Hippopodium* (ponderosum, Sowerby), 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.

Synonyms, Mytilicardia and Cardiocardita (ajar), Bl. Arcinella, Oken.

Type, C. calyculata, Pl. XX., Fig. 5.

Etymology, *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, Bruguière, (*Mytilicardia*, Blainville), has an anterior tooth. *C. concamerata*, Bruguière, found at the Cape, has a remarkable cup-like inflection of the ventral margin of each valve.

Sub-genus. Venericardia, Lamarck. V. ajar, Pl. XX., Fig. 6. *Shell* cordate, ventricose; hinge without lateral teeth. *Animal* locomotive, with a sickle-shaped foot like the cockles.

Distribution, 54 species. Chiefly in tropical seas, on rocky bottoms and in shallow water; the *Venericardiæ* on coarse sand and sandy mud. West Indies, United States, West Africa, Mediterranean, Red Sea, India, China, Australia, New Zealand, Pacific, West America. *C. borealis*, Conrad, inhabits the sea of Ochotsk; *C. abyssicola*, Hinds, ranges to 100 fathoms; *C. squamosa*, to 150 fathoms.

Fossil, 170 species. Trias—. United States, Patagonia Europe, Southern India.

? VERTICORDIA, Searles Wood, 1844.

Synonyms, Hippagus, Philippi, not Lea. Trigonulina, D'Orb. (*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.

Distribution, 2 species. China Sea (Adams); Mediterranean? (Forbes.)

Fossil, 2 species. Miocene—. Britain, Sicily.

Hippagus isocardioides, Lea, 1833, Eocene, Alabama, is edentulous. *Trigonulina ornata*, D'Orbigny, Jamaica, has hinge-teeth 2.2; right valve with a long posterior tooth. Epidermis of large nucleated cells, as in *Trigoniadæ*, to which family it undoubtedly belong

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.

Synonyms, Merceneria, Antigone, and Anomalocardia (flexuosa) Schum, Chione, Megerle (not Scop.). Erycina (carioides), Lamarck, 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 United States, has massive valves, ribbed like the clam-shell. The North American Indians used to make coinage (*wampum*) of the sea-worn fragments of *Venus mercenaria*, by perforating and stringing them on leather thongs.

Distribution, 176 species. World-wide. Low water—140 fathoms. *V. astartoides*, Behrings' Sea. *V. verrucosa*, Britain, Mediterranean, Senegal, Cape, Red Sea: Australia?

Fossil, 200 species. Oolites—. Patagonia, United States, 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.

Distribution, 8 species. India, Australia, West America.

Cytherea, Lam.

Etymology, *Cytherea*, from Cythera, an Ægean island.

Synonyms, Meretrix, Gray. Dione, Megerle. Cryptogramma, Mörch.

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.

Distribution, same as *Venus.* Recent 113 species.

Fossil, 80 species.

Meroe, Schum.

Etymology, Meroë, an island of the Nile.

Synonyms, Cuneus (part) Megerle (not Da Costa). Sunetta, Link.

Type, M. picta (=Venus Meroë, L. Donax, Deshayes). 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.

Distribution, 11 species. Senegal, India, Japan, Australia.

Trigona, Mühlfeldt.

Etymology, *trigonos*, three-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.

Distribution, 28 species. West Indies, Mediterranean, Senegal, Cape, India, West 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 species. Eocene—Miocene. United States, France.

Artemis, Poli.

Etymology, *Artemis*, in Greek mythology Diana.

Type, A. exoleta, Pl. XX., Fig. 12.

Synonym, 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.

Distribution, 100 species. Boreal—Tropical seas; low water 80 fathoms.

Fossil, 13 species. Carb—. United States, Europe, South India.

Sub-genera. Cyclina, Desh. V. Sinensis, Chemn. Orbicular, ventricose, margins crenulated, no lunule, sinus deep and angular. *Distribution*, 10 species, Senegal, India, China, Japan, West America. *Fossil*, 1 species. 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. Distribution*, 6 species. Australia, Philippines.

Lucinopsis, Forbes.

Synonyms, 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.)

The type of this genus having been erroneously placed in *Cyclina* by M. Deshayes, he has proposed a new genus (*Lajonkairia*) for *L. decussata*, Philippines, a fossil of the English *Pliocene*, but still living in the Mediterranean.

Distribution, 10 species. North America, Norway, Britain.

Fossil, 3 species. Pliocene. Britain, Belgium.

Tapes, Mühlfeldt.

Synonyms, Paphia, Bolten, 1798. Pullastra, G. Sby. Omalia, Ryck, 1856.

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.

Distribution, 78 species. Norway, Britain, Black Sea, Senegal, Brazil, India, China, New Zealand. Low water—100 fathoms. (Beechy.)

Fossil, 6 species. Pliocene—. Britain, 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.

Etymology, *Venus*, and *rupes*, a rock.

Synonym, *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, and with a simple fringe and tubular valve, branchial siphon doubly fringed, inner cirri branching; palpi small and pointed.

Distribution, 19 species. Britain—Crimea; Canaries, India, Tasmania, Kamtschatka, Behring's Straits—Peru. In crevices of rocks.

Fossil, Miocene—. United States, Europe.

PETRICOLA, Lamarck.

Etymology, *petra*, stone, *colo*, to inhabit.

Synonyms, 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.

Distribution, 30 species. United States, France, Red Sea, India, New Zealand, Pacific, West America (Sitka—Peru). Burrows in limestone and mud.

Fossil, 20 species. Eocene—. United States, Europe.

Glaucomya (Bronn), Gray.

Synonym, 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.

Sub-genus. Tarysiphon, Benson. Differs from Glaucomya in having the siphons united up to the end.

Distribution, 12 species. Embouchures of rivers; China, Philippines, Borneo, India.

Fossil, 2 species. Tertiary. Europe.

Family XV.—Mactridæ.

Shell equivalve, trigonal, close, or slightly gaping; ligament (cartilage) internal, sometimes external, 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 layer of elongated shell. (Carpenter.)

Mactra, L.

Etymology, *mactra*, a kneading trough.

Synonyms, 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 Isle of Arran *M. subtruncata* is collected at low water to feed pigs. (Alder.)

Distribution, 125 species. All seas, especially within the tropics;—35 fathoms.

Fossil, 30 species. Lias—. United States, Europe, India.

? *Sub-genera*. *Sowerbya*, D'Orb. Isodonta, Buv. S. crassa, Oxfordian, France. Cartilage-pit simply grooved; it receives a tooth of the opposite valve; lateral teeth very large.

Harvella, Gray.

Lateral teeth small; shell cordate; thin; truncated posteriorly, and obliquely striated; ligament external, separated from the cartilage in the inner pit by a ridge; hinge teeth small.

Sub-genus, *Mactrella*, Gray. Mactrinula, Gray. *Shell* cordate, abruptly truncated behind; lateral teeth short.

Gnathodon, Gray.

Etymology, *gnathos*, a jaw-bone, *odus*, a tooth.

Synonym, 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.

Distribution, 1 species. New Orleans. (3 other species ? Mazatlan, California; Moreton B. Australia. Petit.)

Fossil, 3 species. Chalk—. Petersburg, Virginia.

G. cuneatus was formally eaten by the Indians. At Mobile, on the Gulf of Mexico, it is found in colonies along with *Cyrena Carolinensis*, burrowing 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, Lamarck).

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.

Distribution, 18 species. United States, Brazil, Britain, Mediterranean, Senegal, Cape, India, New Zealand, Sitka.

Fossil, 25 species. Carb.—. United States, Europe.

Resembles *Mya*; burying vertically in sand or mud, especially of estuaries; low water, 12 fathoms. *L. rugosa*, found living on the coasts of Portugal and Mogador, is fossil on the coast of Sussex. (Dixon.)

Sub-genus, *Vaganella*, Gray. Mantle sinus, large, round; interior ridges, of which two diverge from the hinge to the ventral edge.

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.

Distribution, 3 species. 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.

Etymology, *Telline*, the Greek name for a kind of mussel.

Synonyms, Peronæa (*part*) Poli. Phylloda (foliacea), Omala (planata) Schumacher. Psammotea (solidula) Turt. Arcopagia (crassa) Leach. Tellinodora, Mörch.

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 other rudimental and directed dorsally.

Tellinides, Lamarck. 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, has the right valve flat; *T. lunulata*, Pliocene, South Carolina, much resembling it in shape, has the left valve flat.

Distribution, above 300 species. In all seas, especially the Indian Ocean; most abuudant and highly coloured in the tropics. Low water — Coral zone, 50 fathoms. Wellington Channel; Kara Sea; Behring's Straits; Baltic; Black Sea.

Fossil, 170 species. Oolites—. United States, South America (Chiloe), Europe.

Gastrana, Schumacher.

Synonyms, Fragilia, Desh. Diodonta, F. and H., not Schumacher.

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.

Gastrana inhabits shallow water, boring in mud and clay, and not travelling about like the *Tellens.*

Distribution, 3 species. Norway, Britain, Mediterranean, Black Sea, Senegal, Cape.

Fossil, Miocene—. Britain, France, Belgium.

Capsula, Schumacher.

Etymology, Dimin. of *capsa*, a box.

Synonyms, Capsa (part), Brug. 1791. Sanguinolaria, Lamarck, 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.

Distribution, 4 species. West Indies, Red Sea, India, China, Australia.

Fossil, 20 species. Carb. —. United States, Europe. (D'Orb.)

Quenstedtia, Morris and Lycett.

Hinge in left valve with obtuse, oblong, transverse teeth; pallial sinus small; ligament in a narrow groove; cardinal teeth 0.1.

Psammobia, Lamarck. Sunset-shell.

Etymology, *psammos*, sand, *bio*, to live.

Synonyms, Psammotea (zonalis) Lamarck. Psammocola, Bl. Gari, Schumacher.

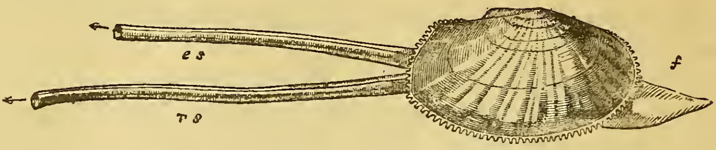


Fig. 262. *Psammobia vespertina*, Chemn, ½. Brit.

Example, P. Ferroënsis, Pl. XXI., Fig. 9. P. squamosa, Pl. XXI., Fig. 10. P. pallida, Fig. 263. P. vespertina, Fig. 262.

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.

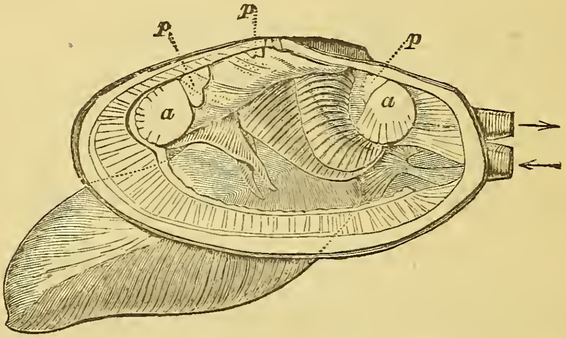


Fig. 263. *Psammobia pallida*, Desh. Red Sea. Left valve, part of the mantle, and retractor of the siphons removed. Siphons much contracted; *a*, *a*, adductors, *p*, *p*, pedal muscles.

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.

Distribution, 50 species. Norway, Britain, India, New Zealand, Pacific. Littoral — coralline zone, 100 fathoms. *P. gari* is eaten in India.

Fossil, 55 species. Oolite? Eocene—. United States, Europe.

SANGUINOLARIA, Lamarck.

Name, from the type, *Solen sanguinolentus*, Chemn.

Synonyms, Soletellina (*diphos*), Bl. Lobaria, Schumacher. Aulus, Oken.

Example, 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.

Distribution, 20 species. West Indies, Red Sea, India, Madagascar, Japan; Australia, Tasmania, Peru.

Fossil, 30 species. Eocene—. United States, Europe.

Semele, Schumacher, 1817.

Etymology, *Semele*, in Greek myth. the mother of Bacchus.

Synonym, Amphidesma, Lamarck, 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.

Distribution, 60 species. West Indies, Brazil, India, China, Australia, Peru.

Fossil, 30 species. Eocene—. United 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. *Distribution*, 10 species. In sponges, sand, and the fissures of rocks, — 7 fathoms. West Indies, India, Australia, West America. *Fossil*, Miocene—. Wilmington, North Carolina.

Syndosmya, Recluz. *Synonyms*, Abra, Leach MS. Erycina (part), Lamarck, 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

* 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 applied 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.

long, slender, diverging, anal shortest, orifices plain; foot large, tongue-shaped, pointed; palpi triangular, nearly as large as the gills; branchiæ unequal, triangular. *Distribution*, Norway, Britain, Mediterranean, Black Sea, India. The species are few, and mostly boreal, ranging from the laminarian zone to 180 fathoms. (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 species. Eocene—. Britain, France.

Scrobicularia, Schumacher. *Synonyms*, Trigonella (part), Costa (not L.), Ligula (part), Mont. "Le Lavignon" (Reaumur), Cuv. Listera, Turt. (not R. Brown). Lutricola, Bl. Mactromya, D'Orbigny (not Ag.) *Type*, S. piperata (Belon), Gmelin, Pl. XXI., Fig. 14. (See p. 60.) *Shell* oval, compressed, thin; sub-equilateral; ligament external, slight; cartilage-pit shallow, 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, five or six inches deep. (Montagu.) The siphons can be extended to five or six times the length of the shell. (Deshayes.) The animal has a peppery taste, but is sometimes eaten on the coasts of the Mediterranean.

Distribution, 20 species. Norway, Britain, Mediterranean, Senegal.

Fossil, 4 species. Tertiary. Europe.

MESODESMA, Deshayes.

Etymology, *meso*, middle, *desma*, ligament.

Synonyms, Eryx, Sw. (not Daud.). Paphia (part), Lamarck, 1799 (see p. 464, note). Erycina (part), Lamarck, 1818 (not Lamarck, 1805, nor Fabr., 1808). "Donacille," Lamarck, 1812 (not characterised)

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.

Ceronia, Gray. Lateral teeth marked with coarse oblique striæ.

? *Davila*, Gray. Laterals unequal; anterior teeth small and erect.

Distribution, 31 species. West Indies, Mediterranean, Crimea, India, New Zealand, Chili; sands at low water.

Fossil, 7 species. Neocomian—. United States, Europe. (*Donacilla*, D'Orbigny.)

Ervilia, Turton. Lentil-shell.

Etymology, *ervilia*, diminutive of *ervum*, the bitter-vetch.

Type, E. nitens, Pl. 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.

Distribution, 2 species. West Indies, Britain, Canaries, Mediterranean, Red Sea. —50 fathoms.

Donax, L. Wedge-shell.

Example, D. denticulatus, Pl. XXI., Fig. 19.

Etymology, *donax*, a sea-fish. (Pliny.)

Synonyms, Chione, Scop. Cuneus, Da Costa. Capisterium, Meuschen.* 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 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.

Distribution, 68 species. Norway, Baltic, — Black Sea, all tropical seas. In sands near low-water mark (—8 fathoms) buried an inch or two beneath the surface.

Fossil, 45 species. Carb.—. United States, Europe.

* Meuschen was a Dutch auctioneer; the names occur in his "sale catalogues." *Idiotæ imposuere nomina absurda.* Linnæus.

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. *Distribution*, 5 species. West Indies, Brazil, West Africa, Pacific, Central America. Inhabits estuaries. *I. ventricosa*, Deshayes, is rayed like *Galatea*, and has its beaks eroded.

? *Isodonta* (Deshayesii). Buv. Bull. Soc. Geol. Oolite. France, England.

GALATEA, Bruguière.

Synonyms, Egeria, Roissy. Potamophila, Sowerby. 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 two nearly equal areas by a longitudinal furrow, indicating their line of attachment.

Distribution, 6 or 7 species? Nile, and rivers of West 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.

SOLEN (Aristotle), L. Razor-fish.

Type, S. siliqua, Pl. XXII., Fig. 4.

Synonyms, 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;

Fig. 264. *Solen siliqua*, L. $\frac{1}{3}$; the valves forcibly opened, and mantle divided as far as the ventral foramen, to show the foot.

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.

Distribution, 23 species. World-wide except Arctic seas;—100 fathoms.

Fossil, 40 species. Carb.—. United 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 one or two 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.

Etymology, *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.

Distribution, 5 species. Africa, India, Nicobar.

Sub-genera. *Ceratisolen*, Forbes. (Polia, D'Orbigny. 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. *Distribution*, 1 species. Britain, Mediterranean, Senegal, Red Sea. *Fossil*, 3 species. 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 by Middendorff, is similar to *Solecurtus*. *Distribution*, India, China, Ochotsk, Oregon, Sitka, Behring's Sea, Newfoundland. *M. costata*, Say, is often obtained from the maw of the cod-fish. *Fossil*, 4 species. Upper Greensand—. Britain, France.

Pharella, Gray. *Shell* nearly cylindrical; anterior muscular impression elongated.

Solecurtus, Blainville.

Etymology, *solen* and *curtus*, short.

Synonyms, Psammosolen, Risso. Macha, Oken. Siliquaria, Schum. Tagelus, Gray.

Examples, S. strigilatus, Pl. XXII., Fig. 8. S. Caribæus, Pl. XXII., Fig. 9.

Shell elongated, rather ventricose, with sub-central beaks; margins sub-parallel; 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 the 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 three or four inches of sand its burrows may be discovered; they are vertical cylindrical cavities, $1\frac{1}{2}$ inches in diameter and 12 or more deep; the animal holds fast by the expanded end of its foot.

Distribution, 25 species. United States, Britain, Mediterranean, West Africa, Madeira.

Fossil, 30 species. Neocomian—. United States, 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. *Distribution*, 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 the 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 two on each side, elongated.

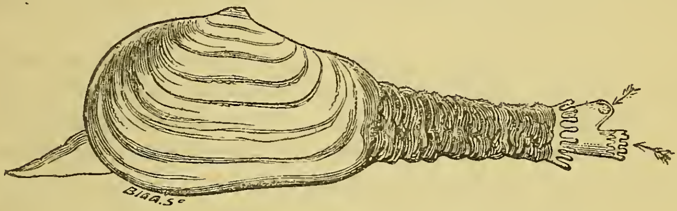


Fig. 265. *Mya truncata*, L. $\frac{1}{2}$. Brit. (after Forbes.)

MYA, L. Gaper.

Etymology, *myax* (-acis), a mussel. (Pliny.)

Synonym, Platyodon, Conrad.

Types, M. truncata, Pl. XXIII., Fig. 1. M. Arenaria, Fig. 207, p. 396.

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), West coast of Africa; posterior side extremely truncated; similar cartilage-processes in each valve. *Fossil*, Miocene; Dax, and the Morea

Distribution, 10 species. Northern Seas, West 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 fathoms. *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 North America, and are excellent articles of food. In Greenland they are sought after by the walrus, the Arctic fox, and birds. (*O. Fabricius.*)

Fossil, 17 species. Pliocene—. United States, Britain, Sicily. Most of the fossil "Myas" have an external ligament, and are related either to *Panopæa* or *Pholadomya*.

CORBULA, Bruguière.

Etymology, *corbula*, a little basket.

Type, C. sulcata, Pl. XXIII., Fig. 2.

Synonyms, 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.

Distribution, 66 species. United States, Norway, Britain, Mediterranean, West Africa, China. Inhabits sandy bottoms; lower laminarian zone—80 fathoms.

Fossil, 120 species. Inferior Oolite—. United 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., Britain.

Sub-genera, *Potamomya*, J. Sowerby. P. gregaria, Eocene, Isle of 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'Orbigny), Pl. XXIII., Fig. 3, lives buried in the mud of the River Plata, but not above Buenos Ayres, and consequently in water which is very little influenced by the superficial ebb of the river. The same species is found in banks widely dispersed over the Pampas near San Pedro, and many places in the Argentine Republic, five yards above the river 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. *Distribution*, 2 species. Britain, France. Burrowing in oyster-shells and limestone, in 10—25 fathoms. *Fossil*, 20 species. Tertiary. Europe.

NEÆRA, Gray.

Etymology, *Neæra*, a Roman lady's name.

Type, N. cuspidata, Pl. XXIII., Fig. 5.

Synonym, 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 movable 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.

Distribution, 22 species. Norway, Britain, Mediterranean, Canaries, Madeira, China, Moluccas, New Guinea, Chili. From 12—200 fathoms.

Fossil, 14 species. Oolite—. Britain, Belgium, Italy.

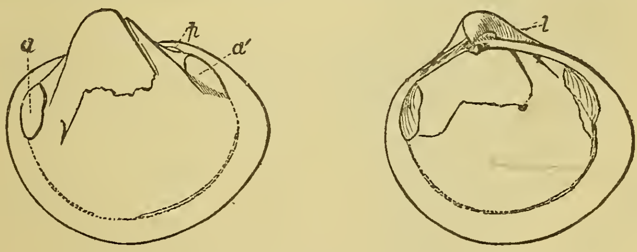


Fig. 266. *Thetis, minor*, Sby. Neocomian, I. Wight.

THETIS, Sowerby.

Etymology, *Thetis*, in Greek mythology, a sea-nymph.

Synonyms, Poromya (anatinoides), Forbes. Embla (Korenii), Lovén? Inoceramus (impressus), D'Orb? Corbula (gigantea), Sby.

Type, T. minor, Fig. 266. 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.)

Distribution, 5 species. Norway, Britain, Mediterranean, Madeira, Borneo, China. 40—150 fathoms.

Fossil, 17 species. Neocomian—. Britain, Belgium, France, South 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.

Etymology, *Panopè*, a Nereïd.

Example, P. Americana, Pl. XXII., Fig. 12.

Synonym? Pachymya (gigas), Sby. Upper Greensand. Britain, France.

Type, P. glycimeris. Fig. 267.

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 than the inner, 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 North Britain; it was formerly an inhabitant of the Mediterranean, where it now occurs fossil. (= *P. Bivonæ*, Philippi.) The British specimens have been caught, accidentally, by the deep-water fishing-hooks. *P. Natalensis* 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 Mediterranean species *P. glycimeris* attains a length of 6 or 8 inches.

Fig. 267 represents the animal of *Panopœa glycimeris*, as seen on the removal of the left valve and thin part of the mantle. It was obtained on the coast of Sicily, and presented to the Gloucester Museum by Captain Guise.

Mantle and siphons covered with thick, dark, wrinkled epidermis; siphons united, thick, contractile; pedal orifice small, in the middle of the anterior gape; foot small (f), body oval (b), with a prominent heel; pallial muscle (m) continuous; with a deep siphonal inflection (s); lips broad and plain, palpi triangular, deeply plaited (t); gills unequal (much contracted in spirit), reaching the commencement of the siphons; inner gills prolonged between the palpi, plaits in pairs, each lamina being composed of vascular loops arranged side by side; margin grooved, dorsal border of inner lamina unattached; outer gills shorter and narrower, formed of a single series of branchial loops placed one behind the other, dorsal border wide and fixed.

Distribution, 11 species. Northern Seas, Mediterranean, Cape, Australia, New Zealand, Patagonia. Low water — 90 fathoms.

Fossil, 140 species. Inferior Oolite—. United States, Europe, India.

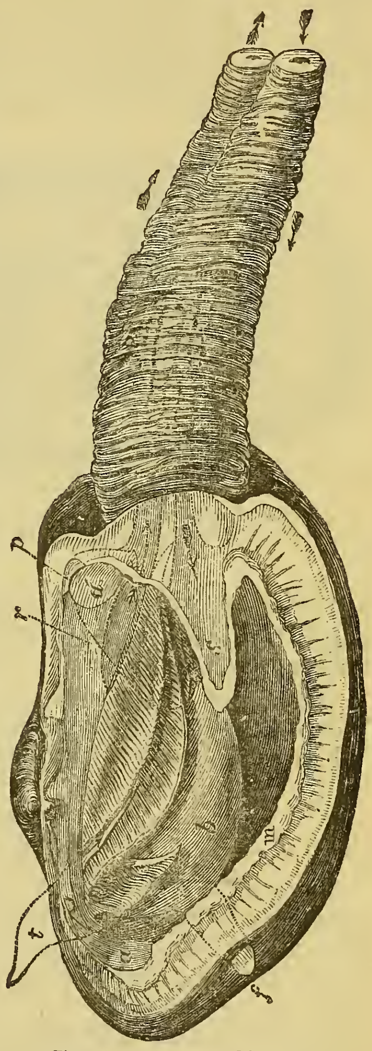


Fig. 267. *Panopœa Glycimeris*
$\frac{2}{7}$ The size of the original.
a, a', adductor muscles; p, posterior pedal muscle; r, renal organ.

Glycimeris, Lamarck.

Etymology, *glukus*, sweet, *meris*, bitter.
Type, G. siliqua, Pl. XXII., Fig. 14 and Fig. 268.
Synonym, 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;

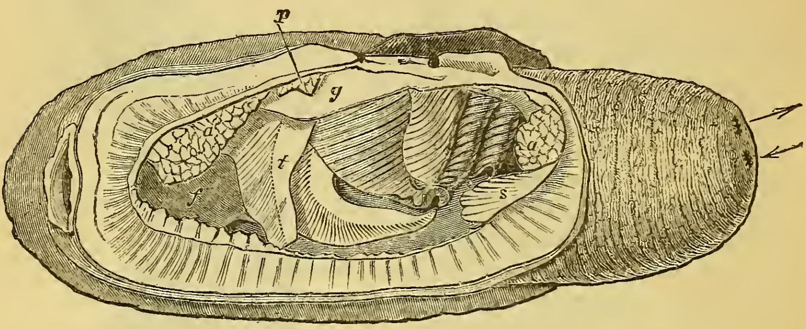


Fig. 268. *Glycimeris siliqua*, Chemn. Newfoundland.
a, *a*, adductor muscle; *p*, pedal muscle; *s*, siphonal muscle; *f*, foot; *t*, labial tentacles; *g*, gills, much contracted and crumpled.

pedal opening small anterior; foot conical; palpi large, striated inside, the posterior border plain; gills large, extending into the branchial siphon.

Distribution, 2 species. Arctic Seas, Cape Parry, North Western America, Newfoundland.

Fossil, Pliocene—. Britain, 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; has no ossicle. The external surface of these shells is often rough with large calcareous 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.)

Synonyms, Laternula, Bolten MS. Auriscalpium, Muhlf. Osteodesma, Blainville. Cyathodonta (undulata), Conrad ? West 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.

Distribution, 20 species. India, Philippines, New Zealand, West America.

Fossil, 50 species. Devonian ?—Oolite—. United States, Europe.

Sub-genera. *Periploma* (inequivalvis), Schum. "Spoon-hinge" of Petiver; oval, inequivalve, left valve deepest; posterior side very short and contracted. *Distribution*, West Indies, South 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, ossicle minute; 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.) *Distribution*, 2 species. United States, Britain, Mediterranean. *Fossil*, Pliocene, Sicily.

Cercomya, Agassiz. C. undulata, Sowerby. (=Rhynchomya, Agassiz.) *Shell* very thin, elongated, compressed, attenuated posteriorly; sides concentrically furrowed, umbones fissured, posterior (cardinal) area more or less defined. *Fossil*, 12 species. Oolite—Neocomian. Europe.

THRACIA (Leach), Blainville.

Synonyms, Odoncinetus, Costa. Corimya, Agassiz. Rupiccla (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.

Distribution, 17 species. Greenland, United States, Norway, Britain, Mediterranean, Canaries, China, Sooloo; 4—110 fathoms.

Fossil, 36 species. (Trias?) Lower Oolite—. United 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.)

Distribution, 1 species. Tropical Africa.

Fossil, 160 species. Lias—. United States, Europe, Algeria, Thibet.

Homomya (hortulana), Agassiz. *Shell* thick, concentrically furrowed, without radiating ribs; 12 species. Oolites, Europe.

Tyleria, Adams. Cartilage inserted in a spoon-shaped hollow; interior of shell with a layer of carbonate of lime between the spoon-shaped hollow and the anterior edge.

MYACITES (Schlotheim), Bronn.

Synonyms, Myopsis (Jurassi), Agassiz. Pleuromya, Agassiz. Arcomya (Helvetica), Agassiz. Mactromya (mactroides), Ag. Anoplomya (lutraria), Krauss.

Example, M. sulcatus, Fleming. (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 species. Lower Silurian—Lower Chalk. United States, Europe, South Africa.

Sub-genera ? Goniomya, Agassiz. Mya literata, Pl. XXII., Fig. 16. (Lysianassa, Münster, not M. Edwards.) *Shell* equivalve, thin, granulated; ligament external, short, prominent. *Fossil*, 33 species. Upper Lias—Chalk. Europe.

Tellinomya (nasuta), Hall; Silurian, United States, Europe. Not characterised.

? *Grammysia*, Verneuil. Nucula cingulata, His. Upper Silurian, Europe. Valves with a strong transverse fold extending from the umbones to the middle of the ventral margin.

? *Sedgwickia* (corrugata), M'Coy. = ? Leptodonus (senilis), M'Coy. *Shell* thin, ventricose, concentrically furrowed in front; escutcheon long and flat. Silurian—Carb. Europe.

Ribeiria, Sharpe, 1853.

Shell gaping at both ends; sub-ovate, rounded in front, elongated and rather attenuated behind; punctate-striate; casts of interior with a large umbonal impression (caused by a cartilage-plate, as in *Lyonsia ?*) and a notch in front of it.

Fossil. Lower Silurian. Portugal.

Ceromya, Agassiz.

Etymology, *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 species. Inferior Oolite—. Greensand? Europe.

Sub-genus ? Gresslya (sulcosa) Ag. (Amphidesma and Unio, species, Philippi). *Shell* oval, rather compressed; umbones anterior, incurved, not prominent; valves thin, close, smooth or concentrically furrowed; pallial sinus deep. *Fossil*, 50 species. 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), Sowerby (not Koninck). Carbonate of 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 species. Lower Silurian—Carb. North America, Europe.

EDMONDIA, KONINCK.

Example, E. sulcata, Ph. (T. Pal. Soc. 1850, Pl. XX., Fig. 5.) Carb. Britain.

Synonyms, 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? or the plate may be equivalent to the sub-umbonal blade in *Pholas;* pallial line simple?

Fossil, 4 species. Carb.—Permian. Europe.

Sub-genus. *Scaldia*, Ryckholt, 1856. Carb. Tournay. Shell like *Edmondia*, with a single cardinal tooth in each valve.

LYONSIA, Turton, 1822 (not R. Brown).

Synonyms, 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.

Distribution, 12 species. Greenland, North Sea, Norway, West Indies, Madeira, India, Borneo, Philippines, Peru.

L. Norvegica ranges from Norway to the sea of Ochotsk; in 15—80 fathoms.

Fossil? Miocene—. Europe. (100 species. Lower Silurian—. D'Orbigny.)

? *Entodesma* (Chilensis), Phil. *Shell* thin, saxicava-shaped, slightly inequivalve and gaping, covered with thick epidermis; hinge edentulous; each valve with a semicircular process containing the cartilage.

PANDORA (Solander), Bruguière.

Type, P. rostrata, Pl, XXII., 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. 217). (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.

Distribution, 18 species. United States, Spitzbergen, Jersey, Canaries, India, New Zealand, Panama; 4—110 fathoms, burrowing in sand and mud.

Fossil, 14 species. Carb.—. United States, Britain.

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 two tooth-like ridges in the left valve, with a free sickle-shaped ossicle; pallial line sinuated; structure like *Anatina;* outer cells large, rather prismatic.

Distribution, 10 species. New Zealand, New South 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 two tooth-like projections in each valve, and furnished with a movable 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 four, two at the base of the gills and two below the dorsal laminæ. (Hancock, An. Nat. Hist., 1853.)

Distribution, 5 species. New South Wales; attached to *Crassatella* and *Trigonia*, in 8 fathoms water; the fry (as indicated by the umbones) is free, regular, and Myadora-shaped.

Chamostrea, Roissy.

Type, C. albida, Pl. XXIII., Fig. 14.

Synonym, 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.)

Distribution, 1 species. 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 root; 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 $\frac{1}{2}$ 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.

Distribution, 10 species. West Indies, Britain, Canaries, Mediterranean, Red Sea, India, Mauritius, Pacific Islands, Gallapagos, Panama;—30 fathoms.

Fossil, 20 species. Inf. Oolite—. United 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. *Distribution*, 3 species. Madagascar, India, Philippines, Australia; burrowing in sand or mud. *Fossil*, Inf. Oolite—. United States, Europe, Southern India.

SAXICAVA, Bellevue.

Etymology, *saxum*, stone, *cavo*, to excavate. S. rugosa, Pl. XXII., Fig. 13.

Synonyms, 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 Break-water 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 Mediterranean, at the Canaries, and the Cape. It occurs fossil in the Miocene tertiary of Europe and in the United States, and in all the glacial deposits.

Clavagella, Lamarck.

Example, 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, *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.

Distribution, 6 species. Mediterranean, Australia, Pacific:—11 fathoms.

Fossil, 14 species. U. Greensand—. Britain, Sicily, Southern India.

Aspergillum, Lam. Watering-pot shell.

Type, A. vaginiferum, Pl. XXIII., Fig. 18.

Synonym, 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.

Distribution, 21 species. Red Sea, Java, Australia, New Zealand; in sand.

Fossil, 1 species. (A? Leognanum, Hœning. Miocene, Bordeaux.)

Humphreyia, Gray.

Shell developed in the substance of the siphons, which grow with the ventral side uppermost.

Distribution, 1 species. South Sea.

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. 394);* 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 has frequently a calcareous 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.

Etymology, *pholas*, a burrowing shell-fish, from *pholeo*, to bore.

Synonyms, Dactylina, Gray. Barnea, Risso.

Type, P. dactylus, Fig. 269.

Example, 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.

* 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.

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. 22) lodged in it, is large and curious. *P. costata* is sold in the market of Havannah, where it is an article of food.

P. dactylus has two accessory valves to protect the umbonal muscle, with a small transverse plate behind; a long unsym-

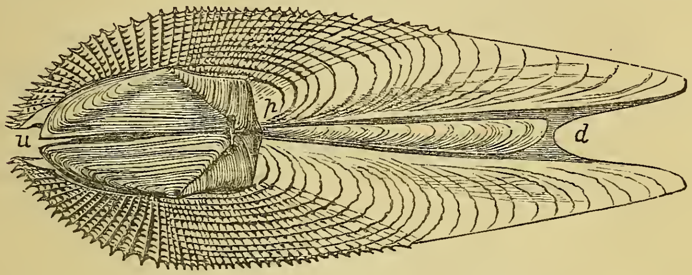


Fig. 269. *Pholas dactylus*. Chalk, Sussex Coast.
u, umbonal valves; *p*, post-umbonal valve; *d*, dorsal valve.

metrical 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

Distribution, 32 species. United States, Norway, Britain, Western Africa, Mediterranean, Crimea, India, Australia, New Zealand, Western America :—25 fathoms.

Fossil, 25 species. (U. Lias—) Eocene—. United 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.

Distribution, 7 species. Britain, New Zealand, Ecuador. Low tides—10 fathoms.

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. 11 species. West 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 twelve 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. *Distribution*, 4 species. Philippines, Western America. *Fossil*, Miocene —. France.

Parapholas, Conrad, P. bisulcata, Pl. XXIII., Fig. 22. Valves with 2 radiating furrows. *Distribution*, 4 species. Panama, Torres Straits.

XYLOPHAGA, Turton.

Etymology, *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.

Distribution, 2 species. Norway, Britain, South 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.

Synonyms, Septaria, Lamarck. Hyperotis, Guettard.

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.

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 $2\frac{1}{2}$ feet; it destroys soft wood rapidly, and teak and oak do not escape; it

Fig. 270. Ship-worm, *Teredo Norvegica*, removed from its burrow.

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, Lamarck, 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, Lamarck) 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. nana* are divided longitudinally and also concamerated by numerous, incomplete transverse partitions at the posterior extremity.

T. palmulata (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 Greensand of Blackdown.

Distribution, 21 species. Norway, Britain, Black Sea; Tropics:—119 fathoms.

Fossil, 24 species. Lias—. United States, Europe.

Sub-genus. *Teredina*, Lamarck. T. personata, Pl. XXIII., Figs. 24, 25. Eocene, Britain, France. *Valves* with an accessory plate in front of the umbones; free when young. 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. 25 a.).

* The operations of the *Teredo* suggested to Mr. Brunel his method of tunnelling the Thames.

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The synonyms are printed in *italics*, and the pages where the genera are described are indicated by an asterisk (*).

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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 Charles Lyell, Mr. Sylvanus Hanley, Prof. James Tennant, and Mr. Lovell Reeve.

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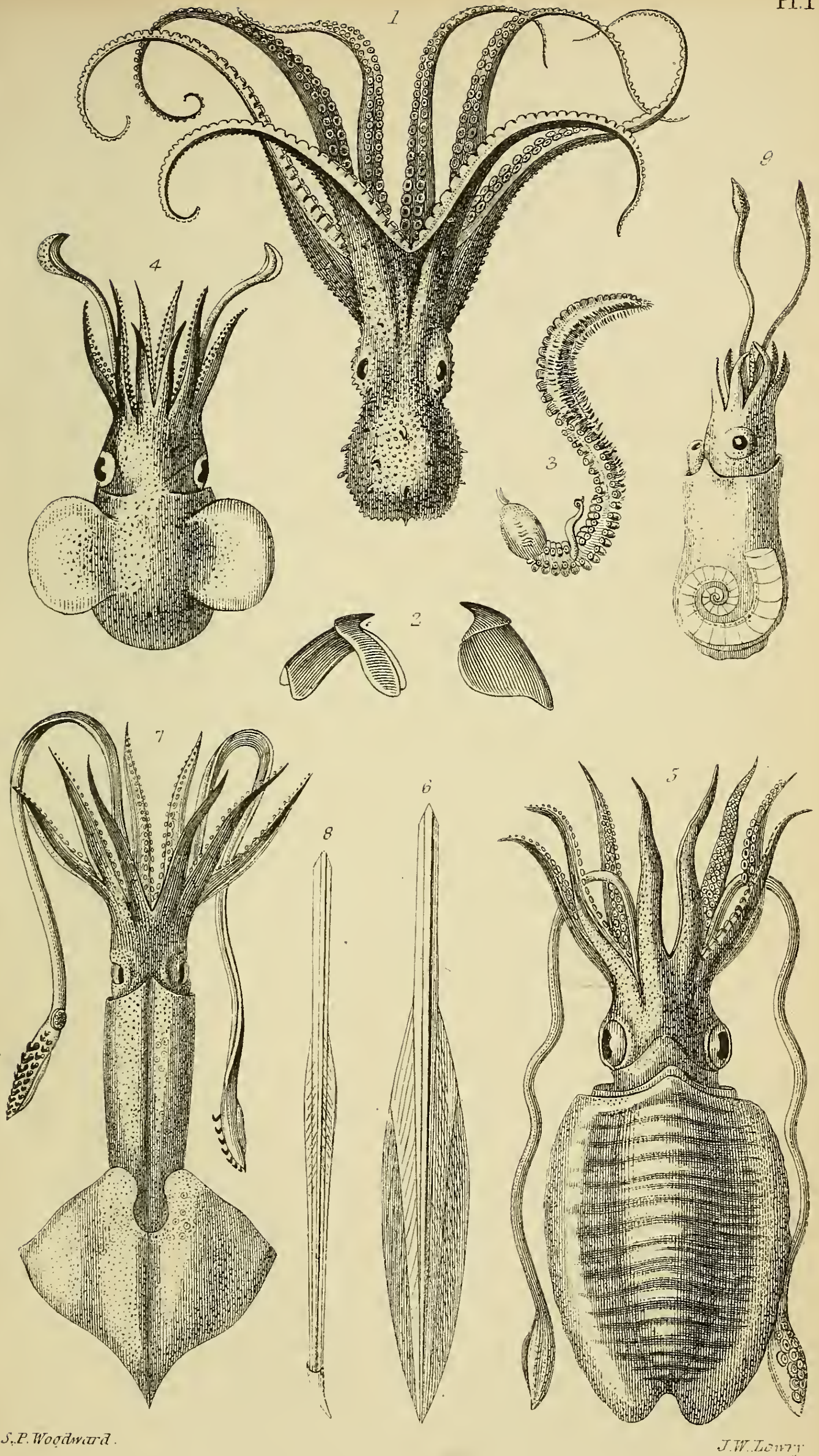

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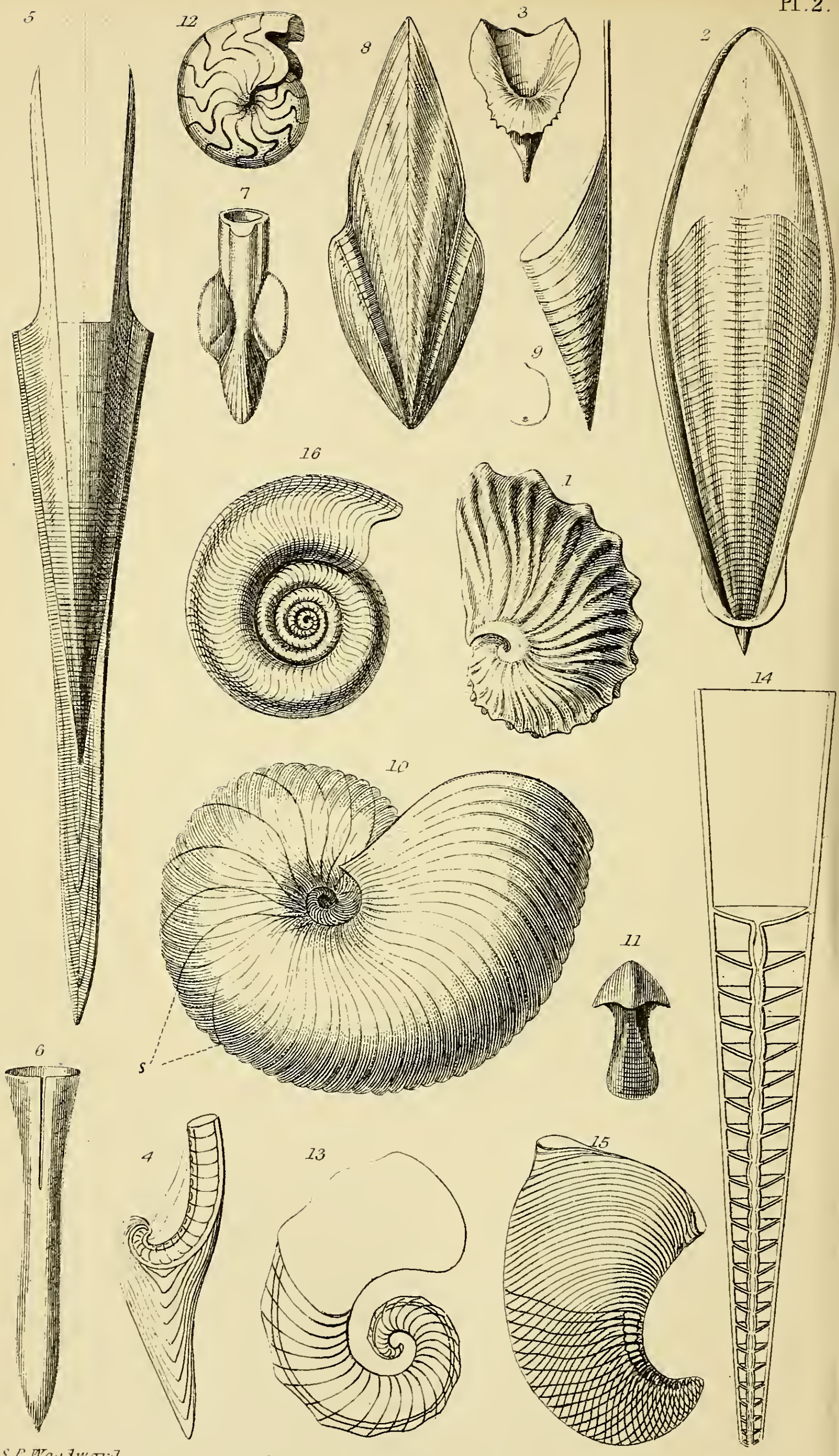

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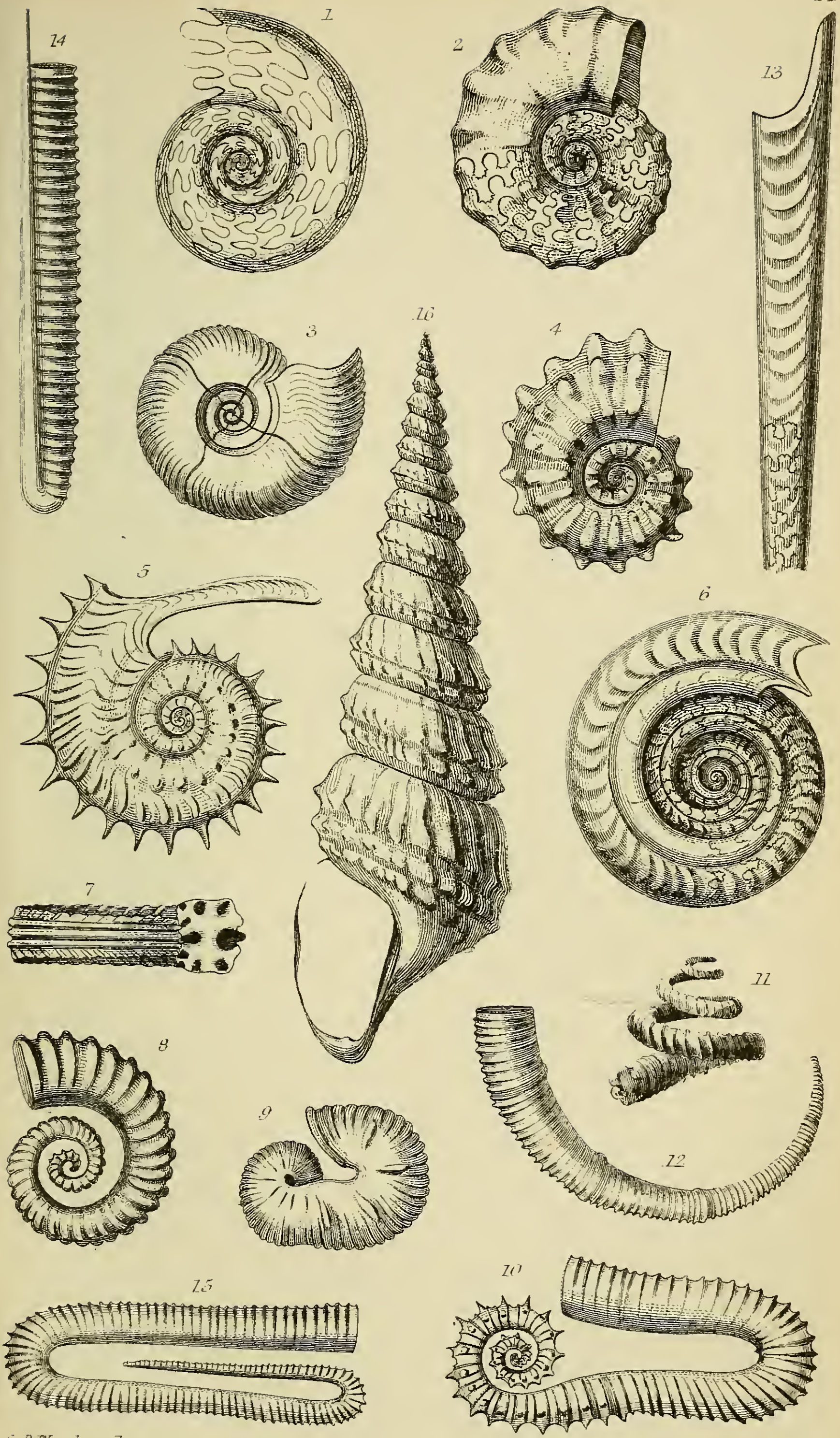

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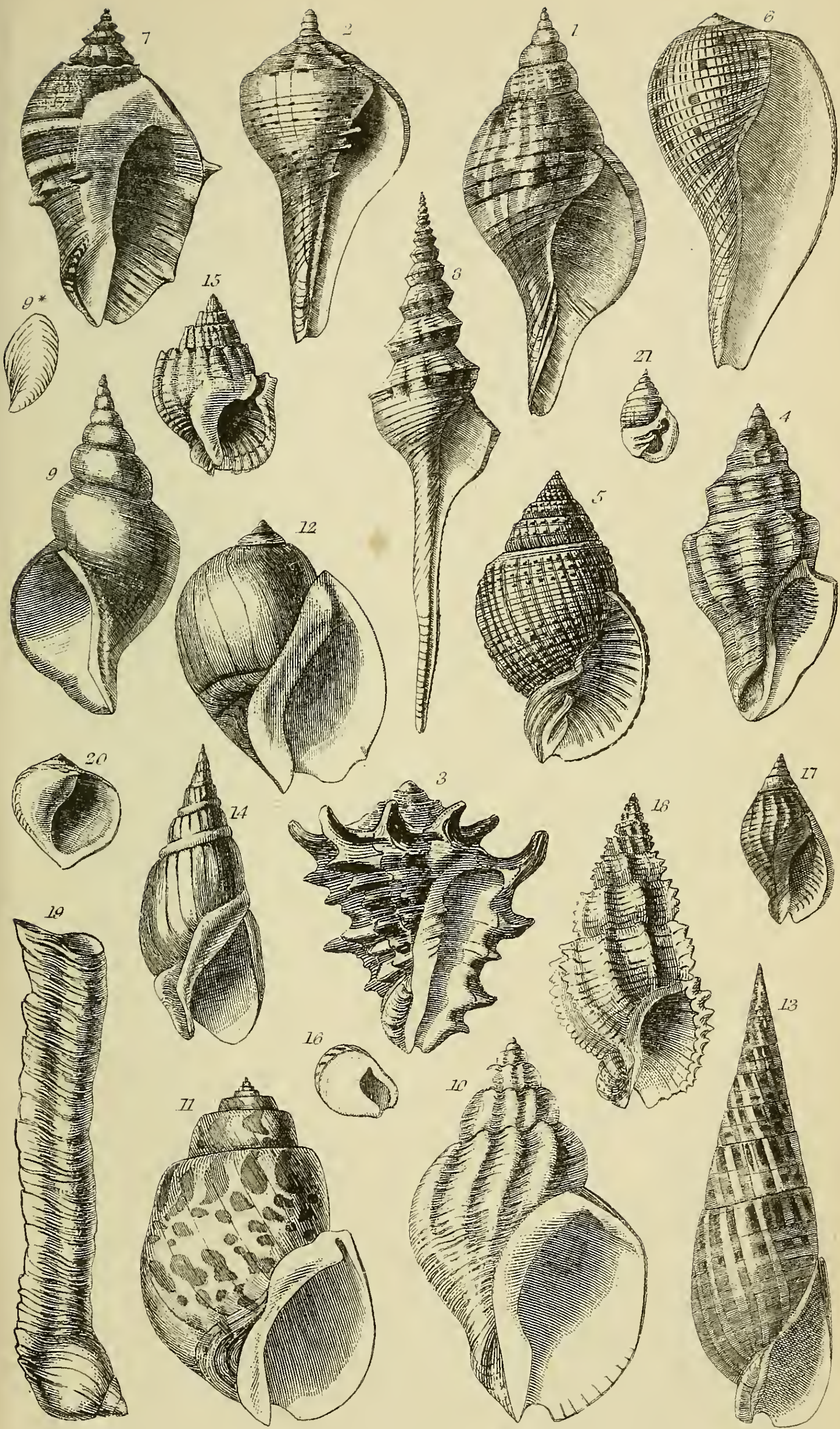

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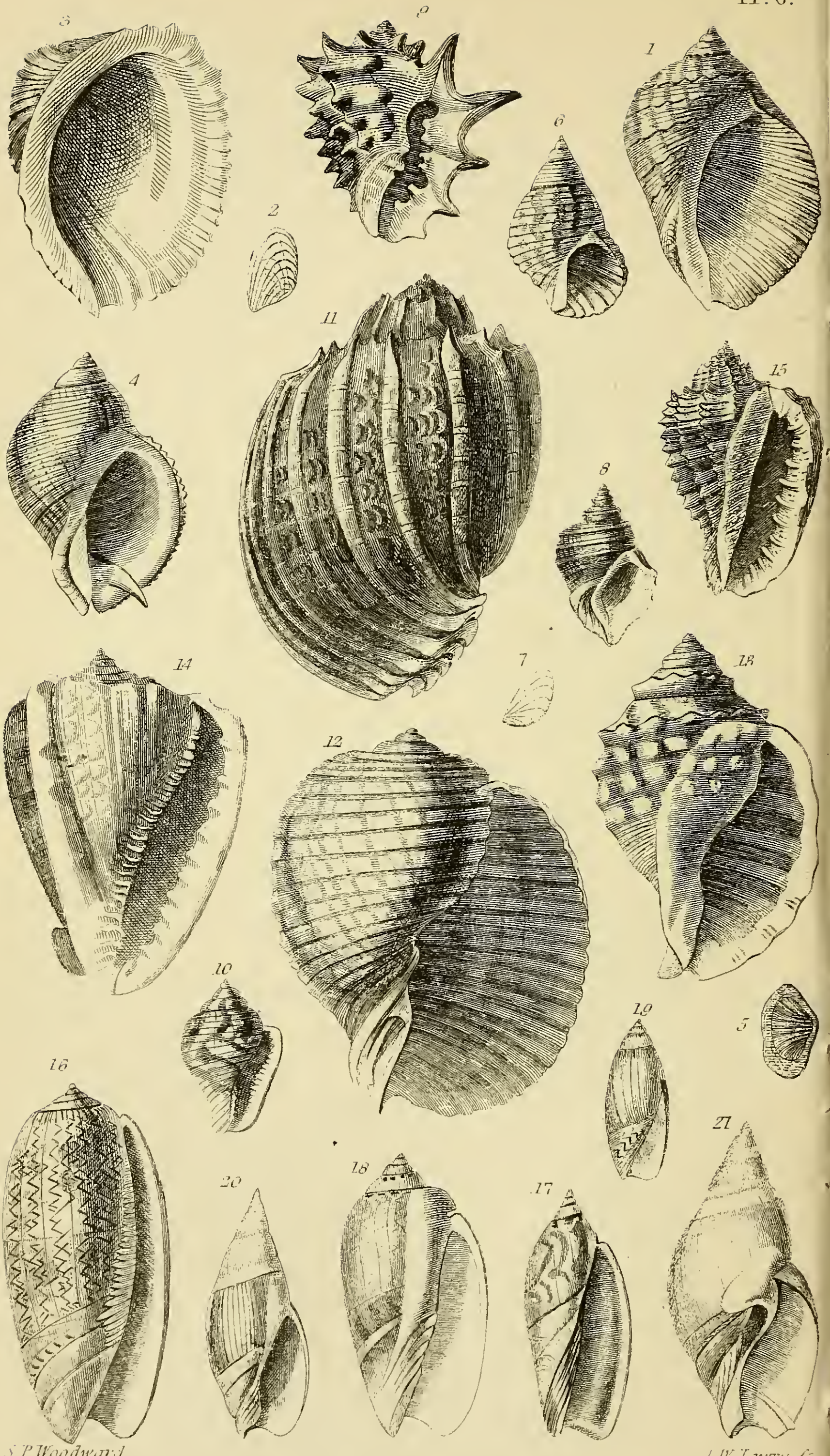

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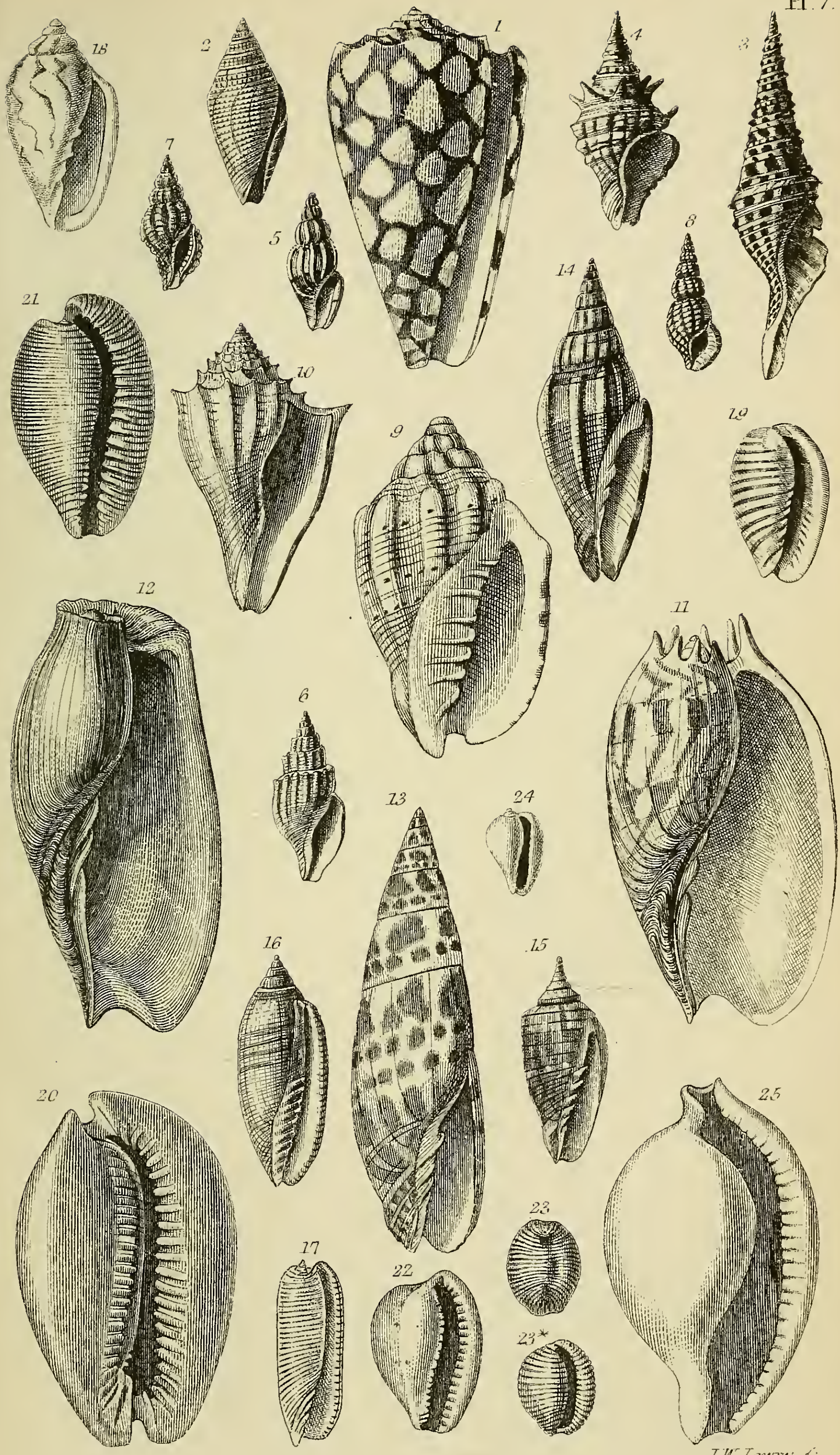

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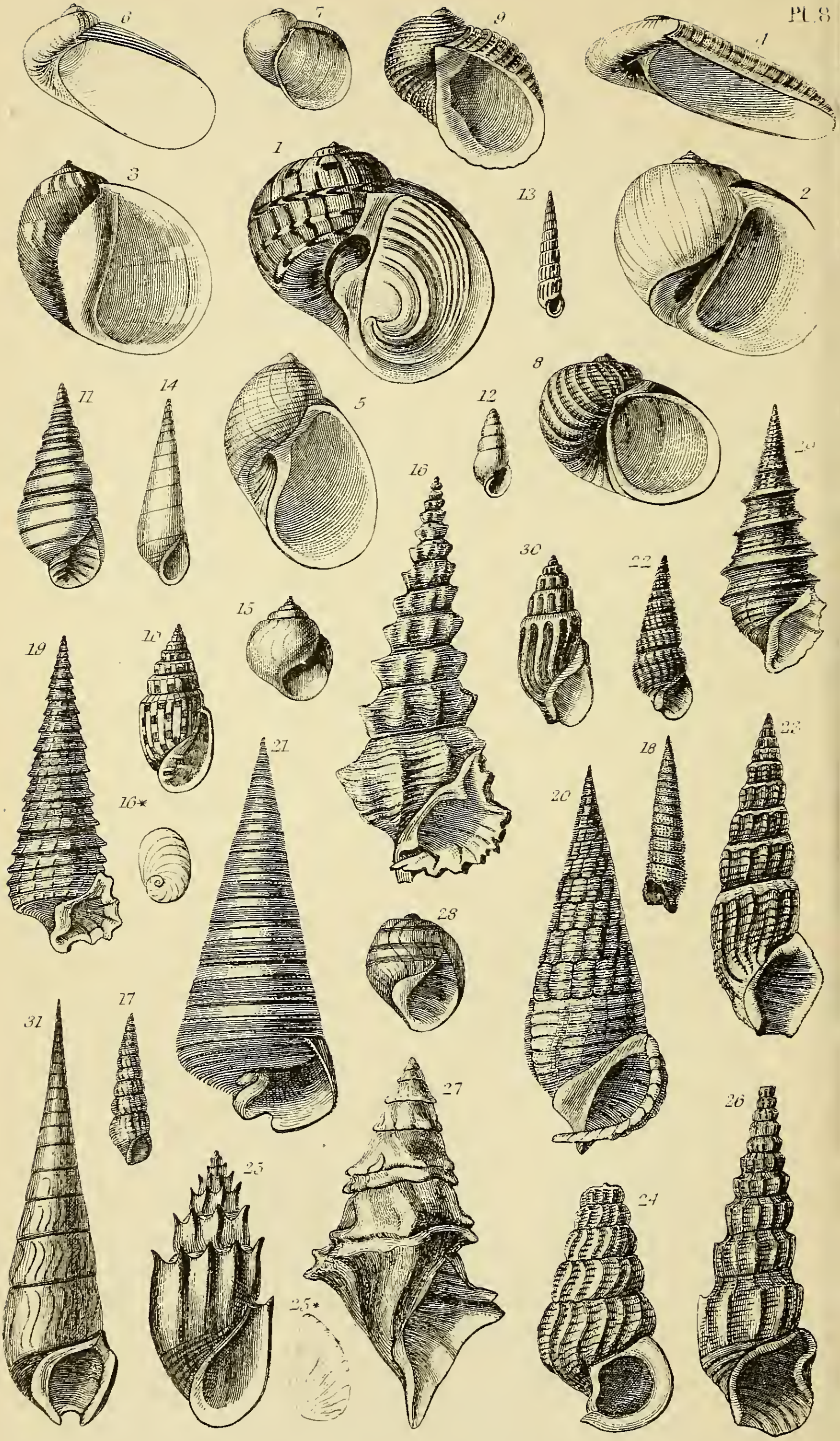

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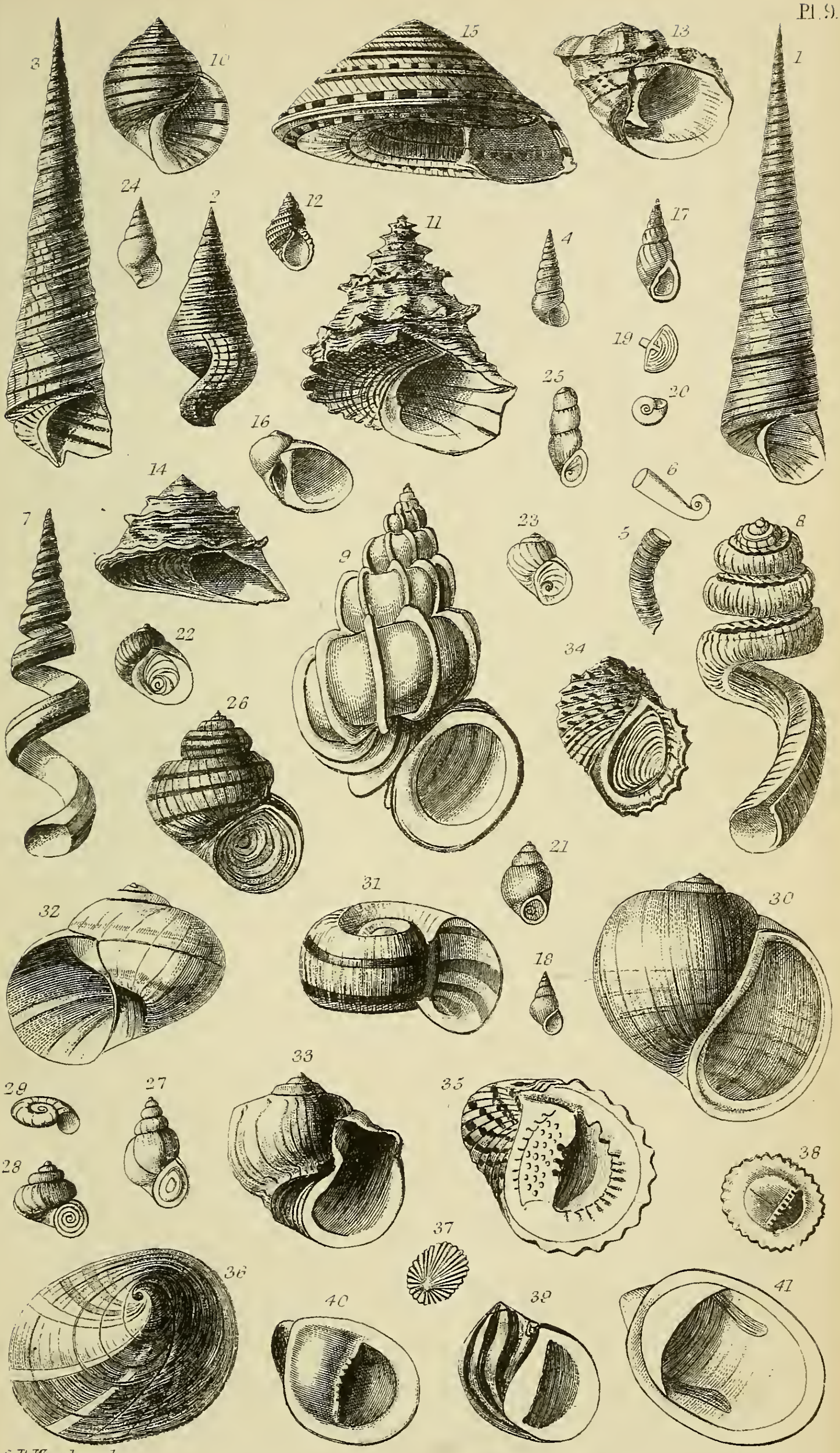

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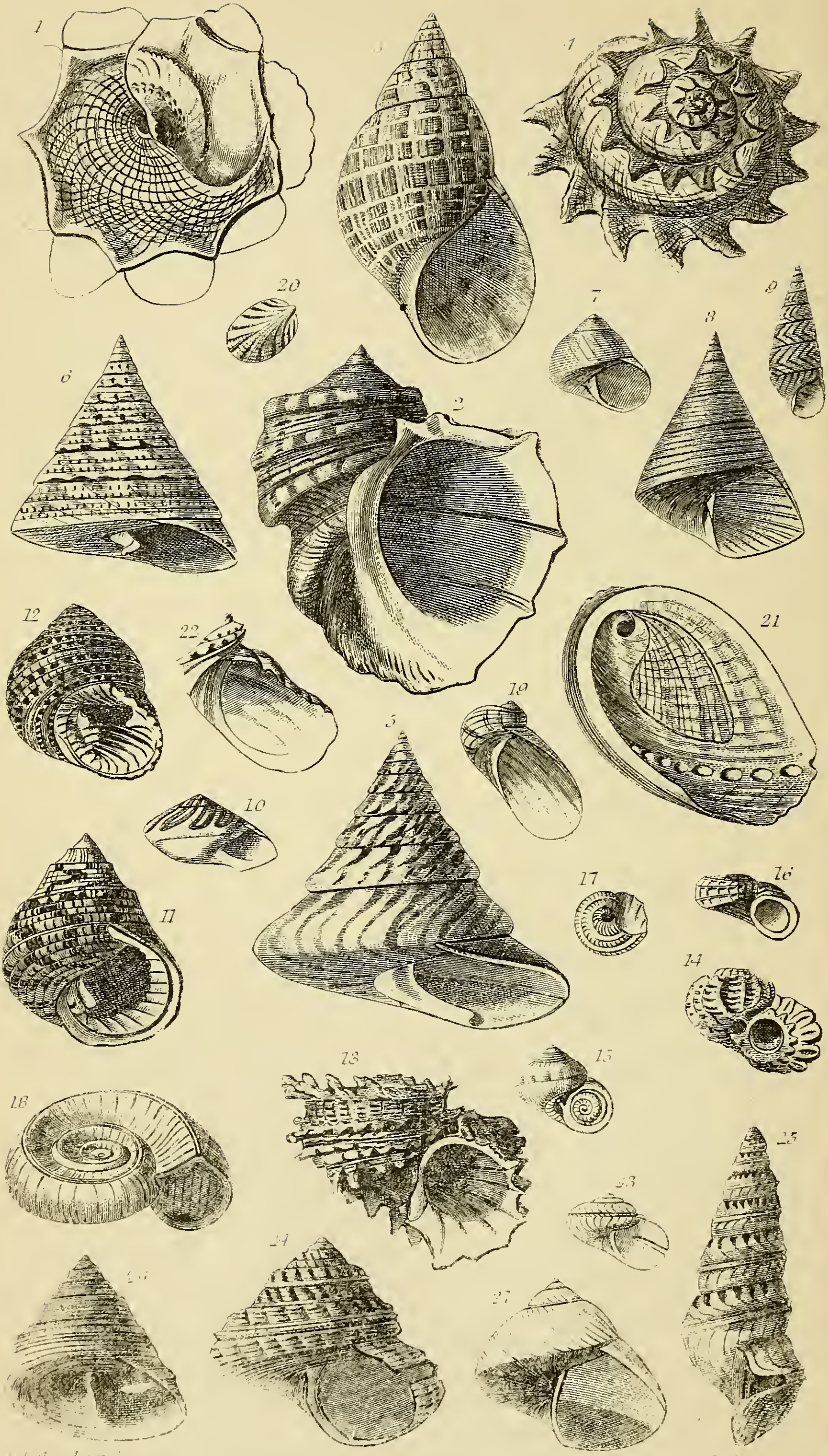

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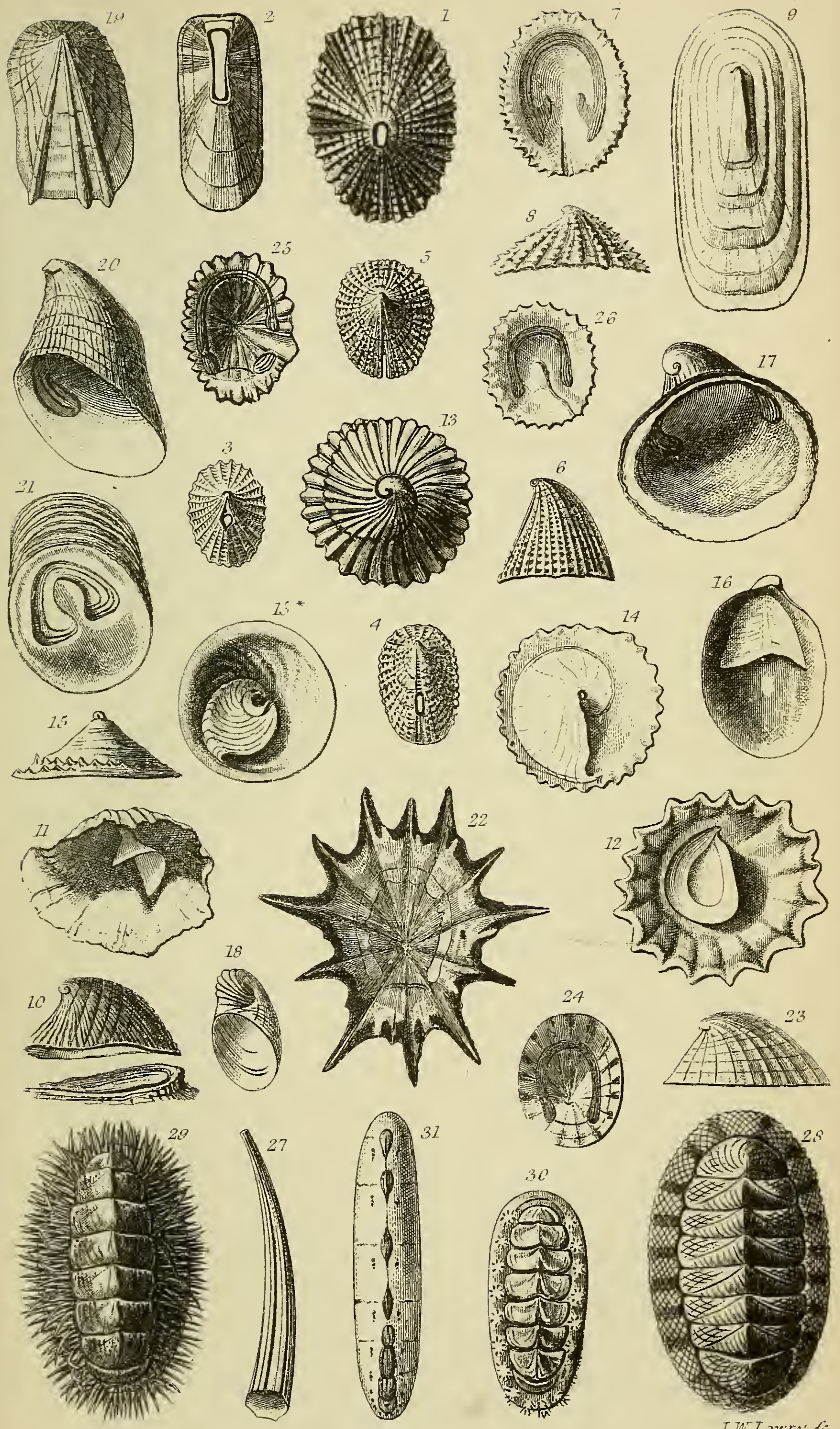

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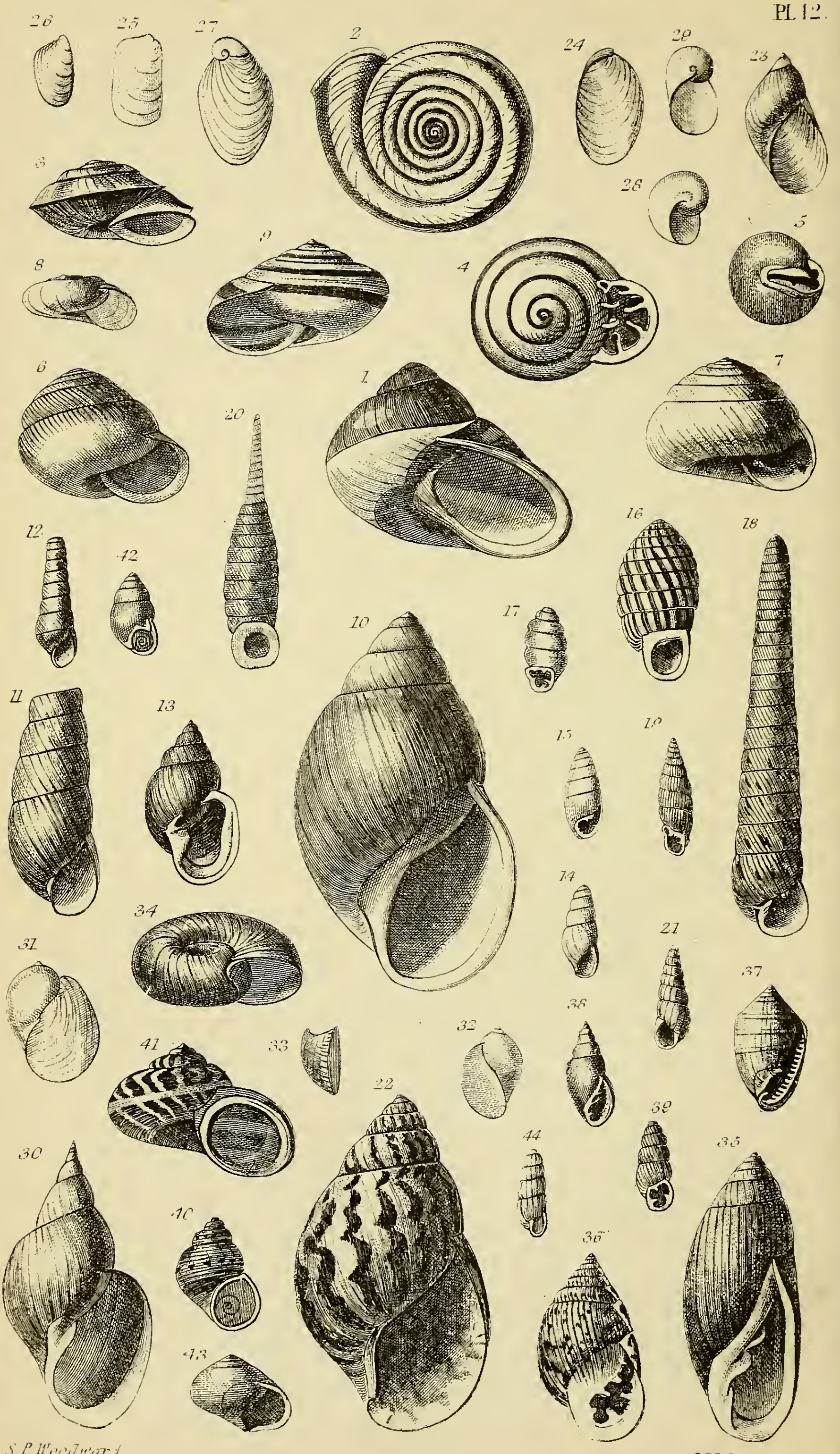

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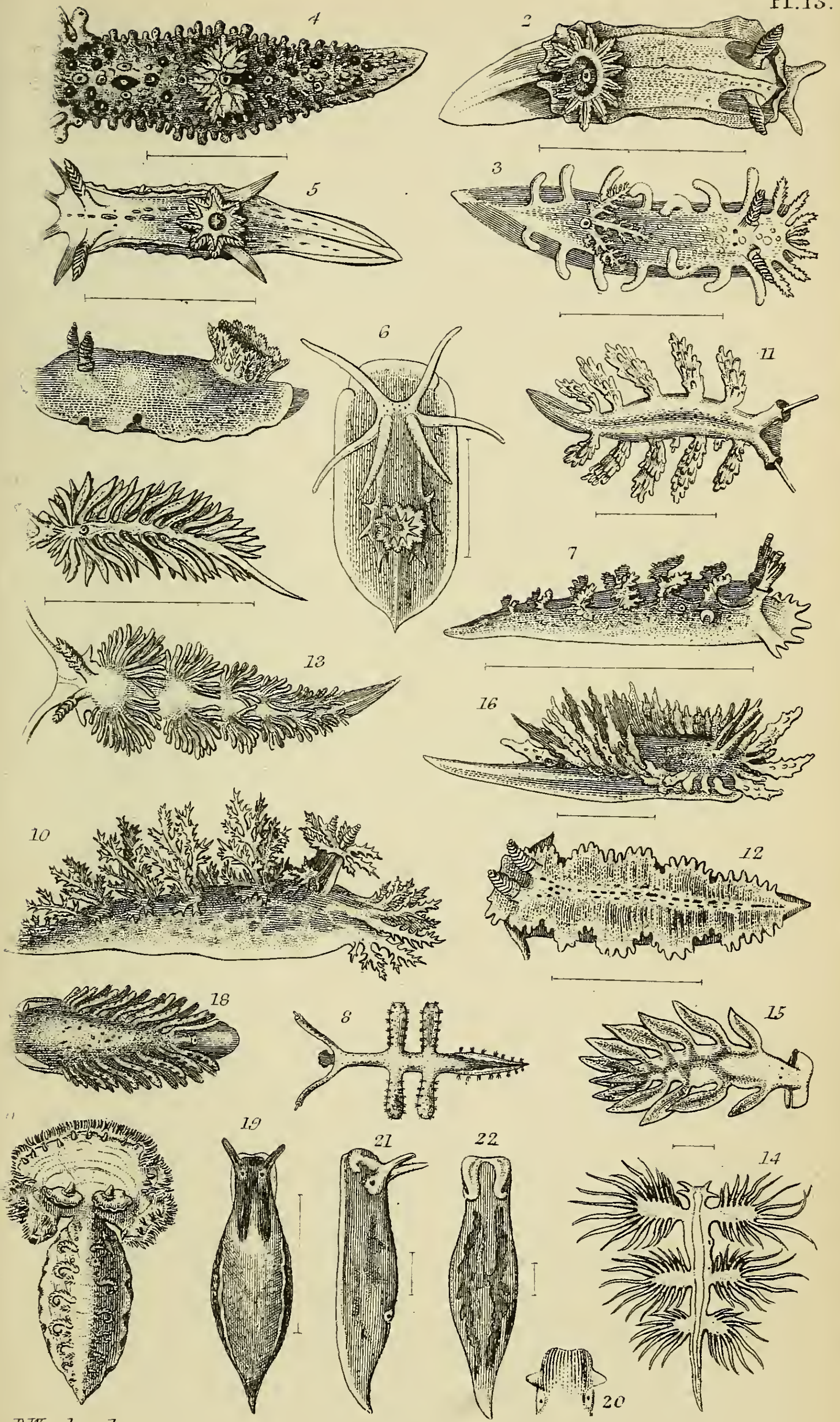

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Pl. 14.

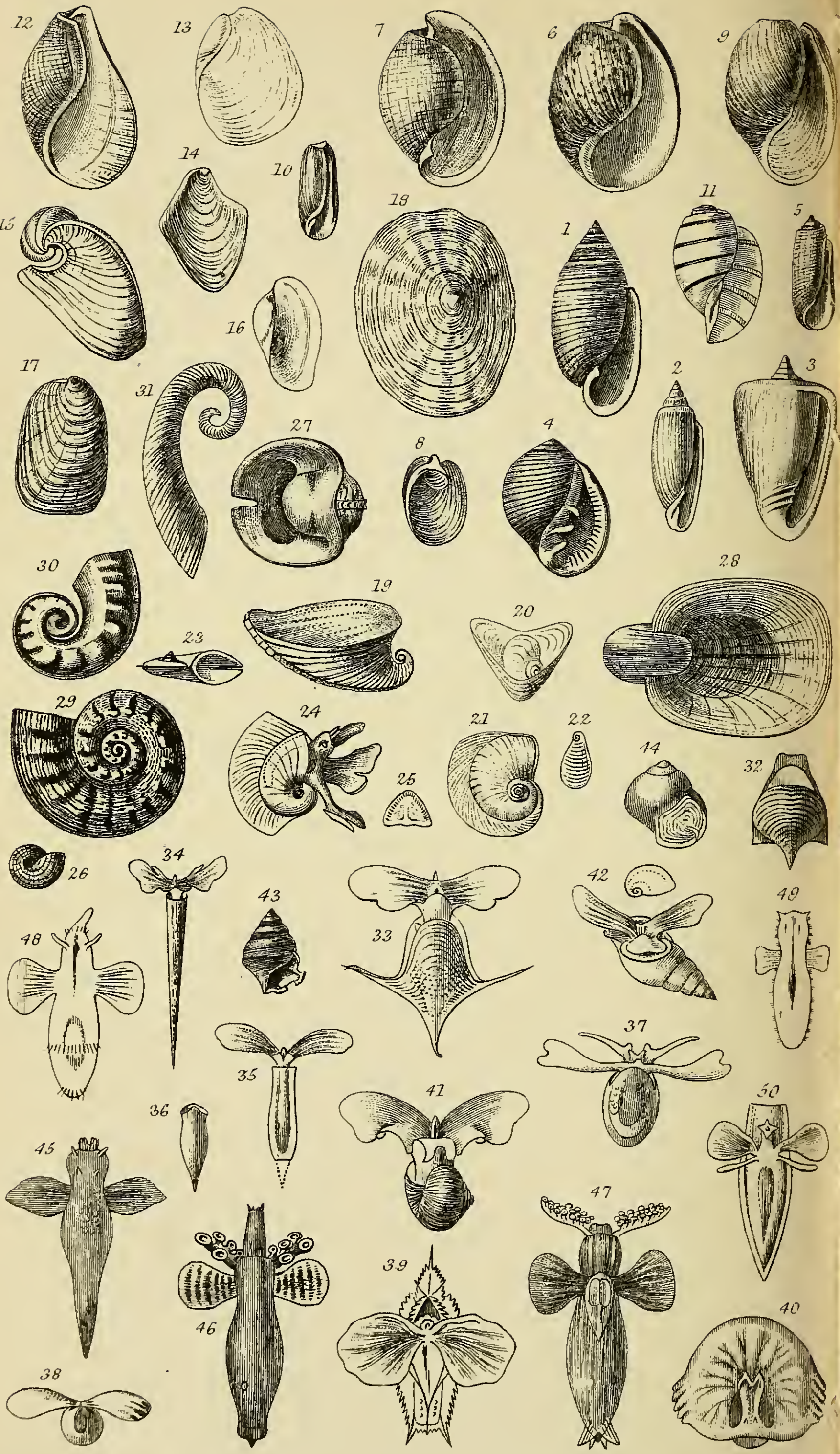

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PLATE XIV.

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PLATE XV.

All, except those marked *, are *dorsal* views.

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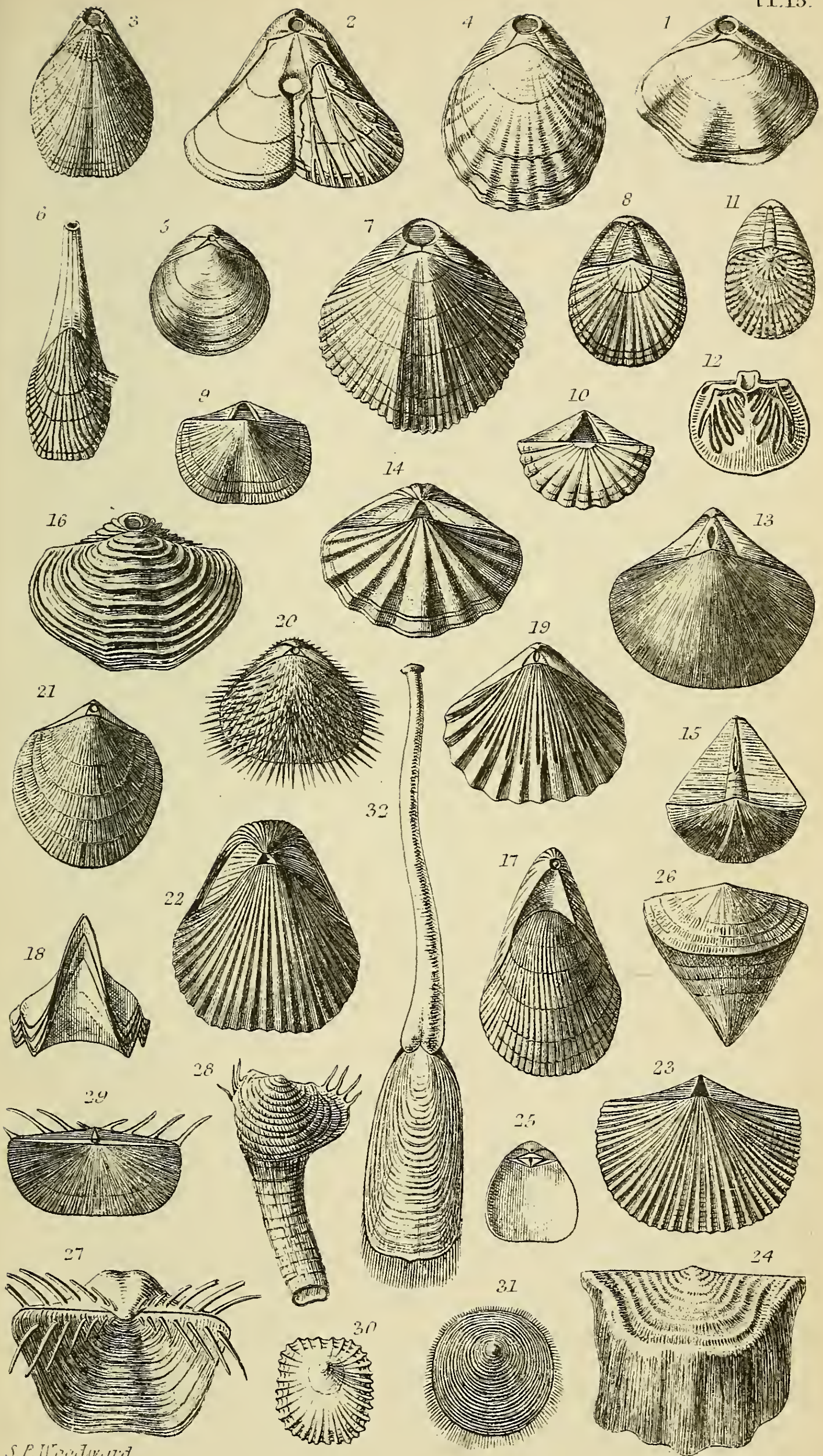

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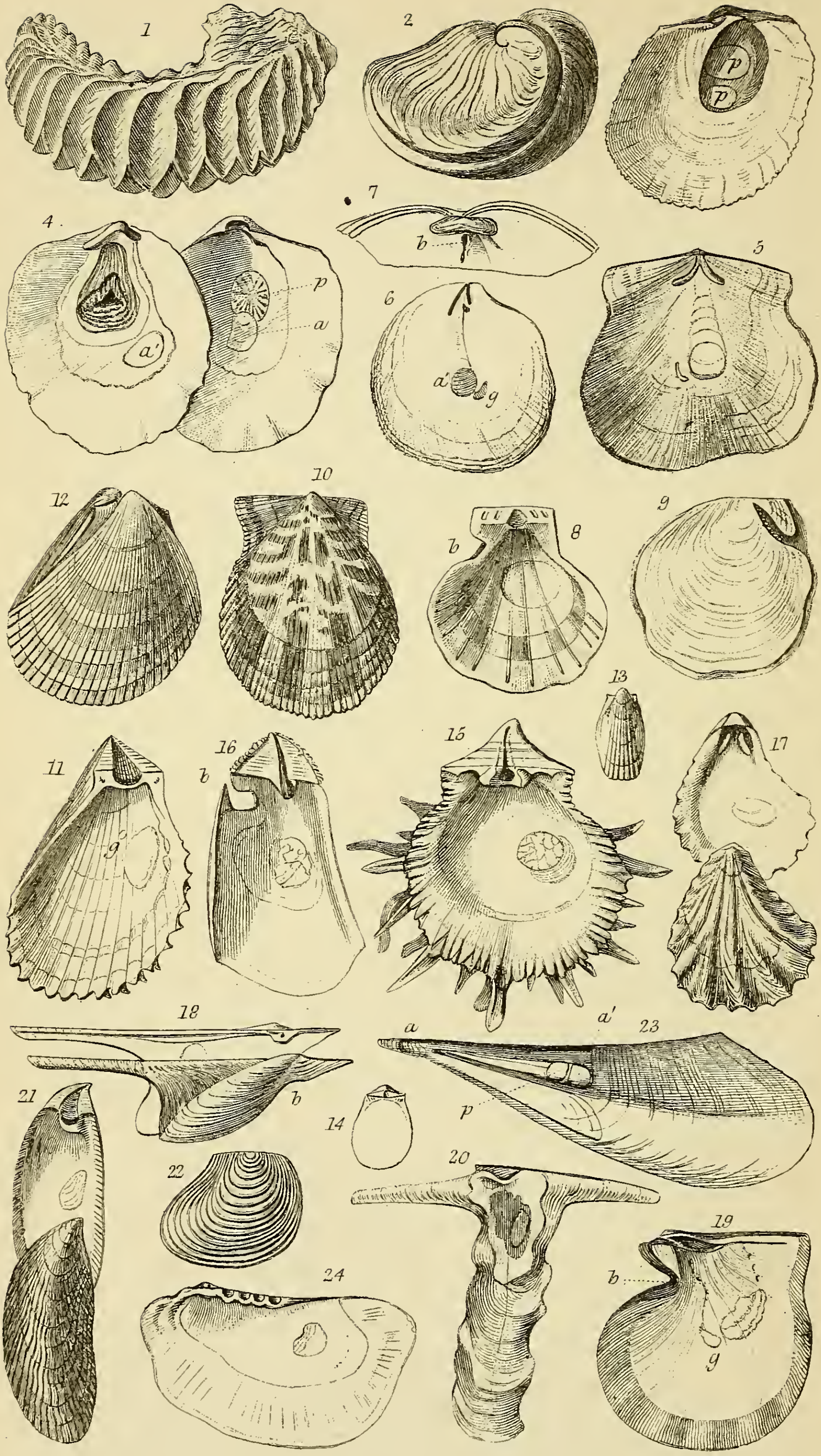

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a,a' adductor impressions.

p, pedal muscles.

g, suspensors of the gills.

b, byssal foramen or notch.

PLATE XVII.

* The figures marked are left valves (interiors).

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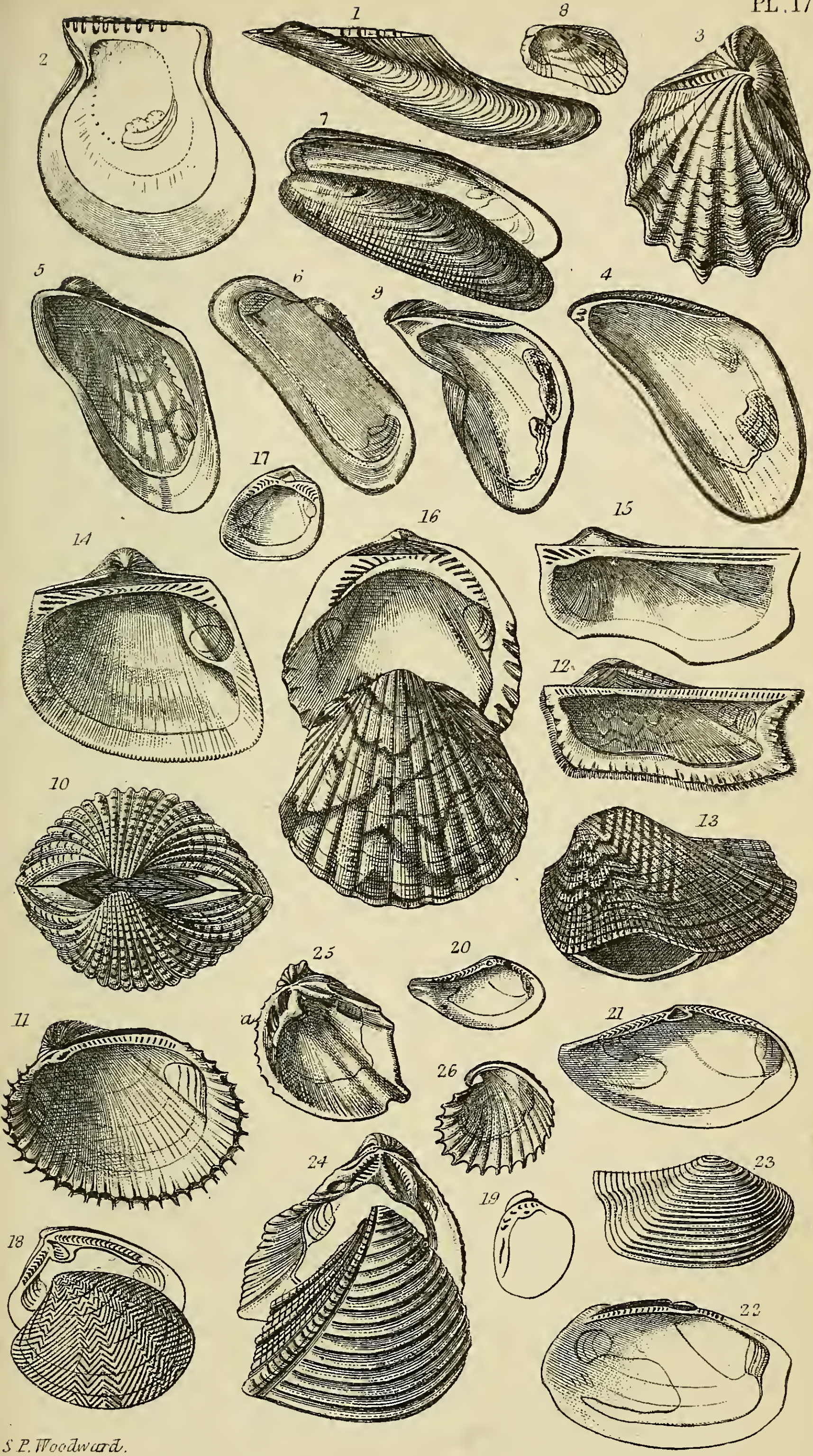

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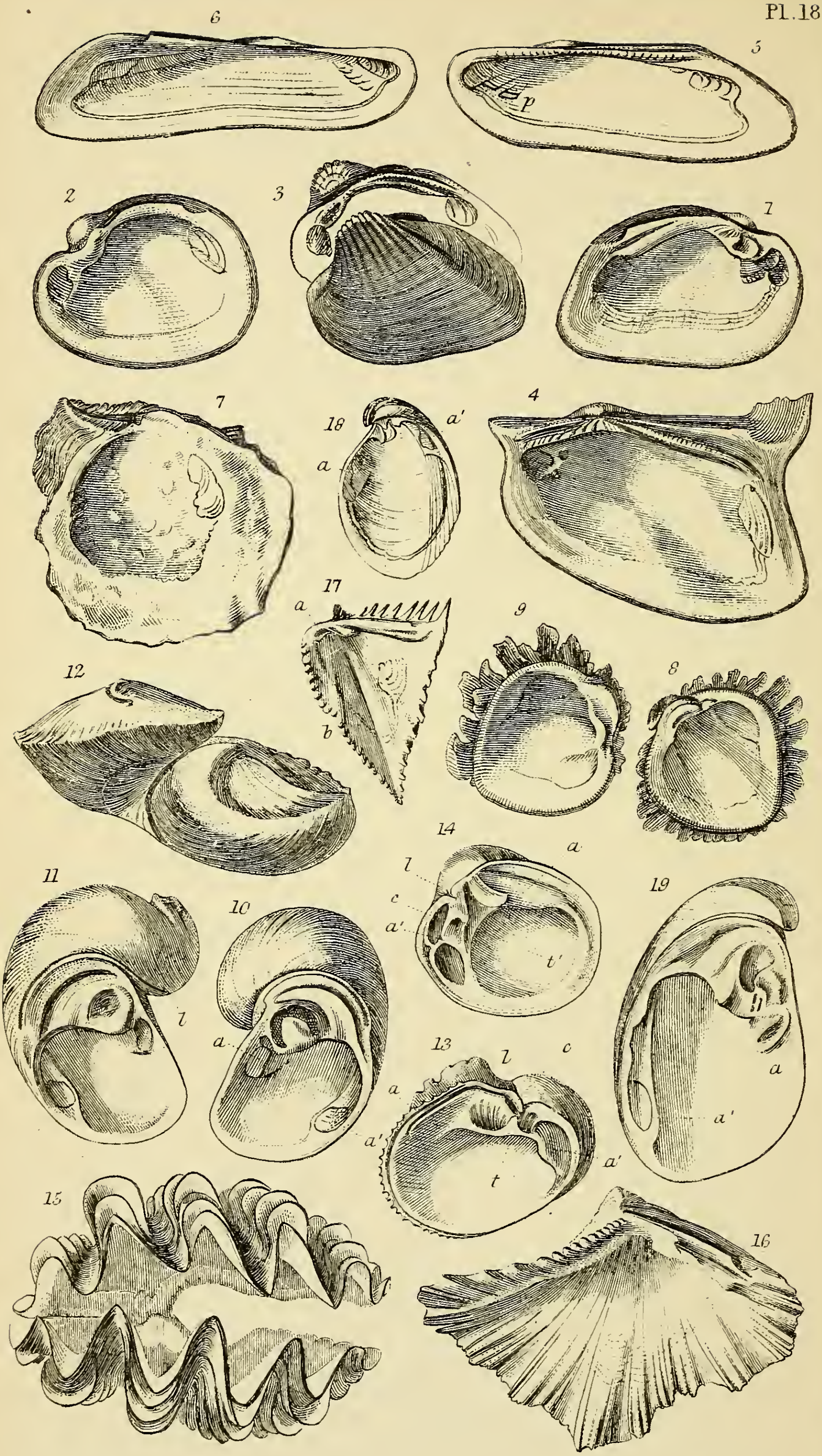

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* The figures marked are *left* valves.

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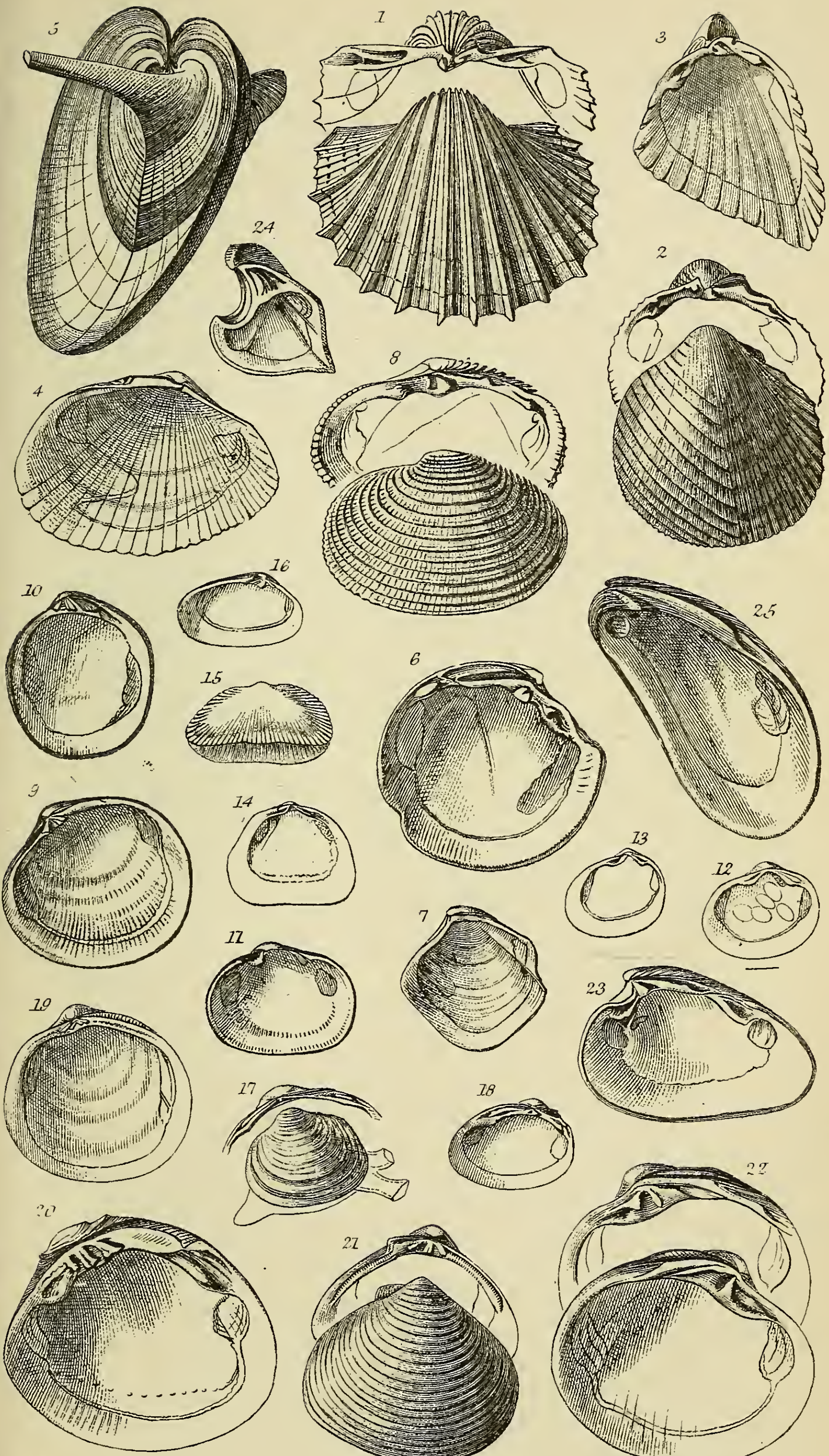

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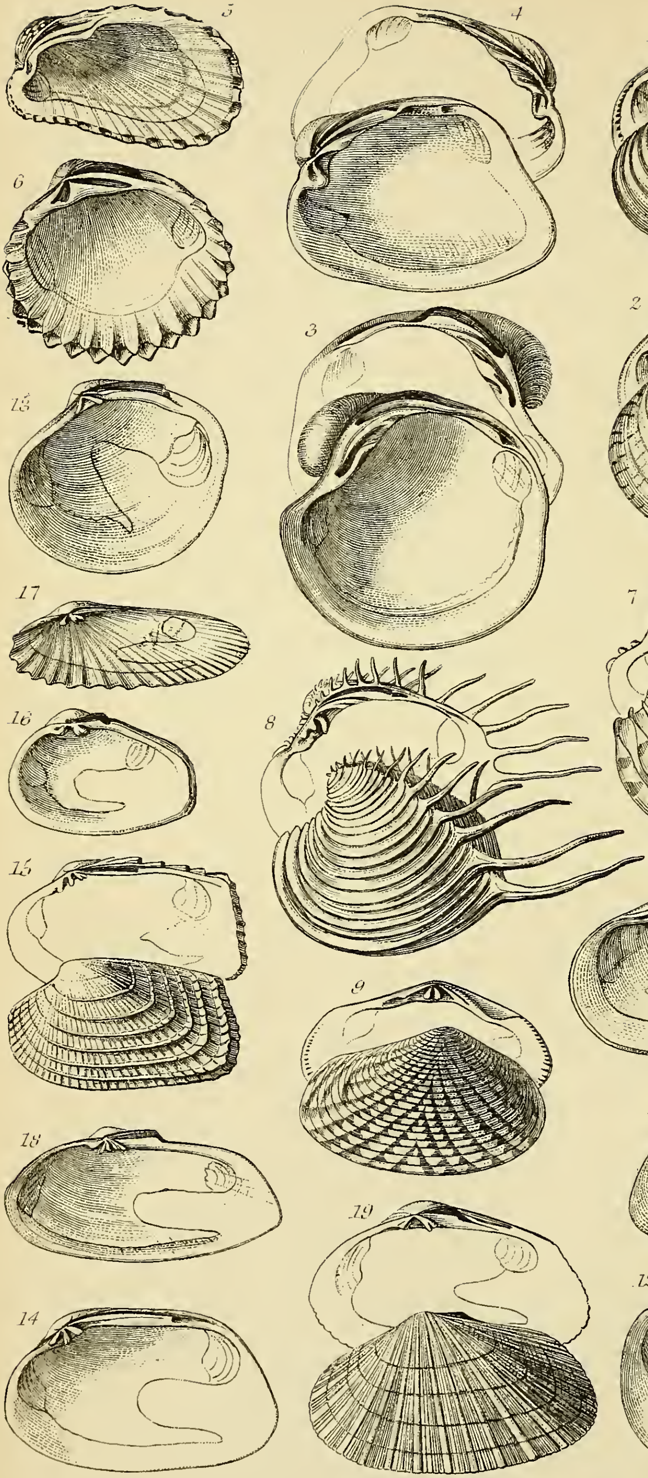

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PLATE XX.

(All the *interiors* are right valves.)

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(All the interiors are *right* valves.)

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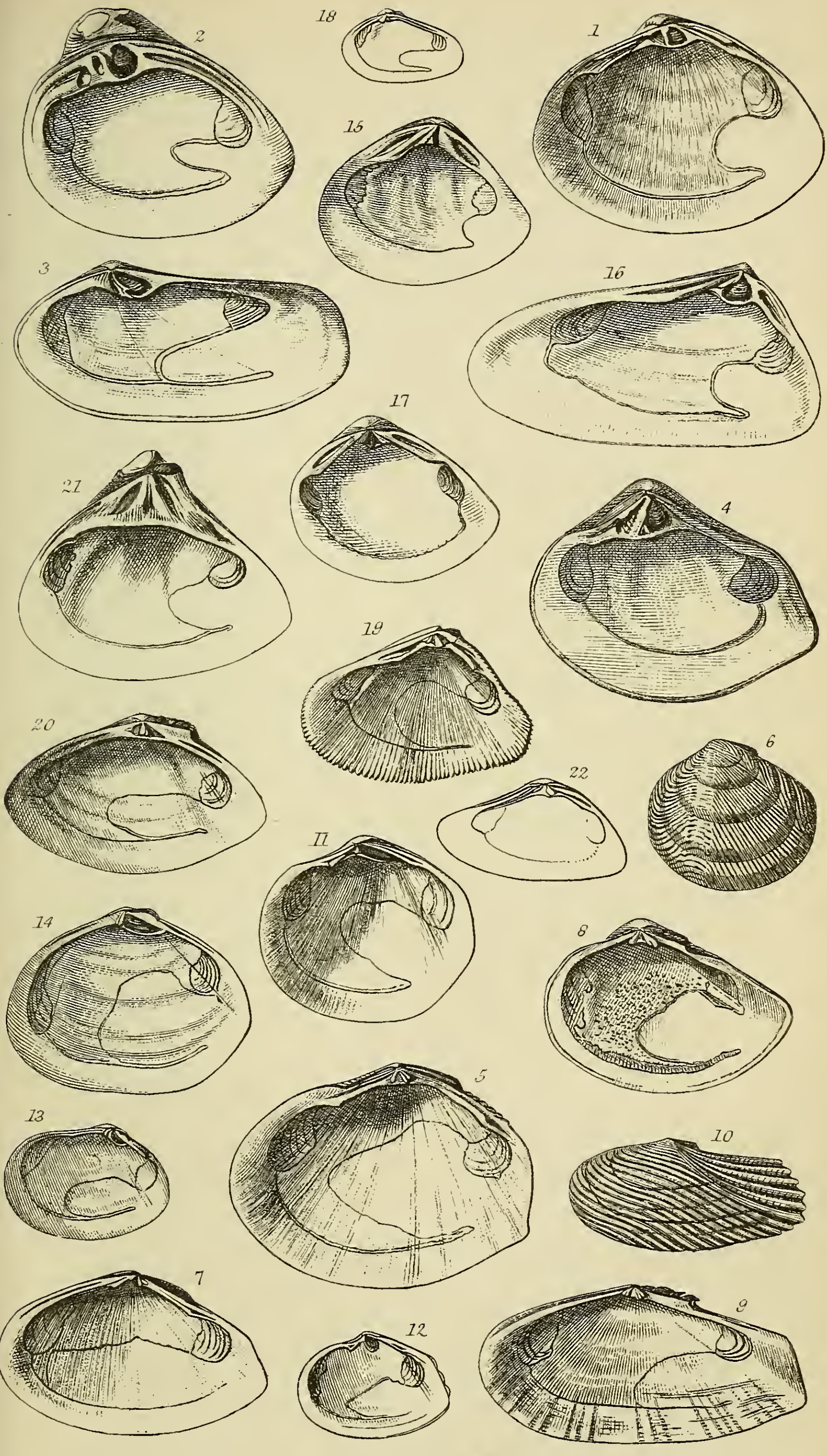

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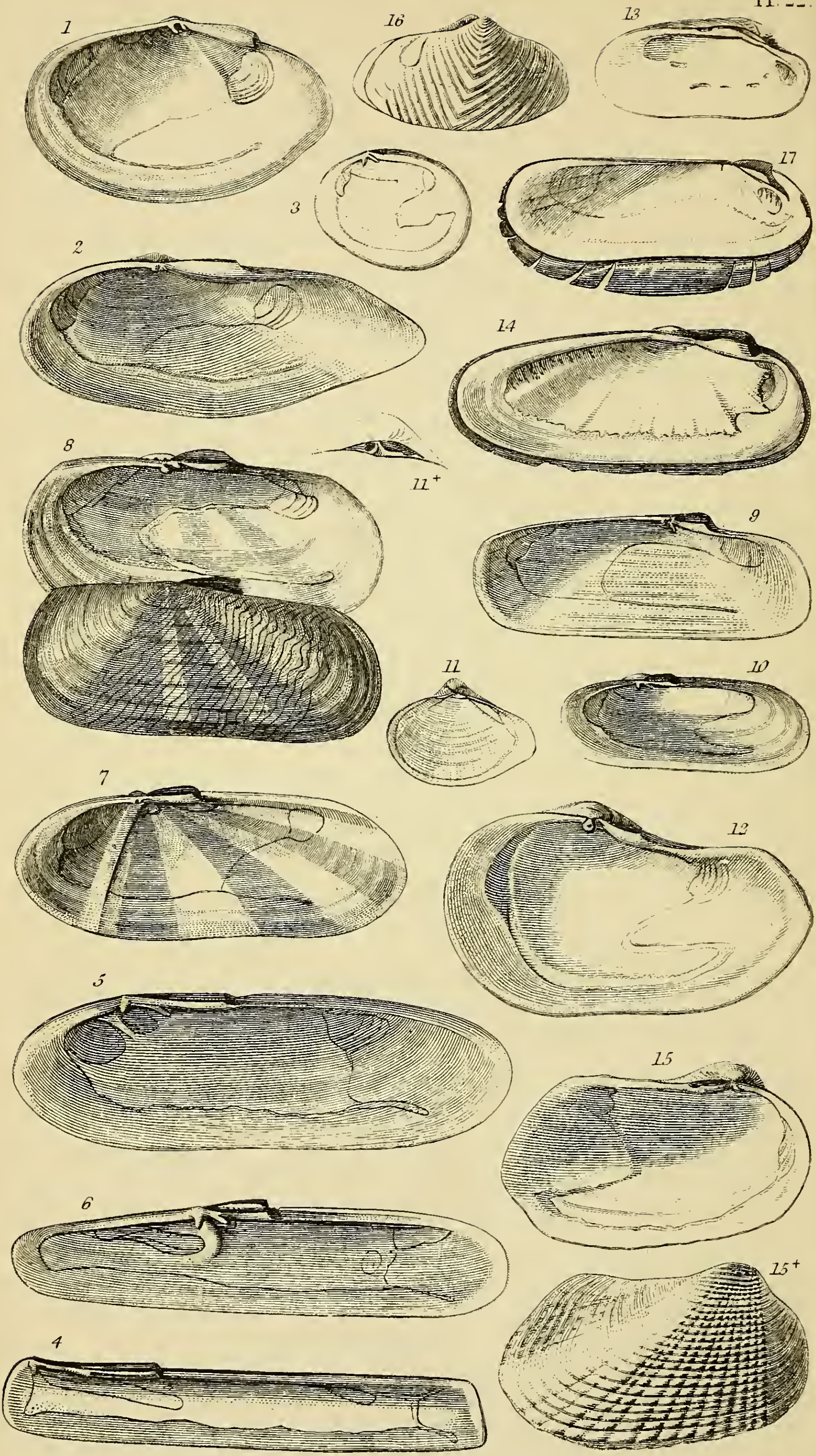

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PLATE XXII.

* The figures marked are *left* valves (interiors).

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PLATE XXIII.

* The interiors marked are *left* valves.

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Anatinidæ.

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27.	——— siphonal end of the tube, broken to show septa	506
28.	——— palmulata, Turt. (styles). Brit.	507

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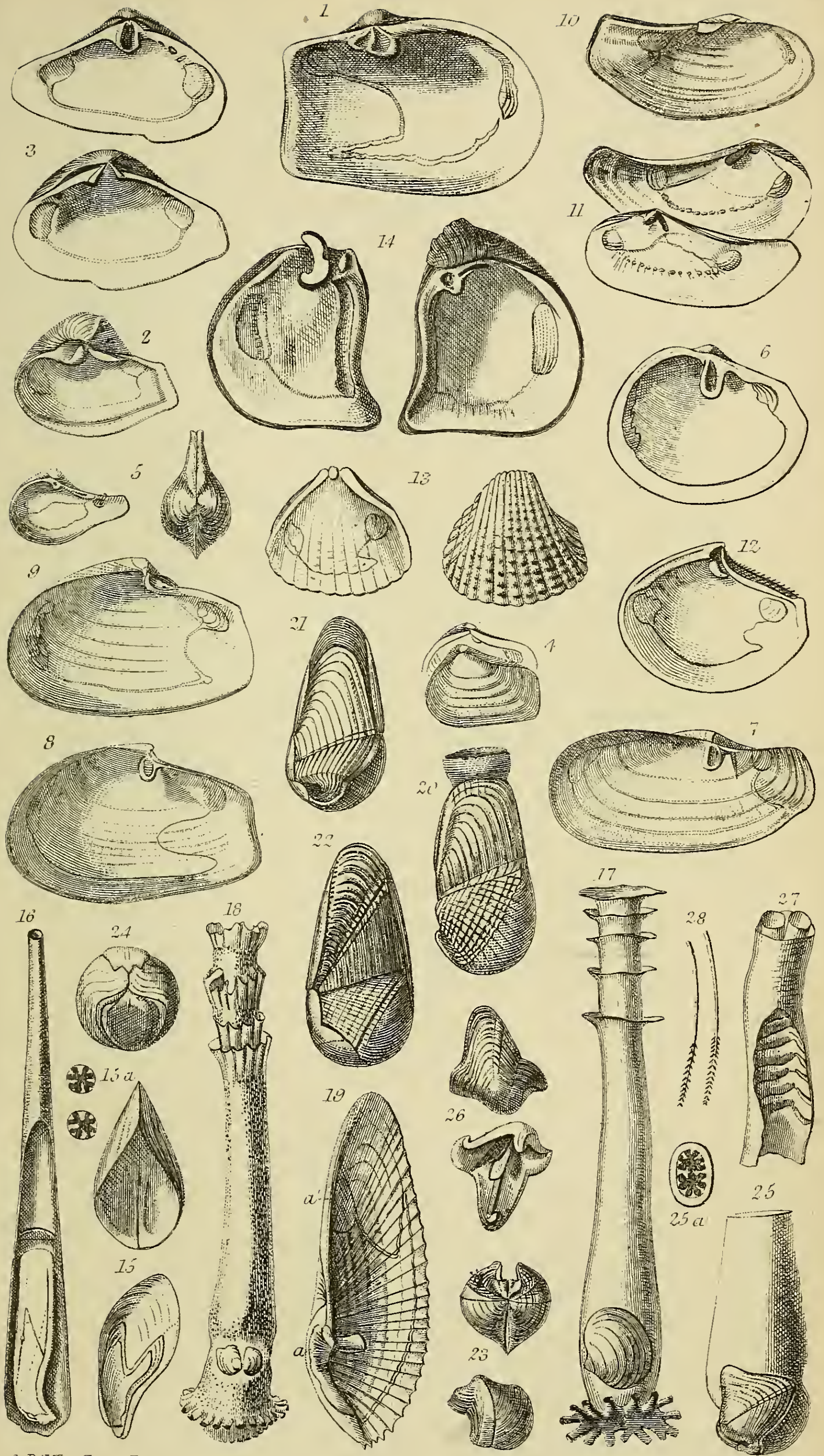
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J. W. Lowry fc.

APPENDIX

TO THE

MANUAL OF MOLLUSCA,

OF S. P. WOODWARD, A.L.S.,

CONTAINING SUCH

RECENT AND FOSSIL SHELLS

AS ARE NOT MENTIONED IN THE SECOND EDITION OF THAT WORK.

By RALPH TATE, A.L.S., F.G.S.

LONDON:
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NEW YORK: VIRTUE & YORSTON.
1868.

CLASS I.—CEPHALOPODA.

Order I.—Dibranchiata.

Family III.—Teuthidæ.

Phylloteuthis, Meek and Hayden.

Type, P. subovatus. Cretaceous. Nebraska.

Pen corneous, thin, subovate, slightly concave below, and convex above. From behind the middle it narrows towards the front, the outline of the lateral margins being convex, while the posterior end is more or less obtusely angular. Apparently related to *Beloteuthis* and *Teudopsis*. (See p. 168.)

Family IV.—Belemnitidæ.*

The *Shell* of *Belemnites* consists fundamentally of:—

1. A hollow cone, the *phragmocone*, Fig. 1, *p*, with a thin shelly wall, termed the *conotheca*, c, and which is divided by transverse septa, concave above and convex below, into chambers or loculi; the septa are perforated near the ventral margin by a *siphuncle*.

2. A *guard* or *rostrum*, *g*, more or less extensively enveloping the apical part of the phragmocone. "The phragmocone is not a chambered body made to fit into a conical hollow previously formed in the rostrum, as some have conjectured, but both *rostrum* and cone grew together; the former was formed on the exterior of a secretive surface, and the latter on the interior of another secretive surface." (Phillips.)

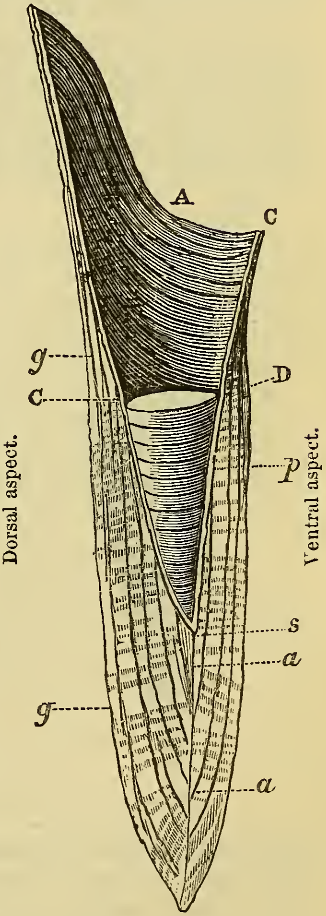

Fig. 1.

The rostrum is composed of calcareous matter arranged in fibres perpendicularly to the planes of the laminæ of growth. Pro-

* See p. 173.

fessor Owen describes the fibres, in specimens from Christian Malford, as of a trihedral prismatic form, and $\frac{1}{2000}$th of an inch in diameter. These fibres are disposed concentrically around an axis, *a*, the so-called apical line, which extends from the extremity of the phragmocone to that of the rostrum. Indications of a thin capsule or formative membrane appear in some *Belemnites* investing the guard; in those of the Oxford clay it is represented by a granular incrustation; in some liassic species it appears in delicate plaits, like ridges or furrows; in some specimens of *Belemnitella mucronata* from the upper chalk of Antrim, it is in the form of a very thin nacreous layer.

3. A *pro-ostracum*, or anterior shell, which is a dorsal extension of the *conotheca* beyond the end where the guard disappears. The surface of the conotheca is marked by lines of growth, and, according to Voltz, it may be described in four principal regions radiating from the apex: one dorsal, Fig. 2, *a*, with

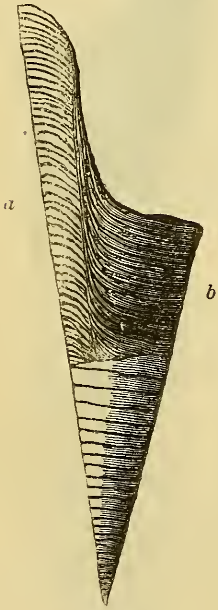

Fig. 2.

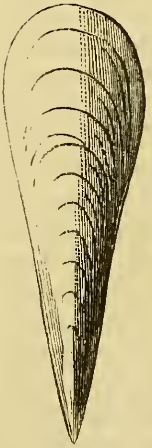

Fig. 3.

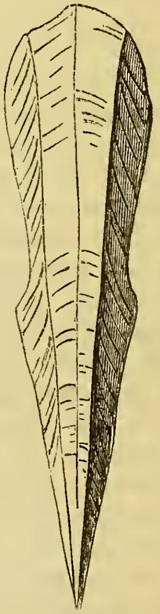

Fig. 4.

loop lines of growth advancing forward; two lateral, *b*, separated from the dorsal by a continuous straight or nearly straight line, and covered with very obliquely arched striæ in a hyperbolic form, in part nearly parallel to the dorso-lateral boundary line, and in part reflexed, so as to form lines in retiring curves across the ventral portion nearly parallel to the edges of the septa.

There were at least three kinds of pro-ostracum in the family *Belemnitidæ*.

A. In many *Belemnites* the extension of the *conotheca* seems to run out in one simple broad plate, Fig. 3, as in *B. hastatus* from Solenhofen.

B. In *Belemnites Puzosianus*, D'Orbigny, the pro-ostracum is very thin, and apparently horny or imperfectly calcified in the dorsal region, supported laterally by two long, narrow, parallel, calcareous plates, Fig. 4, as in *B. Puzosianus* from the Oxford clay. Professor Huxley considers this difference between the pro-ostraca of generic importance.

C. The third kind of pro-ostracum is exhibited by *Orthocera elongata*, De la Beche, the type of the genus *Xiphoteuthis*, Huxley; it is calcareous, and is composed of concentric lamellæ, each of which consists of fibres disposed perpendicularly to the plane of the lamella; the *phragmocone* is very long and narrow, and the guard cylindroidal.

Professor Huxley suspects that a thoroughly well-preserved specimen of *Belemnoteuthis* will some day demonstrate the existence of a fourth kind of pro-ostracum among the *Belemnitidæ*.

The genera in the family are:—1, *Belemnites*; 2, *Belemnitella*; 3, *Xiphoteuthis*; 4, *Belemnoteuthis*; 5, *Plesioteuthis*; 6, *Celæno*; 7, *Beloptera*; 8, *Belemnosis*; 9, *Conoteuthis*; and ? *Helicerus*.

"The *A anthoteuthes* of Munster, so far as they are known only by hooks and impressions of soft parts, may have been either *Belemnites*, or *Belemnoteuthis*, or *Plesioteuthes*, or may have belonged to the genus *Celæno*." (Huxley.)

The genus *Belopeltis*, Voltz, was founded on the pro-ostraca of *Belemnites*, species of which were unknown.

The genus *Actinocamax*, Miller, was founded on the guard of *Belemnites* and *Belemnitella*, the upper parts of which had decayed, and thus presented no alveolar cavity.

Order II.—Tetrabranchiata.

Family I.—Nautilidæ
(including Family II.—Orthoceratidæ).

Division *a*.—Air-chambers confined to one part of the shell.

Ascoceras, Barrande, 1846.*

Etymology, *askos*, a leathern bottle, and *ceras*.

* At p. 185 Mr. Woodward refers to M. Barrande's second volume of the "Cephalopods of Bohemia." The *Ascoras*, *Glossoceras*, and *Aphragmites* are here described.

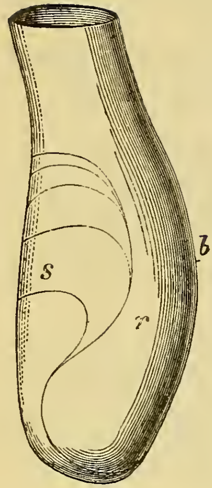

Fig. 5.
Diagram of *Ascoceras* (after Barrande).

Type, A. Bohemicum, Barr., Fig. 5.

Shell flask-shaped, smooth, transversely or longitudinally striated, or ornamented with annular folds, or plicated. The terminal chamber (*r*) occupying the space above the air-chambers (*s*), and extending down one side of nearly the whole length of the shell in the form of a wide and deep cavity, which is embraced by the decurrent edges of the incomplete septa (four or five in number). This cavity also communicates at its base with a small siphuncle which traverses the minute apical air-chambers. Aperture of shell simple.

The wide ventral cavity of *Ascoceras* is of the same nature as the large lateral siphuncle of *Cameroceras*.

Distribution, 16 species. Lower—Upper Silurian. Bohemia, Norway, England, Canada.

Glossoceras, Barrande, 1865.

Etymology, *glossa*, a tongue, and *ceras*.

Type, G. gracile, Barrande. Upper Silurian. Bohemia.

Shell similar to that of *Ascoceras*, but the dorsal margin of the aperture is extended in the form of a ligulate projection, subtriangularly rounded at the end, and recurved towards the interior of the shell.

This process gives rise to a distinct lobe on each side of the opening, which is analogous to that which exists in *Hercoceras*, *Ophidioceras*, and in certain species of *Phragmoceras* and *Gomphoceras*.

Distribution, 2 species. Middle and Upper Silurian. Anticosti; Bohemia.

Aphragmites, Barrande, 1865.

Etymology, *a*, without *phragmos*, a partition; and the usual termination.

Type, Ascoceras Buchii, Barrande.

Shell, similar to that of *Ascoceras*, but the air-chambers are deciduous.

Distribution, 2 species. Upper Silurian. Bohemia.

Division *b*.—Air-chambers occupying the whole cavity of the shell.

Piloceras, Salter, 1859.

Etymology, *pilos*, a cap, and *ceras*, a horn.

Type, P. invaginatum, Salter, Fig. 6.

Shell, broad, conical, sub-cylindrical, or compressed, and slightly curved. Siphuncle and septa combined as a series of conical concave septa, which fit into each other sheathwise.

Distribution, 3 species. Lower Silurian. Scotland. Canada.

Fig. 6. Diagram of *Piloceras* (after Salter).

Orthoceras.*

Sub-genera:—

1. Gonioceras, Hall, 1847.

Etymology, *gonios*, an angle.

Type, G. anceps. Lower Silurian. United States.

Shell, having the general form and structure of *Orthoceras*, flattened with extremely salient angles; septa sinuous; section of shell, an extended ellipse with projecting angles; siphuncle ventral.

2. Endoceras, Hall, see W. M., ii. p. 192.

3. Tretoceras, Salter, 1858 (*Diploceras*, Salter, 1856).

Etymology, *tretos*, pierced.

Type, Orthoceras bisiphonatum, Sowerby. Lower Silurian. Wales.

Shell elongated; septa pierced by a sub-central beaded siphuncle, and also by a deep lateral cavity continuous with the terminal chamber, and passing down side by side with the siphuncle—the cavity affecting at least seven of the uppermost septa, if not the whole.

Cyrtoceras.†

Sub-genera:—

1. Onoceras, see W. M., ii. 193. "The shells of this genus and *Cyrtoceras* pass gradually into each other, but *Onoceras* may be retained for those species which are much inflated in the anterior half or two-thirds of the shell length" (Billings); and "which have a more or less *strangulated aperture*" (Barrande).

* See p. 190.　　† See p. 194.

2. CYRTOCERINA,* Billings, 1865.

Type, C. typica, Billings.

Shell having the general characters of *Cyrtoceras*, but differs in the short, thick form, and in the large siphuncle on the *dorsal* side.

Distribution, 2 species. Silurian. Canada.

3. STREPTOCERAS, Billings, 1865.

Etymology, *streptos*, curved, and *ceras*.

Shell having the form of *Onoceras*, but with a trilobed aperture like *Phragmoceras*.

Distribution, 2 species. Middle Silurian. Canada.

LITUITES, Breynius.†

Type, L. lituus, Hisinger.

Shell discoidal, whorls (2—5) close or separate; last chamber produced in a straight, or nearly straight line, sometimes slightly curved, in a direction contrary to that of the spire; lateral margins of the aperture extended and curved towards the interior of the shell; the aperture contracted thus presents two distinct orifices, the smaller corresponding to the convex or ventral side, the larger to the concave or dorsal side of the shell.

L. lituus is the only species in which the aperture has been observed. 28 species from the Middle and Upper ? Silurian rocks of Europe and North America, belong here or to allied genera.

Sub-genus:—OPHIDIOCERAS, Barrande, 1867.

Synonym, *Ophioceras*, Barrande, 1865.

Etymology, *ophiodes*, shaped like a serpent, and *ceras*.

Type, O. Nakholmensis, Kjerulf (*Lituites*).

Shell with the produced portion very short or wanting.

The shells of the Bohemian species are keeled on the convex side.

Distribution, 7 species. Middle Silurian; Norway (1). Upper Silurian, Bohemia (6).

LITUUNCULUS, Barrande, 1867.

Shell as in *Lituites*, but with a simple aperture. No species have been yet observed.

Sub-genus:—DISCOCERAS, Barrande, 1867.

Etymology, *diskos*, a quoit, and *ceras*.

Type, D. antiquissimus, Eichwald (*Lituites*).

* See p. 194. † See p. 189.

Shell with the produced portion very short or wanting.

This sub-genus bears the same relation to *Lituunculus* (the existence of which is supposed) that *Ophidioceras* does to *Lituites*.

Distribution, 3 species. Middle Silurian. Russia, Germany, Norway.

HERCOCERAS, Barrande, 1867.

Etymology, *erkos*, a wall, and *ceras*.

Type, H. mirum, Bar. Middle Silurian, Bohemia.

Shell usually involute, as in *Nautilus*, rarely with separated whorls as in *Gyroceras*, or with a spire as in *Trochoceras*. *Body-chamber* with a diaphragm perpendicular to the axis of the shell, the concavity of which is opposed to that of the last septum. This disposition throws the aperture on the convex side of the shell, which is deeply excavated. *Siphuncle* dorsal, cylindrical, inflated between the chambers, separated from the shell.

Nautilus subtuberculatus, Sandberger, from the Devonian of Nassau, may belong to this genus.

BATHMOCERAS, Barrande, 1867.

Etymology, in allusion to the imbricated arrangement of the partitions.

Type, B. complexum, Barr. (Orthoceras).

Shell having the general appearance of *Orthoceras*. Part of the body-chamber occupied by a series of imbricating plates, which decrease in horizontal extension from below upwards. *Siphuncle* composed of a series of superimposed funnel-shaped tubes, the narrow end directed towards the aperture of the shell.

Distribution, 2 species. Middle Silurian, Bohemia.

AULACOCERAS, Hauer, 1860.

Etymology, *aulax*, a furrow, and *ceras*.

Type, A. sulcatum, Hauer, Fig. 7.

Shell straight, like *Orthoceras*; corrugated, with two deep lateral furrows; siphon simple, very small, marginal and dorsal, situated between the longitudinal sulci. The test increases rapidly in thickness towards the apex of the shell.

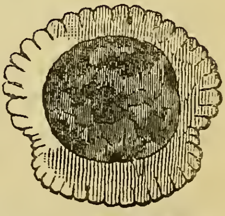

Fig. 7. Transverse section of *Aulacoceras sulcatum*.

The genus is a transition form between the *Nautilidæ* and the *Belemnitidæ*.

Distribution, 4 species. Upper Trias, Austria.

[Family Goniatidæ. Barrande.]

Shell involute or straight; septa concave in their median section; sutures usually with angular lobes; septal tubes conical, more or less prolonged, but always directed backwards. Siphuncle cylindrical, of small diameter, always marginal; siphonal investment not persistent; convexo-ventral margin of the aperture sloped, lines of growth and ornamentation of the shell with a corresponding sinuosity.

The genera enumerated in this family are *Goniatites*, *Clymenia*, and *Bactrites*. Dr. Woodward includes the *Goniatites* and the *Bactrites* (pp. 196, 197) with the *Ammonitidæ;* and the *Clymenia* with the Nautilidæ (p. 190).

Family III.—Ammonitidæ.

Shell various; septa convex in their median section; sutures always lobed, ramified, or denticulated; septal tube cylindrical and always directed forwards. Siphuncle cylindroid of small diameter, always marginal; siphonal investment more or less solid and persistent. Convexo-ventral? margin of the aperture more or less prolonged, which determines a similar convexity in the lines of growth and ornamentation of the test; there are rare specific exceptions.

Division I.—Sutures lobed or denticulated at the base.

1. Rhabdoceras (see p. 196).

2. Baculina, D'Orbigny, 1850.

Example, B. Rouyana, D'Orb. Neocomian, France.

Shell like *Baculites*, but its lobes and saddles are not foliated, there being between these forms a similar distinction to that between *Ceratites* and *Ammonites*.

B. acuarius, Schlotheim, is from the Oxfordian strata of Gammelshausen in Wurtemberg.

3. Cochloceras, Hauer, 1860.

Etymology, *cochlos*, a snail-shell, and *ceras*.

Type, C. Fischeri, Hauer, Fig. 8.

Shell resembling that of *Turrilites*, with the sutural lobes simple, as in *Rhabdoceras* and *Clydonites*.

Distribution, 3 species. Upper Triassic strata of Hallstadt, Austria.

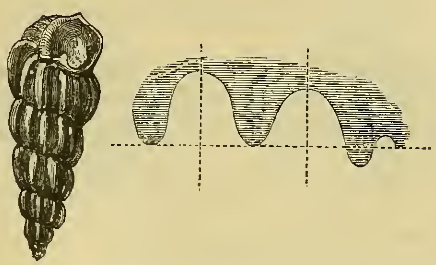

Fig. 8. Shell and sutural lobes of *Cochloceras Fischeri.*

4. Choristoceras, Hauer, 1865.

Type, C. Marshii, Hauer.

Shell somewhat similar in form to *Crioceras*, with the lobular ornamentation characteristic of *Ceratites*.

Distribution, 4 species. Upper Trias, Austria.

5. Clydonites, Hauer, 1860.

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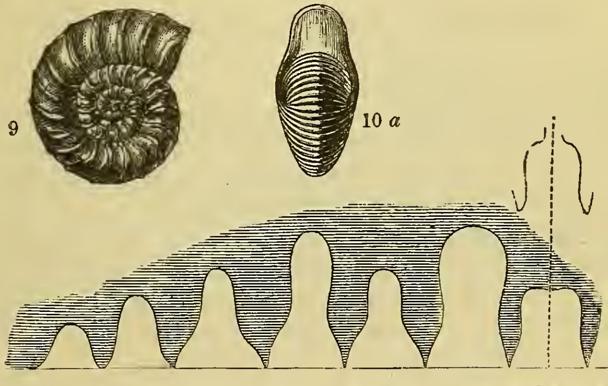

Fig. 9. Shell of *Clydonites costatus*, Hau. Figs. 10a, 10b. Shell and sutural lobes of *C. delphinocephalus*, Hau.

Etymology, *kludon*, the surge, with the usual termination.

Examples, Goniatites Eryx, Münst; Ammonites delphinocephalus, Hauer. Figs. 9, 10.

Shell, discoidal; sutures lobed; lobes entire, not crenulated as in *Ceratites*.

Distribution, Upper Triassic strata, Hallstadt and St. Cassian, in the Austrian Alps; North-western Himalayas; 21 species. Upper Cretaceous, 2 species described as *Ceratites* by D'Orbigny.

6. CERATITES (see p. 197).

DIVISION II.—SUTURES FOLIATED

Including the genera *Ammonites* (p. 197), *Toxoceras*, *Ancyloceras*,* *Scaphites*, *Helicoceras*, and *Turrilites* (p. 200), *Hamites*, *Ptychoceras*, and *Baculites* (p. 201), and the following.

ANISOCERAS (see p. 200), Pictet, 1854.

Etymology, *anisos*, unequal; and *ceras*.

Example, Hamites armatus, Sowerby.

Shell at first growing in an open helicoid spire, afterwards more or less prolonged and reflected; ornamented by transverse ribs. Sutures of septa divided into 5 lobes and 5 saddles, all bipartite; the lateral saddles are the largest.

Fossil, 12 species. Gault—Upper Green Sand, Europe. Cretaceous, India. 1 species, Jurassic. North-west Himalayas.

Species of *Helioceras* founded on helicoid portions of shells may belong to this genus.

HAMULINA (see p. 201), D'Orbigny, 1852.

Example, H. dissimilis, D'Orb.

Shell conical prolonged, having a portion of the body chamber reflected, but not touching the other portion; section of the shell round or laterally compressed; sutures of the septa divided into six lobes, and as many saddles.

Hamulina differs from *Hamites* in being only once reflected instead of twice, and from *Ptychoceras* in having the reflected portion of the shell separate from the other, not close together.

Distribution, 15 species. Neocomian, France. Ootatoor group (= ? Gault), India.

PELTARION, Deslongchamps, 1859.

Founded on the mandibular armature of tetrabranchiate cephalopods

* Many of the forms considered to belong to *Crioceras* have been ascertained by M. Astier to be only more or less incomplete individuals of species belonging to *Ancyloceras*. That *Crioceras* must merge into *Ancyloceras* appears inevitable.

Example, P. bilobatum. Upper Lias, Normandy. Fig. 11. Calcareous plates nearly circular or transversely oval; ante-

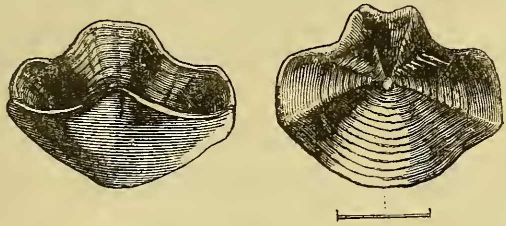

Fig. 11.

rior border rounded, posterior produced and truncated; concave above and flattened below; the two faces have one-half smooth and the other concentrically striated in an inverse direction to each other.

Fossil, 3 or 4 species. Up. Lias — Cor. Rag. England; Normandy; Wurtemberg.

CLASS II.—GASTEROPODA.

Order I.—Prosobranchiata.

Family II.—Muricidæ (see p. 212, &c.).

The genera included in this family are:—

Murex, Typhis, Pisania, Trophon, Fasciolaria, Turbinella (*Cynodonta*, *Latirus*, *Lagena*), Fusus (*Clavella*, *Chrysodomus*, *Pusionella*, *Tritonidea*), Fulgur, Cominella, Myristica, and Lachesis

Anachis, H. and A. Adams.

Type, Columbella scalarina, Sowerby.

Shell like *Columbella;* operculum elongated, unguiform, nucleus terminal, having close analogies with *Pisania*.

Distribution, 27 species. Tropical America.

Ptychatractus, Stimpson, 1865.

Etymology, *ptych*, a fold; *atractus*, a spindle.

Type, Fasciolaria ligata, Mighels and Adams. Deep water; United States.

Shell fusiform, spirally striated; aperture with a rather long canal; columella plicated as in *Fasciolaria*; operculum like that of *Chrysodomus*. Lingual dentition, resembles that of the *Purpuridæ*, 1·1·1. Rhachidian tooth, deeply arched, with three denticles; lateral teeth versatile, elongated, simple, hook-shaped, base swollen.

Buccinopsis, Jeffreys, 1859.

Etymology, having the aspect of Buccinum.
Synonym, Liomesus, Stimpson, 1865.
Type, Buccinum Dalei, J. Sowerby, Britain.
Shell oval, spirally striated; epidermis filmy; spire short, obtuse; outer lip smooth within; canal short and open; operculum triangular; nucleus placed on the inner base of the aperture.

The lingual dentition makes an approach to Mangelia, and consists of a single plain and slightly curved tooth on each side of a thin non-denticulated plate.

The egg cases of Buccinopsis are separate.

Distribution, 3 species. German Ocean, North Atlantic, Spitzbergen, Behring's Straits.

Fossil. B. Dalei occurs in the Red, Antwerp, and Coralline Crags. England, Belgium.

Cheletropis is the fry of species belonging to the *Muricidæ*.

Adamsia, Dunker, resembles a sculptured *Cominella* without the sutural construction of the whorls. 2 species. Australia.

Family III.—Buccinidæ.*

The enumerated genera are :—

Buccinum, Pseudoliva, Bullia, Eburna, Phos, Nassa (*Cyllene*, *Northia*, *Cyclonassa*), Columbella, Truncaria, and Terebra (*Myurella*), Subula (*Euryta*).

Truncaria, A. Adams and Reeve, 1848.

Synonym, Buccinopsis, Deshayes.
Type, T. filosa (Buccinum). Adams and Reeve. China.
Shell oval, oblong; spire elongated; apex acute, often channelled at the suture; aperture oblong, dilated in front, angulated, sometimes with a small canal behind; outer lip simple or bordered; columella concave, abruptly truncated, and shorter than the right lip.

* See p. 218, &c.

Species of this genus are *Buccinums* with a truncated columella.

Distribution, 5 species. China, Central Ameria, Vigo Bay.

Fossil, 3 species. Eocene. Paris basin.

[FAMILY PURPURIDÆ]

Is composed of the following genera:—

PURPURA, including *Monoceros* (of sectional value)* and the sub-genera:—

Concholepas, *Cuma*, *Rapana* (see p. 217, under *Pyrula*), *Pinaxia*, Adams.

Iopas, H. and A. Adams, 1853. *Shell* bucciniform, with a small canal in the posterior angle of the aperture. *Fossil*, 3 species. Eocene. Paris.

Vitularia, Swainson, 1840. V. salebrosa. South and Central America. *Shell* with irregular varices; operculum as in *Purpura*.

Nitidella, Swainson. *Shell* as *Cylindra;* spire sometimes decollated; lip continuous or crenated; operculum elongate; nucleus lateral.

RICINULA, HARPA, RHIZOCHCHILUS (*Coralliophila*, Adams), and MAGILUS, with the

Sub-genus Leptoconchus, Rüppell.

Shell similar to that of *Magilus*; young shell only with an operculum.

[FAMILY CASSIDÆ.]

The genera referred to this family are:—

RANELLA (p. 214), TRITON (p. 214), PYRULA (p. 217), CASSIS (p. 224), ONISCIA (p. 225), CASSIDARIA (p. 225), DOLIUM (*Malea*) (p. 226), and

NASSARIA, Pfeiffer.

Animal analogous with that of *Ranella*, as regards the length of the tentacles, position of the eyes, smallness of the head, and by the form of the operculum, but is provided with a long branchial siphon.

Shell sub-canaculated in front, and deeply notched.

[FAMILY OLIVIDÆ]

Includes OLIVA (*Olivella*, *Scaphula*, *Agaronia*), ANCILLARIA (*Monoptygma*, Lea).†

* See p. 223. † See p. 227.

[FAMILY VOLUTIDÆ]

Contains COLUMBELLINA (p. 227), MITRA (*Imbricaria*, *Cylindra*, *Strigatella*, and *Hyalina*) (p. 231), VOLUTA (*Volutilithes*, *Scaphella*, *Volutomitra*, and *Melo*) (p. 230), CYMBA (p. 231), MARGINELLA (p. 232), VOLVARIA (p. 232), and

LYRIA, Gray, 1847.

Synonyms, Harpella, Gray; Enæta, Gray.

Types, L. deliciosa, Montf.; L. harpa, Barnes.

Shell ovate oblong, mitriform, thick, sometimes longitudinally costated; aperture subovate, with a large number of columellar plaits, the two anterior of these being the strongest; posterior portion of the inner lip provided with a large number of short cross-plaits. Operculum ovate-elongate, thin; corneous nucleus at first nearly central, at a more advanced age subapical.

Distribution, 14 species. Pacific Ocean, America, Madagascar, Australia, Japan, New Caledonia, Antilles.

Fossil, 3 species. Cretaceous. India. The species in the Tertiary strata have not been distinguished from *Voluta*.

CYSTISCUS, Stimpson, 1865.

Type, C. capensis, Cape of Good Hope.

Shell resembling that of *Marginella;* small, thin, ovate, inflated, smooth, and polished; aperture narrow, columella plaited.

Animal with an elongated foot, truncated in front; head oblong, depressed; tentacles triangular, flattened, and horizontal; eyes at the lateral margins of the head, at the bases of the tentacles. Lingual dentition, 0·1·0, resembling the rhachidian teeth of *Murex*, thick and strong, with seven unequal conical denticles.

[FAMILY CYPRÆIDÆ]

Includes ERATO, CYPRÆA (*Cyprovula*, *Luponia*, and *Trivia*), OVULA (*Volva* and *Radius*), PACHYBATHRON, PEDICULARIA, and DENTIORA, Pease, 1862.

Type, D. rubida, Sandwich Islands.

Shell differs from that of *Pedicularia* in the flat or excavated columella, compressed, and toothed.

Family Conidæ

Contains Conus (*Conarbis*), Dibaphus, Pleurotoma (*Drillia*, *Bela*, *Clionella*, *Daphnella*), Clavatula (*Tomella*), Mangelia (*Clathurella*), Lachesis, Cithara, and

Borsonia, Bellardi, 1839.

Synonym, Cordieria, Ronault, 1848.

Shell like *Pleurotoma*, with oblique folds on the thick columella, and thus establishes a passage between *Pleurotoma* and *Turbinella*.

Distribution, 4 species. East Indies.

Fossil, 23 species. Eocene—. France, Italy, England, United States.

Gosavia, Stoliczka, 1865.

Type, Voluta squamosa, Zekeli.

Shell similar to that of *Conus*; aperture narrow, elongated; base emarginate; outer lips notched near the posterior suture; columella lip plicated, the anterior plaits being always the strongest.

Fossil, 8 species. Cretaceous. —Eocene? Gosau; India.

[Family Naticidæ.]

The genera are—

Natica, containing as sub-genera *Naticospis*, *Neverita*, *Lunatia*, *Globulus*, *Globularia*, *Polinices*, *Cernina*, and

Euspira (Agassiz), Morris and Lycett, 1850.

Spire more or less elevated; whorls few, distinct, angulated, or carinated.

Fossil, 6 species. Inferior Oolite—. Forest Marble. England.

"*Euspira* presents considerable affinities to the Palæozoic genus, *Scalites* (Hall), in the lines of growth having the appearance of a slight fissure, where the angle occurs in the volution." (Mor. and Lyc.)

Sigaretus (and sub-genus *Naticina*).

Lamellaria (*Oncidiopsis* and *Marsenia*), Velutina.

Amaura.

Type, A. candida, Möller. Greenland.

"*Animal* allied to *Natica;* foot small, compact without any posterior lobe; the front lobe deeply sinuated; eyes subcutaneous, situated at the internal base of the lobe; operculum terminal, few-whorled, horny, thin.

"*Shell* ovate, imperforate, spire small, produced; mouth reversed, pear-shaped, about half the length of the shell." (Möller.)

Fossil, species. Cretaceous. Germany, Britain.

DESHAYESIA, Raulin, 1844 (see p. 236).

Dedicated to M. Deshayes, author of "Description des Animaux sans Vertèbres dans le bassin de Paris," &c.

Synonym, Naticella, Grateloup (non Münster).

Type, D. Parisiensis, Raulin.

Shell subglobose, thick, umbilicated; spire short; aperture entire, semicircular, oblique; columella oblique; callosity denticulated; umbilicus covered by the callosity; right lip acute, smooth internally.

This genus presents a very remarkable combination of the characters of *Natica* and *Nerita*, and appears to establish a passage between these two genera, types of distinct families.

Distribution, 2 species. Oligocene and Miocene. Paris and Bordeaux Basins

PTYCHOSTOMA, Laube.

Fossil, 3 species. St. Cassian.

[FAMILY CANCELLARIDÆ.]

The genera are—

CANCELLARIA (*Admete*, p. 216), TRICHOTROPIS (p. 216), ? CERITHIOPSIS (p. 242), ? SEPARATISTA, and

PURPURINA,* D'Orbigny, 1850 (p. 222).

Type, Purpurina Bellona, D'Orbigny, Fig. 12.

* This genus has been the subject of careful research and revision by Messrs. Eugene Deslongchamps and Piette; and I think it advisable to replace the characters of this group, given in p. 222 of the Manual, by those emended by the authors above mentioned.

Shell oval, elongated, ventricose, thick; whorls rounded or rendered angular by the upper portion being channelled; last whorl much developed. Ornamentation usually of large longitudinal ribs, crossed by numerous striæ; aperture large in the young state, slightly notched in front; columella rounded; umbilical groove deep, narrow, but well defined.

Fossil, 8 species. Inferior Oolite—Kelloway Rock. England, France, Germany.

Fig. 12 *Purpurina Bellona.*

TORELLIA (Loven), Jeffreys, 1867.

Dedicated to Dr. Otto Torell, of Norway.

Type, T. vestita, Jeffreys. Shetland and Norway.

Animal with the produced lips and lingual dentition of *Capulus*.

Shell globose, covered with a velvety epidermis; spire very short; apex depressed; aperture roundish; pillar with a blunt tubercle at its base; groove internal, scarcely perceptible; operculum like that of *Trichotropis*.

[FAMILY NERITOPSIDÆ.]

Genera:—NERITOPSIS and NARICA with *Naticella* as a subgenus (see p. 261).

[FAMILY PYRAMIDELLIDÆ.*]

The following genera and sub-genera are additional:—

PYRAMIDELLA. Sub-genus *Chrysallida*, P. Carpenter, 1857.

Shell pupiform; peristone continuous; edge of lip thin; columella-plait distinct, though hidden; operculum in the typical species radiately corrugated.

Distribution, 25 species. E. and W. Indies, Japan, Mazatlan.

ODOSTOMIA. Some of the Mazatlan species have the peristone continuous.

Sub-genera:—*Auriculina*, Gray.

Shell having the general aspect of *Odostomia*, but presenting no vestige of a plait. Mazatlan, 3 species.

Fossil, 4 species. Tertiary. United States.

Parthenia, Lowe (*Ebalia*, Adams). Surface sculptured; columella plaited.

Distribution, 10 species. Mazatlan, Japan.

* See p. 238.

SCALENOSTOMA, Deshayes, 1863.

Type, S. carinatum, Isle of Bourbon.

Shell in form allied to *Pyramidella* and *Niso*, turriculated, white, imperforate; columella not plicated; opening subtriangular, slightly bent in the direction of its length; margin simple, notched near the suture.

CHEMNITZIA. Sub-genera :—*Dunkeria*, P. Carpenter (dedicated to Professor W. Dunker). Aperture as in *Chemnitzia*, but the whorls rounded as in *Aclis*; whorls cancellated.

Distribution, 7 species. Mazatlan, Japan.

Pseudomelania, Pictet and Campiche, 1864.

Etymology, *pseudo*, false, and *Melania*, a generic name.

Shell turriculated, spire acute, test thick, imperforate, without ornamentation. Aperture oval, rounded in front, more or less angulated behind; columella thick, conforming to the general curvature of the aperture; lip simple.

Distribution. Trias—Chalk. Europe, South Africa. The cretaceous species are 14 in number.

EULIMA. Sub-genus :—*Leiostraca*, H. and A. Adams (*Balcis*, Leach).

Shell with a slight varix on each side of the spire.

Distribution, 8 species. Mazatlan, Taboga.

ACICULINA, Deshayes, 1864.

Shell small, aciculated; apex laterally inclined; whorls numerous, convex, smooth; aperture entire, small, subquadrangular; columella straight, narrow, cylindrical, and simple.

Distribution, 6 species. Eocene. Paris basin.

MATHILDA, Semper, 1865.

Shell turriculated, apex revolute, abruptly turned from left to right; whorls in the typical species transversely cingulated and reticulated, longitudinally striated; aperture entire, subrotund, base sometimes subeffuse; lip acute; columella smooth, not plicated.

Distribution. The type *Turritella quadricarinatus*, Brocchi, is living in the Mediterranean, and is fossil in the Crag of Anvers, and at Bologna.

Fossil, 13 species. Eocene—. Europe, United States.

SOLENISCUS, Meek and Worthen, 1860.

Etymology, *soleniskos*, a little channel or gutter.

Type, S. typicus. Upper Coal Measures. Springfield, Illinois.

Shell fusiform, smooth, body whorls contracted below into a distinct straight canal, with an oblique plait on the columella.

Agrees with *Macrocheilus* in its smooth surface and columella fold, but differs in its fusiform outline, narrow aperture, and distinct canal. In its general appearance resembles *Fasciolaria*, but has only one instead of two or three columella folds, and is destitute of ornamentation, and its outer lip is smooth within.

Euchrysalis, Lambe.

Fossil, 6 species. St. Cassian, Austria.

[Family Stiliferidæ.]

The genera are :—

Stilifer.—Dr. Fischer supposes that *Stilifer*, though living like a parasite on the tegumentary system of the echinoderms or their appendages, does not feed on their substance, as has been supposed. Mr. Gwyn Jeffreys's impression is that it feeds on the excretions of the echinoderms.

Styliferina, Adams.

Shell imperforated, ovate conical, thin, smooth; whorls many, produced in a styliform spire; nucleus sinistral; aperture subquadrate; lip simple, straight.

Distribution, 2 species. Japan.

M. Freyer, of Trieste, is of opinion that *Entoconcha* (*E. murabilis*), which is parasitic on *Synapta digitata*, is the embryonic condition of a species of *Natica*.

Family III.—Cerithiadæ.*

Includes Cerithium (*Rhinoclavis* and *Bittium*), Triforis, Potamides (*Vicarya*, *Cerithidea*, *Terebralia*, *Pyrazus*, and *Lampania*), Nerinæa, and the following additional genera and sub-genera :—

Cerithium.—*Sub-genus.* *Sandbergeria*, Bosquet, 1860. Dedicated to Professor Sandberger. *Type*, Cerithium cancellata, Nyst. sp. *Shell* short, like *Cerithium*, canal terminal, very broad, and short. M. Bosquet describes the type as having an operculum as in *Stenothyra;* it is very questionable as to whether the operculum belonged to the shell.

* See p. 242, &c.

Distribution, 29 species. Cretaceous; India. Eocene. France, Netherlands.

EUSTOMA, Piette, 1855.

Type, E. tuberculosa, Piette.

Shell in the young state resembling *Cerithium;* in the adult, the margins of the aperture are much expanded and posteriorly united by an indistinct canal; canal elongated.

Fossil, 2 species. Great Oolite. Ardennes.

EXELISSA, Piette, 1861.

Etymology, exelisso, to unfold.

Synonym, Kilvertia, Lycett, 1863.

Type, Cerithium strangulatum, D'Archiac.

Shell small, elongated, subcylindrical, somewhat pupæform, many whorled, perpendicularly costated, tuberculated or spined; last whorl cylindrical, contracted at the base, with a tendency to separate from the axis; aperture orbicular, entire, the lips elevated, produced, and slightly thickened; columella solid.

Fossil, 14 species. Mid. Lias—Kimmeridge Clay. England and France. The shelly freestone of the Inferior Oolite, Gloucestershire, contains some undescribed species. Cretaceous, 1 sp.? India.

FIBULA, Piette, 1857.

Example, Turritella Roissyi, D'Archiac.

Shell elongated, columella straight, with a rudimentary groove near the base; outer lip arched, slightly notched at the suture; base of the aperture forming a slight canal, or rounded and entire, depending upon the exact period of growth at which the animal perished.

The species of this genus possess characters intermediate and approximating them to *Turritella* and to *Cerithium.*

Fossil, 21 species. Triassic—Cretaceous. Europe, India.

CRYPTOPLOCUS, Pictet and Campiche, 1854.

Etymology, cryptos, hidden; *ploce,* a plait.

Example, Nerinæa monilifera, D'Orb.

Shell, as in *Nerinœa,* without columella and labial plaits; one plait on the posterior face of the aperture, a disposition very analogous to that in some *Cerithiums,* such as *C. nodulosum;* aperture rounded, not channeled in front; umbilicated or imperforate.

Distribution, 7 species. Jurassic and Cretaceous. France, Switzerland, Germany.

PLANAXIS. M. Deshayes places this genus in *Littorinidæ*, but Dr. Macdonald states that it is anatomically closely related to *Cerithium*, the lingual teeth are similar, and that the auditory sacs contain spherical otoliths.

QUOYIA, Deshayes, 1830.

Dedicated to the celebrated naturalist to the Astrolabe.

Synonyms, Fissilabria, Brown; Leucostoma, Swainson.

Shell solid, elongated, conical, apex decollated; whorls flat, the body whorl sub-angular at the base; aperture small, semilunar, produced in front; columella thick, curved, truncated anteriorly, with a spiral fold posteriorly, operculum horny, paucispiral, nucleus lateral.

Distribution, 2 species. New Guinea, Cochin China.

Fossil. Eocene, Paris (1). Miocene, Dax (1).

The three following genera are provisionally referred to *Certhiadæ.*

CERITELLA, Morris and Lycett, 1850.

Etymology, diminutive of *Cerithium.*

Synonym, Tubifer (pars), Piette, 1856.

Type, Ceritella acuta, Mor. and Lyc.

Shell turreted, subulate, spire acute; whorls flat, margins usually sulcated; last whorl large; aperture elongated and narrow; canal short; columella smooth, rounded, and slightly reflected at the base; outer lip thin.

Fossil, 17 species. Middle Jurassic strata. England, France.

BRACHYTREMA, Morris and Lycett, 1850.

Etymology, *brachyos*, short, and *tremos*, a cut.

Examples, B. Buvignieri, Mor. and Lyc., B. Wrightii, Cotteau (Fig. 13).

Shell small, turreted, turbinated; whorls either costated, nodulated, or cancellated; the last whorl large and ventricose; columella smooth, rounded, twisted near its base, and reflecting outwards, forming a short, oblique canal; aperture moderately subovate, its length being usually less than that of the spire.

Some species, as *B. varicosa* and *B. pygmæa*, acquired at certain arrests of growth thickened outer lips or varices, as in *Triton.*

Fig. 13. *Brachytrema Wrightii.*

Fossil, 16 species. The greater number belong to the Great Oolite, others occur in the Kelloway Rock. England, France.

MESOSTOMA, Deshayes, 1864.

Example, M. grata, Dh.

Shell elongated, turreted, scalariform; aperture nearly circular, dilated, obliquely cut, terminating in front by a semi-canaliculated angle; columella slightly concave, cylindrical, obliquely truncated, lip simple, and slightly expanded.

Fossil, 4 species. Eocene. Paris basin.

[FAMILY APORRHAIDÆ, Gray, 1856,]

Includes the genera APORRHAIS (see p. 244), PTERODONTA, STRUTHIOLARIA (p. 246), and HALIA; also

ALARIA, Morris and Lycett, 1854.

Synonym, Tessarolax, Gabb, 1864.

Etymology, *ala*, a wing.

Examples, Alaria trifida, Phillips, sp.; A. cingulata, Pictet and Roux, sp.

Shell turreted, fusiform, terminating anteriorly by a canal; wing digitated or palmated, formed by the prolongation of the free border of the last whorl, and which is applied against the last whorl but one, but never adheres to the rest of the spire; posterior canal wanting; right lip without a sinus.

Distribution, about 50 species. Jurassic. Europe, Himalaya Mountains, South Africa. Cretaceous, 9 species. England, France, Germany.

The species of this genus have been referred to *Rostellaria*, *Pterocera*, and *Aporrhais*.

DIARTHEMA, Piette.

Shell with continuous varices.

Distribution. Lower Oolites. France.

Pelicaria vernis, Adams, has a spiral shell; the spire of adult covered with an enamel coat; aperture ovate; outer lip sinuous, sharp-edged.

? BULIMELLA, Hall, 1857.

Shell more or less fusiform; whorls convex, the last one much enlarged; columella truncated; outer lip thin, with a slight notch or sinus at the margin near its junction with the pillar.

Distribution, 3 species. Carboniferous. Indiana.

[Family Vermetidæ.]

The shells of species of this family are distinguished from those of the *Serpulæ* by the presence of a spiral nucleus and of concave smooth interior septa.

If the shell is formed of a solid matter strongly sculptured with longitudinal grooves or scales, or of a brownish colour, it is certainly formed by a *Vermetus;* but if the shell is of a soft earthy matter, feebly longitudinally grooved, it is doubtful to which it belongs.

The shells of the *Serpulidæ* have an anal opening (except *Cymospira*), and appear only to be composed of two layers, the *Vermetidæ* having three.

The interior of several species contains very long lamellæ, generally regarded of generic value; but they are dissolved with age, like the teeth of some species of *Pupa*.

All the *Vermeti* are viviparous, and the lamellæ within the tubes may serve for the retention of the fry.

The genera and sub-genera contained in this family are Vermetus (*Petaloconchus*, *Serpulorbis*) (p. 249), and Siliquaria (p. 249).

[Family Cæcidæ.]

Shell with a spiral nucleus; tubular, regular, sometimes fixed aperture orbicular; operculum horny, multispiral; margin sometimes fimbriated.

Cæcum, Fleming.*

Nuclear whorls orbicular, in the same plane as the adult, frequently decollated; operculum concave or flattened.

Sections :—*Elephantulum*. Comparatively of large size, tapering; sculpture longitudinal.

Distribution, 9 species. Mazatlan (6), West Indies, Mauritius.
Fossil, 1 species (C. liratum), Carpenter. Cor. Crag. Sutton.

Anellum (typical Cæca). *Adult shell* annulated.

Distribution, 14 species. Europe, Matzatlan, Australia, Japan.
Fossil, 2 species. Eocene. Paris, Suffolk.

Fartulum. Smooth, cylindrical.

Distribution, 10 species. Mazatlan, Teneriffe, Singapore, Australia.
Fossil, *C. mamillatum*, S. Wood. Cor. Crag. Sutton.

Sub-genera :—Brochina, Gray.

Type, Dentalium glabrum, Mont.

* See p. 249.

Shell like *Cœcum*, smooth; aperture simple, acute; apex closed by a mamillated plug; operculum, convex.

Distribution, 2 species. Europe, West Indies, Mazatlan.

MEIOCERAS, Carpenter.

Etymology, *meion*, rather small; *ceras*, horn.

Young shell spiral or flat; *adult* somewhat inflated; aperture oblique; operculum spiral, scarcely concave.

Distribution, 3 species. West Indies.

STREBLOCERAS, Carpenter, 1858.

Etymology, *streblos*, twisted; *ceras*, horn.

Shell with the spire not decollated, no plug formed; nuclear whorls orbicular, perpendicular to the plane of the adult; the plane of growth is flat, as in *Cœcum*, but some examples have a slight twist, forming an approach to *Meioceras*.

Fossil, 4 species. Eocene. Hampshire, Paris.

FAMILY V.—TURRITELLIDÆ*

Includes TURRITELLA, PROTO, MESALIA, and

CASSIOPE, Coquand, 1865.

Synonym, Omphalia, Zekeli, 1852 (non *Omphalius*, Philippi, 1847).

Example, Turritella Renauxiana, D'Orbigny.

Shell thicker, and with more rapidly increasing whorls than in *Turritella*, often pupiform; aperture rounded, continuous; outer lip notched or sinuated by an impressed furrow, which winds round the last whorl; columella usually distinctly umbilicated.

Distribution, 32 species. Cretaceous. Europe, India, and America.

[FAMILY SCALARIADÆ†]

Includes SCALARIA and the sub-genera *Eglisia*, *Pyrgiscus*, and *Cirostrema*, Mörch.

Shell solid, varices irregular, whorls generally cancellated.

COCHLEARIA, Braun.

Synonym, Chilocyclus, Bronn.

* See p. 248. † See p. 250.

Shell turriculated, thick; aperture circular, continuous, with a large expanded border.

Fossil, 2 species. Saint Cassian beds, Austria.

HOLOPELLA, McCoy, 1852.

Example, H. gregaria, Sow. (Turritella), Sil. Syst. t. 3, f. 1.

Etymology, *'olos*, entire, and *ope*, an aperture.

Shell elongated, slender, of numerous gradually increasing whorls, generally crossed by slightly arched striæ; mouth circular, with the peristome entire; base rounded, with or without a minute umbilicus.

The shells of the species composing this genus differ from those of *Turritella* in the continuous peristome and definite round margin to the aperture, thus approaching much nearer to *Scalaria*.

Fossil, 12 species. Silurian—Trias. Europe, United States.

FAMILY IV.—MELANIADÆ.*

MELANIA.—Tentacles long, with eyes on the exterior side at about a third of the length; margin of the mantle festooned.

Sub-genera, *Vibex*, *Melanatria*, *Hemsinus*, and

Philopotamis, Layard, *P. sulcata*, Reeve, sp. *Operculum* sub-spiral; nucleus marginal. *Shell* solid, paludiniform. *Distribution*, 5 species. Ceylon. Habit of *Tanalia*.

PALUDOMUS (*Type*, P. conicus, Gray), as restricted by the separation of *Philopotamis* and *Tanalia*, is characterised by the concentric structure of the adult operculum resembling that of *Paludina*, and a spiral nucleus situated about the middle of its height, and nearest to the left margin.

Distribution, India, Burmah, Egypt, East Indian Archipelago, Mauritius, Ceylon (2 species, reduced from 14). In tanks and marshes.

Sub-genus, *Tanalia*, Gray.

Synonym, Ganga, Layard, founded upon certain monstrous forms of *T. aculeata*.

Type, T. aculeata Chemnitz.

Shell semiglobose, costate, nodulose; mouth very large, ovate; operculum unguiculate; nucleus marginal.

Distribution, 2 species. Inhabiting mountain streams, adhering to rocks, or crawling over sandy bottoms, Ceylon.

Fossil, 2 species. Upper Chalk. Gosau

* See p. 246, &c.

Io, Lea, 1831.

Synonyms, Melafusus and Ceriphasia, Swainson; Pleurocera and Strepoma, Raf.; Trypanostoma, Lea; Telescopella, Gray.

Type, I. fluvialis, Say (Fusus).

Animal with the mantle margin plain; eyes at the base of the tentacles, which are short; operculum subspiral.

Shell fusiform, inflated, conical or oval; aperture produced into a more or less obvious canal in front.

Distribution, 100 species. North America.

Sub-genera, *Lithasia*, Haldeman, 1840. *Synonyms*, Angitrema, Haldeman; Potodoma, Sw.; Glotella, Gray.

Columella callously thickened above and below; base of aperture notched. *Distribution*, 31 species. North America.

Strephobasis, Lea, 1861 (Megara sp., A. and H. Adams). *Shell* with a retorse canal at the base of the squarish aperture.

Distribution, 8 species. North America.

Gyrotoma, Shuttleworth, 1845.

Synonyms, Goniobasis, Lea, 1862; Eurycœlon, Lea.

Shell solid, oval, oblong, or turreted; many forms resemble *Paludomus;* aperture subrhomboidal, subangular in front, without a canal; columella frequently callously thickened above; operculum subspiral, as in *Melania.*

Distribution, 289 species. United States.

Fossil, 8 species. Eocene. North America.

Sub-genera, *Schizostoma*, Lea, 1842 (*Schizochilus*, Lea; *Melatoma carinifera*, Anthony); aperture with a slit in the upper part of the outer lip immediately under the suture. *Distribution*, 27 species. North America.

Meseschiza, Lea, 1864. Slit in the middle of the outer lip. *M. Grosvenori.* Indiana.

Paladilhea, Bourguignat, 1865.

Dedicated to Dr. Paladilhe.

Shell somewhat resembling that of *Acme;* test thin, crystalline, extremely fragile; base of aperture produced in front; peristome continuous, thin, truncated; outer lip with a slit towards the suture.

Distribution, 3 species. Fresh-water deposits. Herault. One of the species is living in the neighbourhood of Montpellier.

Bugesia, Paladilhe, 1866.

Shell resembling somewhat a very small *Cerithium* or microscopic *Lithasia*, but differing generically in having a wide, compressed, not callous columella like that of *Lacuna*.

Distribution, *B. Bourguignati*. In washings of the River Lez, Montpellier.

Anculosa, Say, 1821.

Synonyms, Leptoxis, Rafinesque; Anculotus auctores.

Type, A. præmorsus.

Shell oval; aperture entire and rounded in front; columella callously thickened above.

Distribution, 31 species. North America.

Melanopsis, including *Pirena*, see p. 248, W. M., ii.

Family VII.—Paludinidæ.*

The genera contained in this family are—

Paludina, Ampullaria (*Pomus*, *Marisa*, *Asolene*), Lanistes, Meladomus, Bithinia, with the following sub-genera of the last:—

Stenothyra (*Nematura*), *Hydrobia*, *Syncera*, *Paludinella*, *Littorinella*, *Amnicola*, and

Moitessieria, Bourguignat, 1863.

Type, Paludina Simoniana, Charpentier.

Shell somewhat similar to that of *Acme;* test pitted; depressions octagonal, tetragonal, and rounded according to their position; peristome externally thickened; no operculum has been observed.

Distribution, 1 species. Saline springs at Fouradade (Pyrenees).

Fossil, 3 species. Alluvium of the river Garonne, at Toulouse.

Pomatiopsis, Tyron, 1865.

Synonym, Chilocylus, Gill.

Shell elongated; margin of aperture slightly expanded; operculum corneous, subspiral, without an internal process.

Animal like that of *Hydrobia*, but the foot is furnished with lateral sinuses; terrestrial or amphibious.

Distribution, species. America.

* See p. 257, &c.

[Family Rissoidæ]

Includes Litiopa (p. 255), Rissoina (p. 256), Rissoa (p. 255), and the following additional genera:—

Diastoma, Deshayes, 1864.

Type, Melania costellata, Lamarck.

Shell elongated, turreted; whorls with varices; aperture very oblique, semi-lunate, entire; base sinuated, subangular; posterior angle acute, detached from the penultimate whorl; lip thin, curved; columella concave, depressed, narrow.

Fossil, 4 species. Eocene. Paris basin.

Amphithalamus, P. Carpenter, 1865.

Type, A. inclusus. West Coast of North America.

Shell like *Rissoa*, nucleus large; aperture with a produced lip, suddenly contracted in the adult.

This genus bears the same relation to *Rissoa* that *Stoastoma* does to *Helicina*.

Keilostoma, Deshayes, 1848.

Type, Melania marginata, Lamk.

Shell elongated, turriculated, regularly conical; generally striated transversely. Aperture entire, short, effuse at the base, angulated posteriorly; columella short, callous; the peristome entire, the left lip broad and thick, the right broadly margined.

Fossil, Eocene, 6 species; Paris basin. Belgium, England, Punjaub. Cretaceous, 5 species; India, Gosau.

Pterostoma, Deshayes, 1864.

Type, P. tuba. Eocene. Grignon, Paris.

Shell elongated, turriculated; peristome continuous, circular, very dilated and margined; columella very broad, expanded, and continuous with the peristome.

Scaliola, Adams, 1860.

Type, S. bella.

Animal with the rostrum elongated, cylindrical, annulated, bifid at the end; tentacles filiform, eyes prominent, black at the outer base of the tentacles; foot short, ovate, posteriorly sub-acuminate; operculum corneous, ovate, subspiral; nucleus subterminal.

Shell turreted, umbilicated or rimose; aperture more or less circular; peristome continuous; margin straight, acute.

The species have the habit of agglutinating grains of sand to the surface of the shell.

Distribution, 4 species. Japan, Philippines, 2—70 fathoms.

Fossil, 1 species. Oligocene, Latdorf.

Microstelma, A. Adams, 1863.

Type, M. Dædala, Adams. Japan, 48 fathoms.

Shell turreted, ovate, rimose, somewhat resembling *Pyramidella;* spire conical; whorls longitudinally plicated. Aperture oblong, produced in front, sub-canaliculate; columella thickened, straightish; lip simple.

Fossil, 1 species. Sub-apennine formation. Asti, Italy.

Barleeia, Clark.

Named in honour of the late G. Barlee.

Type, Turbo ruber, Montagu. Britain, Mediterranean.

Animal and *shell* related to *Rissoa;* mantle and opercular lobe destitute of filaments; operculum solid, auriform, and gibbous, nucleus excentric.

Distribution, 3 species. Atlantic and Pacific Oceans.

[Family Skeneidæ]

Includes *Skenea* (p. 256), and

Homalogyra, Jeffreys, 1867.

Synonyms, Omalogyra, Jeffreys; Spira, Brown; Ammonicerina, Costa, 1861.

Etymology, a flat circle.

Type, H. atomus, Philippi (Skenea nitidissima, F. and H.).

Animal with a flattened body, no tentacles; eyes sessile, and placed behind the head.

Shell minute, forming a flat coil; spire involute; whorls more or less angulated; mouth clasping both sides of the periphery; operculum few-whorled, with a central nucleus.

The upper part of the body of *H. atomus* is partially ciliated. The tongue has only a single row of teeth, resembling miniature shark's teeth.

Distribution, 2 species. In pools, and just beyond low water, on sea-weeds and *Zostera.* Norway, Britain, France, shores of the Mediterranean.

Fossil, upper tertiary deposits.

FAMILY VI.—LITTORINIDÆ.*

The genera are—

LITTORINA, including *Tectaria*, *Modulus*, and *Risella*; LACUNA, and

FOSSARUS, Philippi (p. 253).

Synonyms, Phasianema, Wood; Maravignia, Arados.

Shell perforated, sculptured; inner lip thin; aperture semi-lunate; operculum not spiral.

Animal with two frontal lobes between the tentacles.

Distribution, 43 species, including species of the sub-genera. Mediterranean and tropical seas.

Fossil, 4 species. Miocene. Europe.

Sub-genera, *Conradia*, *Couthouyia*, *Cithna*, *Gottoina*.

Fossarina, Adams, differs from *Fossarus* in the curved inner lip and circular aperture. 2 species. Australia.

Isapis, H. and A. Adams. *Columella* with a plait; in *I. anomala* it is almost obsolete. 4 species. Jamaica and Mazatlan.

LACUNELLA, Deshayes, 1864.

Etymology, diminutive of *Lacuna* (see p. 255).

Type, L. depressa, Desh. Eocene. Paris.

Shell ovate, thin, pellucid, shining, very depressed; apex obtuse; aperture large, dilated; outer lip thin, reflected; columella narrow, thin, concave, grooved, with the base perforated.

? RAULINIA, Mayer, 1864.

Dedicated to M. Raulin.

Type, Odostomia alligata, Deshayes. Eocene. Paris basin.

Shell turbinated, oval-oblong, moderately thick, spirally sulcated; whorls rapidly increasing, convex; last whorl very large; aperture large, angulated posteriorly, expanded in front; columella broad, arcuate, flattened, with a prominent tuberculous tooth.

EUCYCLUS, E. Deslongchamps, 1860.

Etymology, *eu-kuklos*, circling, in allusion to the numerous plications or rings of the spire and base.

Examples, Turbo ornatus, Sow.; T. capitaneus, Münst.

* See p. 250.

Synonym, Amberleya,* Morris and Lycett.

Shell very thin (without a nacreous layer?); spire elongated, almost turriculated; surface ornamented by longitudinal plica-

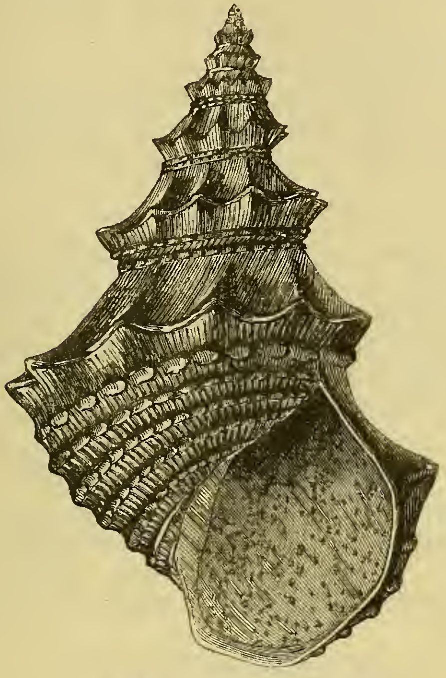

Fig. 14. *Eucyclus goniatus*, Desl..

tions and nodes; aperture oval, angular above; lip semi-circular, thin; columella flattened, imperforated.

Fossil, 23 species. Upper Lias— Kelloway Rock. England, France, Germany.

[Family Solaridæ]

Contains—

Solarium (see p. 253).

Sub-genera, *Torinia*, Gray.

Philippia, Gray (p. 253). *Shell* trochiform; umbilicus small. *Fossil*, 3 species. Miocene. America.

Disculus, Deshayes. *Shell* discoid; umbilicus very narrow, inferior angle of the aperture extended and oblique.

Adeorbis (p. 266), Cirrus (p. 271), Discohelix (p. 253), Euomphalus (pp. 267, 346), Bifrontia (p. 253), Platystoma (p. 254), Phanerotinus (p. 267), Maclurea (p. 345).

* This name was published in 1854, but the genus was insufficiently characterised.

OPHILETA, Vanuxem (p. 267), was founded on species of *Maclurea*, with very slender whorls. Mr. Billings regards them as distinct, and distinguishes them as follows:—"In *Maclurea* the aperture is entire, and the whorls usually large, but in *Ophileta* it has a sinus below and a notch above, while the whorls are usually more slender.

"In *Maclurea crenulata* (Billings) there is a sort of spiral band, and also there are indications of a sinus in the lip on the flat side, but they are only incipiently developed."—(Billings.)

STROPHOSTYLUS, Hall.

Etymology, *strepho*, I turn, and *stylus*, columella.

Shell subglobose or ovoid; spire small, body whorl large and ventricose; outer lip thin; columella twisted or spirally grooved within, not reflected; umbilicus wanting; aperture ovate or transversely oval; apparently related to *Platystoma*.

Distribution, 10 species. Silurian. United States.

HELIOCRYPTUS, D'Orbigny, 1850.

Shell depressed, orbicular; whorls embracing; umbilicated on both sides; aperture vertical, oval transverse.

Distribution. *H. pusillus*, Coral Rag, France, Germany; *H. radiatus*, U. G. S. Blackdown, Mans.

[FAMILY IANTHINIDÆ]

Includes—

IANTHINA and RECLUZIA (see p. 285).

FAMILY XII.—CALYPTRÆIDÆ.*

PLATYCERAS, Conrad, 1840 (see p. 277).

Type, Pileopsis vetusta, Sowerby.

Synonyms, Acroculia, Phillips, 1841; Orthonychia, Hall, 1843.

Shell depressed, subglobose to oblique, subconical; spire small; whorls few, free or contiguous; aperture more or less expanded, often campanulated, entire or sinuous.

Many species show a sinuosity of the striæ, indicating a notch in the margin of the aperture during the first stages of growth. Mr. Hall has been unable to recognise the peculiar muscular impressions which are characteristic of *Pileopsis*. Specimens of some species show the expansion of the columellar lip, and its partial or entire union with the volution, presenting all the

* See p. 275.

appearance of a thin columella with a deep umbilicus. P. *dumosum* is spiniferous ; *P. subrectum* is simply bent or arcuate.

Distribution, 46 species. Silurian—Carboniferous. Europe, North America.

FAMILY IX.—TURBINIDÆ*

Includes PHASIANELLA (p. 263), IMPERATOR (p. 264), TURBO (p. 263), with the following sub-genera :—

Callopoma, Gray. Distinguished by the extreme complexity of the operculum. "The opercula of *C. fluctuosum*, Gray (Turbo) (Maz.), are flat, and covered with a dark horny layer inside, displaying about 6 whorls. Outside with a broad, central, spiral callus, white and granular, concealing the umbilicus, with extremely minute pustules over the surface, sometimes with a few sharp prickles. A deeply cut groove surrounds the callus, followed by a green, plaited, spiral frill prickly inside. Between this and the outer margin are 4—6 fine emerald necklaces, supported on slender spiral ribs, with deeply channeled interspaces. The operculum of *C. saxosum*, inhabiting Panama, is formed on a much coarser plan."—(P. Carpenter.)

Uvanilla, Gray. *Example, U. olivacea*, Mexico.

Distinguished by the absence of an umbilicus, and the bi-ridged operculum.

Distribution, 3 species. Mazatlan, Mexico.

PHASIANELLA.

Sub-genus, *Eucosmia*, P. Carpenter, 1864.

Etymology, *eu*, well, and *cosmia*, adorned.

Shell solid, variegated as in *Phasianella ;* aperture and whorls round ; axis *umbilicated.*

Distribution, 4 species. Cape St. Lucas.

TROCHUS.

With the following sub-genera and sections :—

Margarita, Leach (p. 265). *Example*, T. helicinus, Fabr. *Shell* small, pearly, and umbilicated ; lateral cirri, 3—7 in British species. No typical *Trochi* appear to inhabit North-East America, only those of this section. 3 species, Britain.

Gibbula, Leach (p. 265). *Example*, T. magus, Linné. *Shell* low-spired and umbilicated ; lateral cirri, 3 on each side in the British species.

Circulus, Jeffreys. *Shell* very small, nearly flat-spired, with an exceedingly wide and open umbilicus. *Example*, Delphinula

* See p. 263.

Duminyi,* Requien; lateral cirri, 3 on each side (sometimes 4 on one side, and 3 on the other.—Clarke). *Fossil*, in the Coralline Crag; Britain; Catania. *Living*, Britain; Mediterranean.

Trochocochlea, Klein. Spire moderately raised; base, slightly umbilicated in the adult, perforated in the young, pillar lip with a strong tubercular tooth. Lateral appendages 3 to 4 on each side. *Example*, T. lineatus, Da Costa. Britain, France, Spain, Mogador.

Ziziphinus, Leach. Spire pyramidal, base imperforated; pillar lip notched or angulated at the lower part. *Example*, T. granulatus, Born. 7 species, Britain.

Omphalius, Philippi. *Type*, Trochus viridulus, Gmel. Mazatlan.

Shell with a spiral ridge surrounding the umbilicus, ending in one or more tubercles on the columella.

Distribution, 4 species. Mazatlan, China.

Pyramis, *Enida*, *&c.*

ROTELLA (see p. 265).

Sub-genera. *Isanda* (I. coronata), Adams. *Shell* orbicular, conical, pillar edge crenated; whorls rounded; axis umbilicated; operculum orbicular, of many whorls.

Chrysostoma, Gray. Turbo Nicobaricum, Gmel., related to *Isanda*. Pillar edge callous; operculum horny, spiral.

Microthyca, Adams, differs from *Isanda* in its continuous peristome and thickened outer lip. 1 species, Japan.

Umbonella, Adams. *Shell* porcellanous, small, turbinated, allied to *Chrysostoma*, but the aperture is circular, and the axis imperforate. 1 species, Japan.

LEUCORHYNCHIA, Crosse, 1867.

Etymology, *leucon*, white; *rhynchion*, a beak.

Type, L. Caledonica, Crosse; inhabits under stones, New Caledonia.

Shell depressed, sub-discoid, umbilicated, polished, of few whorls; aperture rounded, not nacreous. A thick callosity arises from the front margin of the aperture and the columella lip, and is continued as a free rostrated process over the umbilicus. Operculum corneous, rounded, multispiral; nucleus, central.

* Adeorbis supranitida and A. tricarinata are varieties.

TEINOSTOMA, H. and A. Adams, 1853.

Type, T. politum.

Synonym, Calceolina, A. Adams.

Shell like *Rotella*, with a greatly produced mouth and callus. It resembles *Cyclops* among the *Nassidæ*, and in the appearance of the base *Streptaxis* and *Anostoma* among the *Helicidæ*.

Distribution, 9 species. Japan, Mazatlan, St. Helena, Jamaica.

Fossil, 10 species. Eocene. Paris basin.

ETHALIA, H. and A. Adams.

Shell of the general aspect of *Vitrinella*, but agreeing with *Rotella* in having a callous base, and differing from the typical species of that genus in being frequently sculptured; in the callus winding round, generally not covering, the umbilicus; and in the outside of the callus not being glossy. The lip is generally not reflected over the body whorl.

They appear to retain permanently the young state of *Teinostoma*.

Distribution, 12 species, inhabiting deep water. Mazatlan, Jamaica, Japan.

MONODONTA.

DELPHINULA (including *Collonia*, *Liotia*, *Serpularia*, and *Crossostoma*).

CYCLOSTREMA, with *Adeorbis* and *Vitrinella* as sub-genera.

STOMATELLA, GENA, and BRODERIPIA.

FAMILY X.—HALIOTIDÆ.

Sub-family, HALIOTINÆ.

Genera—HALIOTIS (p. 268), STOMATIA (p. 268), TEINOTIS (p. 269).

Sub-family, SCISSURELLINÆ.

Genera—SCISSURELLA (p. 269), PLEUROTOMARIA (p. 270), (*Raphistoma* and *Scalites* are merely sections of this genus), MURCHISONIA (p. 270), CATANTOSTOMA (p. 270), TROCHOTOMA (p. 271), with the following additional genera and sub-genera:—

PLEUROTOMARIA (see p. 270).

Sub-genera:—*Leptomaria*, E. Deslongchamps, 1865. *L. amœna*, Deslong., sp. Shell like *Pleurotomaria;* the respiratory slit is narrow and elongated.

Distribution, Inferior oolite—Cretaceous.

Cryptœnia, E. Deslong., 1865. (*Helicina*, Sowerby) *C. heliciformis*, Deslong., sp. Shell of a rounded and compact form, surface smooth or but slightly ornamented, slit excessively short, sometimes reduced to a simple fold; the band occupies the middle of the whorl, and is only visible on the body whorl.

Distribution. The species are numerous in the Carboniferous system, and range to the Middle Lias.

In the typical *Pleurotomaria* the slit is large, and the band is never concealed by the whorls of the spire.

Schismope, Jeffreys, 1856.

Etymology, schisme, a slit, and *ope*, a hole.

Synonym, Woodwardia, Fischer, 1861.

Type, S. striatula, Ph. Mediterranean.

Shell like *Scissurella*, but the spire is laterally compressed, as in *Stomatia*, and is not so trochiform. The slit in the peristome of the young shell is converted into a foramen in the adult; it does not commence until the animal is half grown.

S. striatula is a littoral species, whilst all the species of *Scissurella* inhabit deep water.

Fossil, 1 species, Miocene, Bordeaux.

Distribution, 4 species. Mediterranean, Japan.

Scissurella and *Schismope* are the analogues respectively to *Pleurotomaria* and *Trochotoma*, differing only in size; but in the two former genera the shell is translucent, not nacreous, as in the two latter.

Ditremaria* (pars, D'Orb.), E. Deslongchamps, 1865.

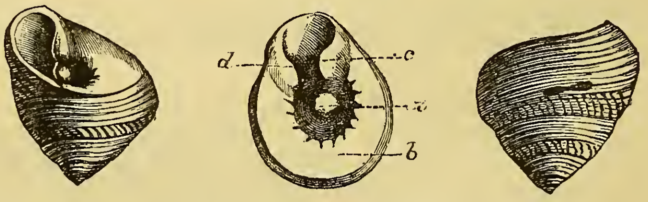

Fig. 15. *Ditremaria quinquecincta.*

a, Central tooth. *b*, Callosity of the base. *c*, Tooth on the right. *d*, Tooth on the left.

Type, D. quinquecincta, Ziet. sp. Coral Rag. Natheim, &c.

Shell trochiform; in place of the respiratory slit of *Trochotoma*, there are two elongated oval holes united by a transverse fissure; the base of the shell presents a large callosity, the umbilicus is deeply excavated, and a rounded tubercle arises

* See p. 271.

from it; the aperture is contracted, and the upper angle of each lip bears a more or less distinct tooth.

Distribution, 2 species, Great Oolite and Coral Rag, France and Germany.

Sub-family—BELLEROPHONTINÆ.

Genera :—PORCELLIA (p. 344), BELLEROPHON (p. 344) (with *Bucania*), and

TREMANOTUS, Hall, 1863.

Type, Bucania Chicagoensis, M'Chesney.

Shell thick, aperture dilated; having the form of *Bucania*, but with a row of isolated oval siphonal openings along the middle of the dorsal side.

Fossil, 2 species. Upper Silurian, North America.

? CARINAROPSIS, Hall.

Shell having a patelloid aspect. Spire usually attenuated; body whorl expanded abruptly; cavity shallow, presenting a kind of septum as in *Crepidula*.

Fossil, 2 species. Silurian, America.

FAMILY XI.—FISSURELLIDÆ.

DESLONGCHAMPSIA, M'Coy, 1850.

Dedicated to Dr. Eudes Deslongchamps, the renowned French palæontologist.

Type, D. Eugenei, M'Coy, Mor. and Lyc.

Shell patelliform, apex acute excentric; with a wide longitudinal anterior sulcus, produced into a rounded lobe.

"This genus differs from *Metoptoma* in its ornamented surface, and the front margin being produced downwards into a rounded lobe. This latter structure would prevent the firm adhesion of the shell."—(M'Coy.)

Fossil, 3 species. Lower Oolites. England, Normandy, Galicia.

FAMILY XIII.—PATELLIDÆ.

HELCION (Montfort, p. 278), Jeffreys.

Etymology, a breast-collar.

Synonyms, Nacella, Schumacher; Patina, Leach; Calyptra (pars), Klein.

Example, H. pellucidum. (Patella pellucida, Linné).

Shell semioval, not resembling a peaked hat as in *Patella;*

apex of embryonic shell slightly twisted; crown never prominent, incurved, and nearly terminal, usually thin, with an opalescent hue.

Animal. Mantle fringed at its edges with cirri; gills not so numerous as in *Patella*, and forming a shorter plume, which is interrupted over the head.

Helcion lives on *Laminariæ* and sea-weeds of a similar kind, and is therefore sublittoral.

Distribution. Species few, but having an extensive range. Europe, West and South Africa, Cape Horn, and Australia.

Fossil, included in *Patella*.

Lepeta, Gray (p. 281).

Derivation, possibly from *lepas*, the ancient name of the limpet.

Type, Patella cæca, Müller.

Shell minute, apex posterior. Animal blind.

Propilidium, Forbes and Hanley (p. 281).

Derivation, from its affinity to the genus *Pilidium*.

Type, P. ancyloide, Forbes.

Shell similar to *Lepeta*, but differing in always having a distinctly spiral apex and a plate or septum inside the crown.

Animal blind, as *Tectura fulva* and *Lepeta cæca* of this family. "The tongue is very long, and the brown central spines conspicuous under the microscope resemble bramble-thorns in miniature."—(Forbes and Hanley.)

Distribution, 1 species. Shores of Ireland, Scotland, Sweden.

Gadinia (p. 281).

Sub-genus:—*Rowellia*, Cooper. *Animal* with broad flat tentacles, rounded and pectinated in front, projecting beyond the shell; foot moderate, round. *Shell* as in *Gadinia*.

Family XIV.—Dentaliadæ.

Gadus, Rang, 1829.

Synonym, Helonyx, Stimpson, 1865.

Example, Dentalium clavatum, Gould.

Shell small, resembling that of *Dentalium*, contracted at the anterior extremity, polished.

Animal with a greatly elongated cylindrical foot, obtuse at the extremity; anal siphon longer than in *Dentalium*, not fissured.

Distribution, 2 species. China; Atlantic.

Fossil, 7 species. Cretaceous-Miocene. Paris; United States.

ORDER II.—PULMONIFERA.*

FAMILY I.—HELICIDÆ.†

SOPHINA, Benson, 1859.

Type, S. schistostelis, Bens.

Shell like *Helix;* columella callous, with a basal slit.

Distribution, 3 species. Moulmein.

CYLINDRELLA (p. 293).

Animal with no buccal plate; the lingual dentition varies considerably in different species; in *C. scæva*, Guild., the formula is $\frac{26 \,.\, 1 \,.\, 26}{130}$; the central plate is small, obtusely pointed, the laterals are uncinated, joined two by two, upper edge fringed.

"*C. Goldfussi* possesses 4 lamellæ on the outer wall of the whorls. The axis of *C. turris* and of some other Mexican species is a highly polished tube, the young shells of which must have a wide open umbilicus."—(Bland.)

MACROCERAMUS, Guilding.

The genus has affinities with *Bulimus*, *Pupa*, and *Cylindrella*.

Animal with an arcuate and striated buccal plate; lingual dentition distinct from that of *Cylindrella;* in *M. signatus*, Guild., $= \frac{27 \,.\, 1 \,.\, 27}{100}$, the central plate is narrow, with an obtuse tooth, laterals with one prominent tooth supporting two denticles and a small one at the base.

Fig. 16. Central plate and laterals of *M. signatus* (Morse).

Shell with the axis simple as in *Bulimus;* in *M. amplus* a lamella revolves on the axis within the lower whorls.

Distribution, 30 species. The genus belongs to the West Indian fauna, and has its greatest development in Cuba and Haiti.

ACHATINA.—Sub-genus, *Geostilbia*, Crosse, 1867.

Type, G. Caledonica, Crosse. New Caledonica.

* See p. 285.   † See p. 288.

Animal unknown; habit subterranean.

Shell similar to that of *Achatina acicula*, but the columella is not truncated, and the outer lip is thickened.

XANTHONYX, Crosse and Fischer, 1867.

Type, Vitrina Sumichrasti, Brot., Mexico.

Animal elongated, too large for complete retraction into the shell; jaw like that of *Arion*; lingual dentition consisting of a series of uniform teeth, with a broad and subquadrangular base; the median tooth with a large central cusp and denticle on each side; the laterals are bicuspid, the internal cusp long, the external short and obtuse, sometimes accompanied with the rudiment of a third; pulmonary orifice near the middle.

Shell imperforated, very thin, transparent, subdepressed, intermediate in form between *Vitrina* and *Simpulopsis*.

Distribution, 3 species. Mexico.

FAMILY II.—LIMACIDÆ.*

HYALIMAX, H. and A. Adams.

Type, Limax perlucidus, Quoy.

Animal limaciform, mantle large, shield-shaped; pulmonary orifice medial and marginal; foot attenuated behind, no mucus gland, separated below from the head by a distinct groove; jaw analogous to that of *Zonites* with the support of *Succinea*; lingual dentition with a tricuspid median plate, laterals with a large cusp, supporting two or three denticles.

Shell internal, rounded, thin, and slightly arched above.

Distribution, 2 species. Bourbon, Mauritius.

KRYNICKIA, Blainville, 1839.

Dedicated to the naturalist Krynicki.

Type, Limax megaspidus, Blainville.

Animal limaciform, but the anterior part of the mantle is free and detached from the body as far as the pulmonary orifice, which is situated far back.

Shell internal, flat, lamellose, elliptical, with no spiral nucleus.

Distribution, 8 species. Crimea, Caucasus, North America (1). Central America (1).

PHILOMYCUS, Rafinesque (p. 296).

Type, Limax Carolinensis, Bosc.

* See p. 295.

Synonym, Tebennophorus, Binney.

Animal elongated, convex, tapering behind, entirely covered by a thin mantle; respiratory orifice near the head; jaw smooth. No shell.

Distribution, 9 species. North America.

Sub-genus:—*Meghimatium*, Hasselt. *Syn.*, *Incilaria*, Benson. Body depressed, rounded at the end.

Distribution, 4 species. Java, Chusan.

Family IV.—Limnæidæ.*

Pompholyx, Lea, 1856.

Etymology, *pompholux*, lat. *bulla*.

Type, P. effusa, Lea. Sacramento river, California.

Shell gibbosely rounded, drawn back beneath, flattened above, imperforate; spire depressed; aperture very large, nearly round, effuse; outer lip acute, inner lip thickened, flattened.

Animal with two long tentacles, bearing eyes, and a second pair of eyes at the base on the inner side of the tentacles.

Distribution, 2 species. Western America.

Pitharella, Edwards, 1860.

Type, P. Rickmani, Ed. "Woolwich and Reading Series," Peckham and Dulwich, London.

Shell partaking of the characters of *Limnœa* and *Chilinia*, subcylindrical; aperture oval, rounded in front, narrowed behind; columella straight, or very obliquely twisted, arched anteriorly; outer lip simple, acute; inner lip thickened.

The species is associated with estuarine shells, remains of mammals and terrestrial plants.

Valenciennesia, Rosseau, 1842.

Dedicated to the late Professor Valenciennes of Paris.

Type, V. annulatus, Ros.; associated with fresh-water shells in a tertiary deposit, near Kertch, Crimea.

Shell resembles a gigantic Ancylus; apex much incurved; surface concentrically marked. A longitudinal plication extends from the apex to the right border, and corresponds with an internal channel; there is a second but less distinct plication on the left side.

Camptonyx, Benson, 1858.

Type, C. Theobaldi, Bens. Guzerat.

* See p. 300.

Shell like *Pileopsis*, dextral as in *Velletia*, with a respiratory channel on the right side.

"*Animal* with the respiratory orifice on the edge of the mantle. Eyes sessile at the middle of the hinder part of the base of the tentacles, and are visible only from above; tentacles rather conical than angular; upper mandible conspicuous, slightly lobed; lingual ribbon broad, with 86 rows of teeth, 87 in a row (43 . 1 . 43); they have simple obtuse hooks as in *Ancylus*; the central row only differs in being symmetrical; the laterals diminish gradually from the 14th to the 43rd, and a second cusp makes its appearance, and increases until the three near the margin are regularly bicuspid."—(Woodward.)

The habits of *C. Theobaldi* are terrestrial.

This genus is doubtfully distinct from *Valenciennesia.*

Poeyia, Bourguignat, 1860.

Dedicated to M. Poey of Havanna.

Type, P. Gundlachioides, Cuba.

Shell, above like *Gundlachia*, below like *Ancylus*; apex posterior, dextral, somewhat compressed, very obtuse; aperture large, peristome simple.

Brondelia, Bourguignat, 1860.

The two species Ancylus Drouetianus, Bourguignat, and B. gibbosa, Bourg., are terrestrial *Ancyli*, living on humid rocks in the forest of Edough, Boué (Algeria).

Acrochasma, Reuss, 1860.

Type, A. tricarinatum, Reuss, from the fresh-water limestones of Bohemia.

Shell trilateral, pyramidal, rounded below in its whole amplitude, with one posterior concave, and two lateral slightly convex planes, ending upwards in an acute reflected apex, beneath with a longitudinal aperture through the shell, which in its living state appears to have been covered with an epidermis. It may be considered as a fresh-water representative of the marine genus *Fissurella.*

Choanomphalus, Gerstfeldt, 1859.

Etymology, *choanos*, a funnel; *omphalos*, an umbilicus.

Type, C. Maacki, Lake Baikal.

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Shell related to certain *Valvatæ*, with an infundibuliform umbilicus; no operculum.

Distribution, 3 species. Lake Baikal, Siberia.

Physella, Pfeiffer, 1861.

Founded on *P. Berendti*, said to be a terrestrial shell from Mirador, Mexico.

Shell like *Bulla*, spire minute; last whorl elongated; columella simple, arched, not truncated; peristome simple, straight.

Family V.—Auriculidæ*

Contains the following genera:—

Auricula, Lamarck. (See p. 304.)

Sub-genera, *Alexia* (A. myosotis), Leach (p. 305); *Leuconia* (A. bidentata), Gray.

Polyodonta, Fischer (*Pythia*, Bolten) (p. 304).

Pedipes, Adams (p. 304).

Distribution, 6 species.

Sub-genus:—*Marinula*, King. M. pepita. The animal has not the transverse groove of the foot of *Pedipes*.

Shell more elongated and destitute of spiral striæ; two convergent parietal plaits, columellar plait smaller, oblique; peristome rather simple.

Distribution, 10 species. Madeira, South America, Australia, Philippines.

Melampus, Montfort (*Ophicardelus*, Beck; *Tralia*, Gray; *Laimodonta*, Nuttall; *Pira*, Tifata; *Signia* and *Persa*, Adams; *Cremnobates*, Sw.) (p. 304).

Sub-genus, *Cassidula*, Ferussac (*Rhodostoma*, Sw.; *Sidula*, Gray). Aperture banded.

Plecotrema, H. and A. Adams, 1853.

Type, P. typica, Adams.

Synonym, Lirator, Beck.

Shell ovate-conic, or rather fusiform, solid, spirally grooved; aperture oblong, contracted; columellar plait single, parietal plaits two, the lower of which is bifid; peristome thickened, sometimes terminating in a varix, bearing within two or rarely three teeth; axis imperforated or umbilicated.

* See p. 303.

Distribution, 14 species. Australia, Borneo, Philippines, China, Cuba.

BLAUNERIA, Shuttleworth, 1854.

Dedicated to M. Blauner.

Type, B. pellucida. Cuba, Jamaica, Florida, and Porto Rico.

Shell somewhat resembling *Achatina*, imperforate, oblong-turreted, thin; aperture narrow, elongated; body of the penultimate whorl bearing a single plait near the columella, which is rather truncated; peristome simple, straight.

Animal showing the characters of the family of the *Auriculidæ*, not of *Helicidæ*.

Distribution, 2 species. West Indies, Sandwich Islands.

STOLIDOMA, Deshayes, 1864.

Type, S. crassidens, Deshayes.

Shell oblong, turriculated, subcylindrical; apex obtuse, smooth polished; aperture elongated, obliquely inflected, narrowed behind, widened in front; columella straight, with a large median plait, compressed, and slightly oblique.

Distribution, 3 species. Eocene. Paris basin.

The shells of this genus are *Auriculæ*, with a single columella-plait, without teeth or plications on the right lip.

CARYCHIUM (see p. 305).

ZOSPEUM, Bourguignat, 1860.

Shell like *Carychium*; tentacles four; eyes absent.

Distribution, 11 species. Inhabiting the subterranean grottoes of Carniola. The animal is most active during the winter, at which time they propagate.

OTINA (see p. 238).

This genus is the type of a sub-family which has nearly the same relation to *Auriculinæ* as *Ancylus* to *Limnæa*.

Distribution, 3 species. Britain, United States, Benguela.

FAMILY VI.—CYCLOSTOMIDÆ.*

CYCLOSTOMA (see p. 306).

Sub-genus :—*Cyclotopsis*, Blanford, 1864.

Type, C. semistriatus, Sow.

Shell umbilicated, depressed, spirally striated; aperture subcircular; operculum concentric, multispiral, internally membranous, externally shelly; margins of the whorls raised.

Distribution, 5 species. India, Seychelles, Mauritius.

* See p. 306.

Cyclophorus (see p. 308).

Sub-genera :—*Jerdonia*, Blanford, 1861.

Type, J. trochlea, Benson sp. Nilgiri Hills, India.

Shell minute, umbilicated, pyramidal, horny, tricarinated; operculum concentric, arctispiral, with a marginal sulcus all round; membranous internally, shelly externally; inner edge of each whorl resting on the outer edge of the next.

Cyathopoma, Blanford, 1864.

Type, C. filocinctum, Benson sp.

Shell minute, umbilicated, turbinated, or somewhat depressed; epidermis thick, sometimes hispid, smooth, spirally striated, or lirated; operculum truncate, conoid, concentric, multispiral; internally membranous, externally shelly; external margins of the whorls raised in the form of shelly plates, incurved; sometimes sculptured.

Animal white, with a short oval foot, undivided beneath; tentacles small, black, with eyes at the base.

Distribution, 5 species. India.

Spiraculum, Pearson.

Distinguished by the possession of a retroverted sutural tube open at both ends, and by a modification of the form of the mantle corresponding to the same.

Opisthoporus forms a sub-genus to *Spiraculum*.

Clostophis, Benson, 1860.

Etymology, *clostos*, coiled, and *ophis*, a serpent.

Type, C. Sankeyi, Benson. Moulmein, Burmah.

Shell subconic; penultimate whorl the largest, last whorl separate and descending, subaxial small; aperture subcircular, entire, toothed; margin expanded.

Rhiostoma, Benson, 1860.

Etymology, *rhion*, a promontory.

Type, R. Haughtoni, Benson.

Shell subdiscoidal, broadly umbilicated; last whorl separate, laterally descending; aperture free, with an incision at the top, and a subtubular prominence crowning the slit; operculum multispiral.

Distribution, 6 species. Burmah, Siam, Cochin China.

ANAULUS, Pfeiffer, 1855.

Type, A. bombycinus. Borneo.

Shell umbilicated, pupinæform; peristome double, internal continuous, external dilated, perforated at the margin by a canal; canal sutural and internal, terminating anteriorly, and embraced by the outer portion of the double peristome (it can be traced externally along the last whorl), and reaching into the concavity of the spire. Operculum very thin, corneous; narrow-whorled.

Distribution, 3 species. East Indian Archipelago.

"The use of the sutural tube seems to be the preservation of a communication with the external air when the aperture is closed."—(Benson.)

OPISTHOSTOMA, Blanford, 1860.

Synonym, Plectostoma, Adams, 1865.

Type, O. Nilgirica, Blanford. The Nilgiris, India.

Shell pupiform, umbilicated, with a regular costulated ornamentation; apical whorls obliquely distorted; last whorl strangulated, separated from the others, and applied to the penultimate; peristome double, free portion prolonged backwards; operculum horny (?)

O. De Crespigni, Adams (*Plectostoma*), has a conical spire, and the apical whorls are not excentric to the axis of the lower whorls, as they are in the ovate spire of *O. Nilgirica*.

Distribution, 5 species. India, Borneo, West Africa.

[FAMILY PROSERPINIDÆ.]

Animal with a short annulated muzzle; tentacles two lateral, subulate; eyes subsessile on the outer side of the base of the tentacles; sides simple; foot moderate, truncated in front, acute, and keeled above behind, with a concavity in the front part; lateral and central teeth large, irregular, lobed, or dentated; operculum wanting.

Shell heliciform, shining, imperforated; base callous; the septa between the upper whorls absorbed as in *Helicina* and *Stoastoma*.

This family is most nearly related to *Helicinidæ*.

CERES, Gray, 1856.

Etymology, *Ceres*, the goddess of corn.

Type Carocolla eolina, Duclos.

Shell carinated, upper surface rugose, epidermis thin; callous beneath, shining; columella with one tooth or fold; lamelliferous on both sides of the aperture; peristome straight, slightly thickened.

"The lingual membrane of *C. Salleana*, Cuming, is broad, elongate, with numerous longitudinal series of teeth. Teeth 00·5·1·5·00; the central tooth (*o*, Fig. 17) oblong, distinct, with

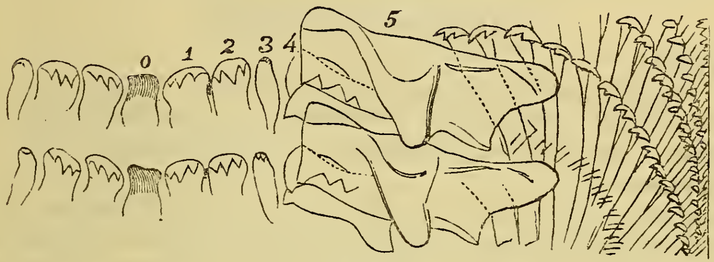

Fig. 17.

a broad simple reflexed tip; the first and second lateral teeth (1 and 2) rather broader than the central one, with a three-toothed recurved tip; the third (3) narrow, elongate, with a slightly recurved end; the fourth and fifth (4 and 5) much larger, oblong, and irregular shaped; the fourth about half as wide as the fifth, with three or four dentations on the inner side of the upper edge; the fifth very large, broad, with a large subcentral reflexed lobe; the lateral teeth are very numerous, subequal, similar, compressed, transparent, with a recurved tip, those of the inner teeth of the series being bifid."—(Gray.)

Distribution, 2 species. Mexico.

Proserpina, Gray, 1840.*

Etymology, *Proserpina*, the daughter of Ceres.

Type, P. nitida, Gray.

Synonym, Odontostoma, D'Orbigny.

Shell globose or depressed, smooth, shining; columella with one fold; body of the penultimate whorl provided with one or many spiral plaits, or wanting; aperture lunate, contracted often by palatal laminæ; peristome thin, straight.

P. Swiftii has the columella fold only, and is the sole representative of the family at present known to inhabit South America.

Distribution, 7 species. Cuba, Jamaica, Venezuela.

* See p. 289.

PROSERPINELLA, Bland, 1865.

Etymology, diminutive of *Proserpina*.
Type, P. Berendti, Bland.
Distribution, Mexico, 3000 to 4,000 feet.
Shell as in *Proserpina;* columella fold absent; aperture with one parietal lamelliform plait.

[FAMILY HELICINIDÆ]

Contains:—
HELICINA (*Lucidella*, *Trochatella*, *Alcadia*).
Schasicheila. *Shell* with very close, long, spiral, epidermal fringes. *Distribution*, 5 species. Central America and the Bahamas.
Perenna, Guppy, 1867; P. lamellosa, Guppy, Trinidad. *Shell* like *Helicina*, depressed; whorls lirate and carinate. Operculum thin, suboval, concentrically striated; nucleus subcentral. *Animal* like *Helicina*. *Distribution*, 2 species. Trinidad, Yucatan.

BOURCIERA, Pfeiffer, 1851.

Type, B. helicinæformis, Pf.
Shell like *Helicina*, dull, and without the columellar callosity; columella toothed beneath; aperture ovate; peristome spreading. Lingual dentition agrees with that of *Helicina*. Operculum ovate, horny, few-whorled.
Distribution, 2 species. South America.
STOASTOMA, and

GEORISSA, Blanford, 1864.

Type, Hydrocena pyxis, Benson.
Animal furnished with hemispherical lobes in the place of tentacles; eyes normal; foot short, rotund. Operculum semi-oval, no spiral structure as in *Helicina;* excentrically striated, testaceous, transparent.
Shell resembling that of *Hydrocena*, imperforated, small, conical, amber-, or reddish-coloured, spirally sulcated or striated.
Distribution, 6 species. Adhering to limestone rocks, India.

[FAMILY ACICULIDÆ.]

The genera enumerated in this family are:—ACICULA, GEOMELANIA, CHITTYA, and TRUNCATELLA, the last with the following

Sub-genus:—*Taheitia*, H. and A. Adams, 1863.

Type, Truncatella porrecta, Gould, Taheiti. Operculum shelly, furnished with erect radiating lamellæ. Aperture of shell ovate; last whorl separate; peristome continuous, expanded.

Order III.—Opistho-branchiata.

Family I.—Tornatellidæ.

Etallonia, Deshayes, 1864.

Dedicated to M. Etallon, a French palæontologist.

Type, E. cytharella, Desh.

Shell ovate, subfusiform, resembling certain small *Mitres;* spire short, conical, obtuse, few-whorled; aperture elongated, narrow, base entire, subemarginate; lip simple, acute, arched; columella thick, cylindrical, twisted in the middle to resemble an obtuse plait; acute anteriorly.

Distribution, 3 species. Eocene. Paris basin, Valognes.

Actæonella.—Sub-genus, *Volvulina*, Stoliczka, 1865; (Actæonella part, Meek, 1863).

Type, Volvaria lævis, Sowerby.

Shell ovate, volvuliform, involute, more or less attenuate above, widest below the middle, entirely without any traces of a spire.

Fossil, 5 species. Cretaceous. Germany, Syria.

Family VI.—Doridæ.

Angasiella, Crosse, 1864.

Dedicated to Mr. G. F. Angas.

Type, A. Edwardsi, Port Jackson.

Animal elongated, rounded in front, attenuated and pointed behind; mantle covering the head and foot; dorsal tentacles two, clavate as in *Doris;* gills plumose, less numerous, and placed in front of the anus as in *Triopa*, and occupying the median part of the back, a more forward position than in others of the *Doridæ*.

Plocamophorus, Ruppell.

Example, P. Ceylonicus, Kelaart sp.

Synonym, Peplidia, Lowe; ? Gymnodoris, Stimpson.

Animal, similar to *Polycera*, but the tentacles are retractile within sheaths.

Distribution, 3 species. Madeira, Australia, Ceylon.

KALINGA, Alder and Hancock, 1863.

Etymology, an old Indian name for *Telinguna*.

Type, K. ornata, Ald. and Han. Coromandel coast.

Animal with an obtusely rounded body; branchiæ plumose, non-retractile, surrounding the vent, but placed separately at a little distance from it on the posterior part of the back.

[FAMILY DORIDOPSIDÆ, Alder and Hancock, 1863.]

Dorsal tentacles retractile within sheaths; no oral tentacles. Tongue atrophied, buccal bulb modified into a delicate suctorial retractile proboscis; mantle devoid of spicula.

DORIDOPSIS, Alder and Hancock, 1863.

Body depressed, oval or elliptical; mantle covering the head and foot, smooth, or with soft warty tubercles; dorsal tentacles laminated; head minute, generally produced into small lateral lobes, without oral tentacles; branchiæ plumose, wholly or partially surrounding the vent on the media-dorsal line, retractile within a common cavity.

Distribution, 10 species. East Indies, China, Madeira.

FAMILY VII.—TRITONIADÆ.*

HERO, Loven.

Example, H. formosa, Lov.

Animal with no mantle; tentacles two, linear, simple non-retractile; veil plain, produced at the sides, gills branched or umbellated. Tongue with a large central denticulated spine, and two simple lateral spines. Jaws corneous.

[FAMILY EOLIDIDÆ.]

PHIDIANA, Gray.

Example, P. Patagonica, D'Orbigny.

Animal with a stout body; dorsal tentacles clavate, laminated; oval tentacles very large; gills in close transverse rows; sides of the foot rounded.

[FAMILY EOLIDÆ.]

MADRELLA, Alder and Hancock, 1863.

Type, M. ferruginosa, Ald. and Han. India.

Animal ovate, depressed, with a distinct cloak. Dorsal tentacles with the upper portion papillated: *no oral tentacles*. Head broad, with a semilunar veil. Branchiæ papillose or linear, placed in several rows round the margin of the cloak. *Anus*

* See p. 332.

lateral. Tongue narrow, with three pectinated plates in each row. Jaws large and strong, margins without denticulations. This genus is closely related to *Antiopa.*

PHYLLOBRANCHUS, Alder and Hancock, 1863.

Type, Proctonotus orientalis, Kelaart. India.

Animal elongated, flattened on the back, angulated at the sides, without a distinct cloak. Tentacles two, dorsal, longitudinally folded, bifurcate above, non-retractile. Head produced at the sides into angulated and folded expansions. Branchiæ leaf-like, with distinct foot-stalks, arranged in several rows along the sides of the back and round the head in front. Anus lateral. The tongue resembles that of *Hermæa.*

CLASS IV.—BRACHIOPODA.*

FAMILY I.—TEREBRATULIDÆ.†

TEREBRATULA (see p. 363).

Sub-genus, *Rensselæria*, Hall, 1859.

Dedicated to the late Hon. Stephen Van Rensselaer.

Examples, R. ovoides, Hall, Fig. 18; Terebratula strigiceps, Römer.

Shell ovoid or suborbicular, without mesial fold or sinus; beak prominent, acute, more or less incurved; foramen terminal, sometimes concealed. Ventral valve with two diverging cardinal teeth supported by strong dental plates. Dorsal valve with the dental sockets between the shell and a strong process from which the slender crura proceed, first in a direct line, and then one division of each, diverging into the centre of the ventral valve, terminate in acute points. On the other side the divisions extend nearly at right angles to the axis of the shell into the cavity of the dorsal valve; and thence bending abruptly forward and gradually converging, terminate above the centre of the shell in a thin flattened or longitudinally concave plate.

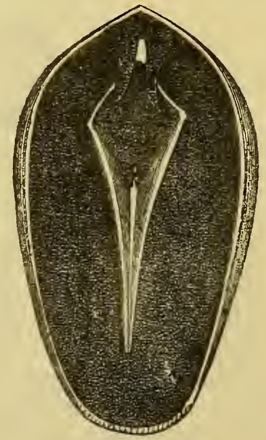

Fig. 18.
The interior of the dorsal valve of *R. ovoides*, showing the thickened processes at the beak, the crura, the loop, and the narrow longitudinal plate.

* See p. 354. † See p. 363.

Rensselæria, if not synonymous with, is closely related to, *Meganteris*.

Fossil, 11 species. Silurian to Devonian. Europe, North America.

CENTRONELLA, Billings, 1859.

Etymology, diminutive of *kentron*, a spur.

Type, Rhynchonella glans-fagea, Hall.

Shell having the general form of *Terebratula*. Dorsal valve with a loop consisting of two riband-like lamellæ, which were united at an acute angle at the point of greatest extension, whence they recurve in a thin vertical plate which is not attached at either margin, approaching in some respects to *Waldheimia*.

Distribution, 4 species. Devonian. North America.

LEPTOCŒLIA, Hall, 1859. (Cœlospira, Hall).

Appears to differ from *Centronella* only in consisting of species which have the surface ribbed instead of smooth.

Distribution, 9 species. Mid. Silurian—Devonian. Europe, North America. No true Terebratulæ have been found in beds older than the Devonian.

FAMILY II.—SPIRIFERIDÆ.*

SYRINGOTHYRIS, Winchell, 1863.

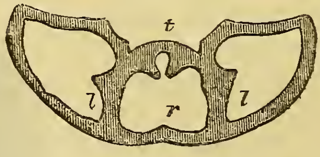

Fig. 19. Section through the beak of the ventral valve of *S. typa* (Winchell). *l*, dental plates or lamellæ; *t*, tube incomplete; *r*, mesial ridge.

Examples, S. typa, Winchell, Fig. 19; Spirifera distans, Sow.

Shell like that of *Spirifera*, with an elongated hinge-line. *Ventral* valve with a broad mesial sinus, a very broad area, and a narrow triangular fissure closed towards the apex by an external convex pseudo-deltidium; beneath which, and diverging from it, is another *transverse plate* connecting the vertical dental lamellæ, which are incurved so as to nearly join their inferior edges, thus forming a *fissured tube*, which projects beyond the limits of the plate from which it originates into the interior of the shell. A low median ridge extends from the

* See p. 271.

beak to the anterior part of the valve. *Dorsal* valve depressed without an area, and with a distinct mesial fold. *Shell-structure* punctate.

Fossil, 2 species. Carboniferous. United States, Ireland, Belgium.

CYRTINA, Davidson, 1858.

Etymology, modified from the diminutive (*Cyrtidium*) of *Cyrtia*.

Examples, C. heteroclyta, C. Demarlii, and C. septosa.

Shell resembling *Spirifera*, but without the vertical shelly plates which diverge from the extremity of the beak. Interior of *ventral* valve with two contiguous vertical septa, which coalesce into one median plate, which extends from the extremity of the beak to within a short distance of the frontal margin, and then diverges to form dental plates, as in *Pentamerus*. The fissure is covered by an arch-shaped deltidium; but in *C. Demarlii* the median septum is continued as far as the under surface of the deltidium, and the dental plates are fixed to the sides, instead of the upper edge, as in *C. heteroclyta* and *C. septosa*.

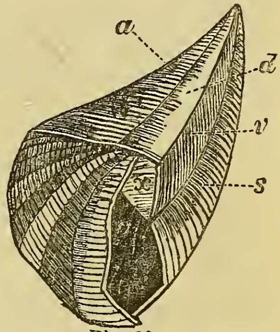

Fig. 20.
Cyrtina heteroclyta. *a*. Area; *s*, Septum; *v*, Dental plates; *d*, deltidium; *x*, v-shaped chamber.

"Spiral coils having the same position as in *Spirifera*, but the two first coils are connected a little in front of the mid-length by an apparatus somewhat like that of *Spirigera*, but not so complicated. A very slender process springs upwards towards the ventral valve from each coil, and, at a height of about one line, curves forwards. The two then unite and form a single band, which extends forwards to about the front of the coil, and there ends in an obtuse point."—(Billings.)

Distribution, 9 species. Devonian—Trias. Europe and North America.

MERISTELLA, Hall, 1860.

Etymology, diminutive of *Merista*, an allied genus.

Examples, Atrypa tumida, *Dal.*; Meristella lævis, Hall.

Shell oval, ovoid, orbicular or transverse. Valves unequally convex, with or without a median fold and sinus; beak apparently imperforate, incurved; area none. Surface smooth or concentrically striated. *Dorsal* valve with a longitudinal septum; upper part of the *ventral* valve with a deep sub-triangular muscular impression which unites with the rostral cavity.

The species of this genus are *Meristæ* without the peculiar appendage of the ventral valve.

Distribution, 17 species. Silurian—Devonian. Europe, North America.

The forms marked by plications on the mesial fold and sinus, and sometimes with obscure or distinct plications on the lateral portions of the shell, constitute the genus LEIORHYNCHUS, Hall. 4 species. Devonian. United States.

CHARIONELLA, Billings, 1861.

Synonym, *Cryptonella*, Hall, 1861.

Type, Athyris scitula.

Shell resembling *Athyris*, but more elongate-ovate or approaching to *Terebratula* in form. *Internal spires* as in *Athyris* and *Merista*, but the dorsal hinge-plate is either obsolete along the middle, or anchylosed to the bottom of the valve. *Foramen* terminal, bounded on the lower side by one or two deltidial pieces, or by a portion of the shell. The mesial septum in the dorsal valve is either absent or rudimentary.

Distribution, 15 species. Devonian. America, Spain.

NUCLEOSPIRA, Hall, 1859.

Etymology, *nucleus*, and *spira*.

Types, Spirifer pisum, Sowerby; Nucleospira ventricosa, Hall, Figs. 21, 22, 23.

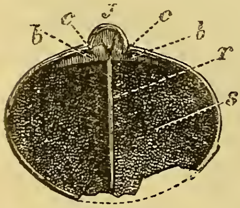

Fig. 21.

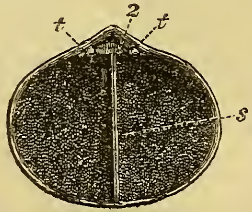

Fig. 22.

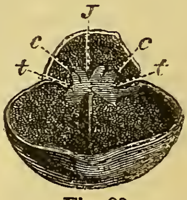

Fig. 23.

Nucleospira ventricosa.

Fig. 21, interior of the dorsal valve. Fig. 22, interior of the ventral valve. Fig. 23, interior of the dorsal valve, with a portion of the ventral valve attached.

J, cardinal process; *c c*, crural processes; *b b*, dental pockets; *r*, muscular impressions; *s*, medio-longitudinal septum; *t t*, teeth; 2, a flattened space or false area beneath the beak. (*Hall.*)

Shell punctate; spheroidal; beaked; hinge line shorter than the width of the shell; cardinal extremities rounded. Internal spires as in *Spirifera*. *Ventral* valve with a flattened space or false area beneath the beak, on each side of which, at the base, is a strong tooth; a narrow medio-longitudinal septum extends from the beak to the base. *Dorsal* valve furnished with a strong spatulate cardinal process, which, rising vertically from the cardinal margin, is closely grasped at its base by the cardinal teeth of the other valve; and thence bending abruptly upwards, and expanding, is projected into the cavity of the opposite beak, lying close upon the under side of the false area. Cardinal process grooved to allow of the passage of the peduncle, for the protrusion of which a minute foramen is sometimes observed in the beak. The crural processes originate at the base of the cardinal process. A medio-longitudinal septum as in the ventral valve.

Surface of shell apparently smooth, under a lens punctate; when perfect, covered with minute hair-like spines.

The larger species of this genus present some analogy in external appearance with *Spirigera*, and the presence of internal spires increases the similarity. The cardinal teeth resemble those of *Spirigera* and *Merista*. In form, and in the punctated test, it simulates *Magas*; while the elongate cardinal process of the dorsal valve resembles that structure in Thecidium.

Distribution, 7 species. Silurian. United States, England

Trematospira, Hall, 1859.

Etymology, *trema*, a foramen, and *spira*.

Example, T. multistriata, Hall.

Shell transverse, elliptical, or subrhomboidal, furnished with internal spires (arranged as in *Spirifera*); hinge line shorter than the width of the shell. Valves articulated by teeth and sockets; beak of ventral valve produced or incurved and truncated by a small round perforation separated from the hinge line by a deltidium. A deep triangular pit or foramen beneath the beak, *which is filled by the closely incurved beak of the dorsal valve*. False area sometimes defined.

Distribution, 7 species. Upper Silurian—Middle Devonian. United States.

This genus and the next appear to be closely related to *Retzia*.

RHYNCHOSPIRA, Hall, 1859.

Etymology, ρυγχος, a beak, and *spira;* in allusion to its similarity in form to *Rhynchonella*, and having internal spires.

Type, Waldheimia formosa, Hall.

Shell somewhat similar to *Rhynchonella*, but usually more symmetrically rounded, and with less distinct mesial sinuosities; and in these characters they resemble *Waldheimia*.

Valves articulated by teeth and sockets, similar to those of *Nucleospira*; the crura supporting two conical spires. The cardinal process of the dorsal valve is a broad emarginate plate; beak of the ventral valve largely perforated. Surface plicated or striated.

Distribution, 7 species. Silurian—Devonian. United States, Russia.

ATRYPA (see p. 378).

The internal appendages of *Atrypa reticularis* (see Fig. 24) consist of a pair of spiral cones, placed side by side, with their apices directed towards the cavity of the dorsal valve; the lamellæ have their origin on the socket-walls, and run parallel with the inner margin of the valve. "The spiral cones are connected by an entire and continuous loop, which is confined to the rostral part of the shell. The loop arises from the posterior portion of the first volutions of the spires, and curves gently forward and upward; the central or elevated portion is situated between and behind the cones, and forms a more or less abrupt curve, or is prolonged into a point directed towards the dorsal valve. The existence and form of this loop have been ascertained in several different varieties of *A. reticularis*, as well as in *A. spinosa*, Hall."—(Whitfield.)

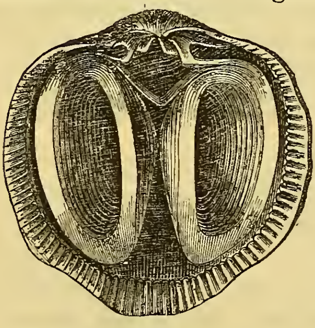

Fig. 24.

Sub-genus, ZYGOSPIRA, Hall, 1862.

Synonym, Stenocisma, Conrad, 1847. Spiral cones connected by an entire and continuous loop in a very similar manner to that shown to exist in *Atrypa reticularis;* but the loop having its connection with the spiral lamellæ at a point relatively more distant from their origin on the hinge plate, and passing over, or in front of the spires.

FAMILY III.—RHYNCHONELLIDÆ.*

EATONIA, Hall, 1859.

Dedicated to the late Professor Amos Eaton.

Examples, Atrypa peculiaris, Conrad; A. singularis, Vanuxem.

Shell like that of *Rhynchonella;* the lower half of the ventral valve with a broad deep sinus. Valves articulating by means of two teeth in the ventral valve, with corresponding sockets in the dorsal valve, and a median septum embraced between the deeply bifurcating cardinal process of the opposite one.

Dorsal valve with four crural processes; in the ventral valve the dental plates are represented by elevated lamellæ surrounding the muscular impression, which is much stronger and differs in some respects from that of *Rhynchonella.*

Fossil, 7 species. Upper Silurian. United States.

CAMERELLA, Billings, 1859.

Examples, C. Volborthi, Billings; Atrypa extans, Hall.

Synonym, Triplesia, Hall, 1859.

Ventral valve with a small triangular chamber beneath the beak, supported by a short mesial septum as in *Pentamerus.* Dorsal valve with a single mesial septum and two short lamellæ for the support of the oral appendages, as in *Rhynchonella.* Surface smooth or obscurely plicated.

Distribution, 9 species. Lower Silurian. North America.

EICHWALDIA, Billings, 1858.

Dedicated to Professor Eichwald, the celebrated Russian palæontologist.

Type, E. subtrigonalis, Lower Silurian. Canada.

Shell with the ventral valve perforated on the umbo for the passage of a peduncle; the place of the foramen beneath the beak being occupied by an imperforate concave plate; the interior of each valve divided by a medio-longitudinal ridge, that of the dorsal valve very prominent; hinge and teeth sockets wanting.

The internal structure of the ventral valve somewhat resembles that of *Pentamerus* or *Camorophoria.*

Distribution, 3 species. Silurian, Canada; England.

STRICKLANDINIA, Billings, 1863.

Dedicated to the late Professor H. E. Strickland.

Synonyms, Stricklandia, Billings, 1859 (non Buckman); Rensselæria (pars), Hall.

* See p. 375.

Type, Pentamerus lens, Sowerby.

Shell usually large, elongate-oval, &c.; valves *nearly equal, never globose;* a short mesial septum in the interior of the ventral valve supporting a small triangular chamber beneath the beak as in *Pentamerus;* in the dorsal valve no longitudinal septa, spires, or loop, the whole of the internal solid organs consisting of two short or rudimentary dental plates, which in some species bear prolonged calcified processes for the support of the cirrated arms. A more or less developed area in the ventral valve.

In *S. lævis* and *S. microcamerus* the hinge line is straight and much extended. In *S. Arachne*, Billings, the area of the ventral valve is so much developed as to give the whole shell the external appearance of an Orthis.

Distribution, 10 species. Middle Silurian, Europe, America. *S. elongata*, Vanuxem, is the only species known in the Devonian rocks.

Family IV.—Orthidæ.*

Skenidium, Hall, 1861.

Etymology, *skenidion*, a little tent.

Type, Orthis insignis.

Shell having the general aspect of *Orthis*, except in the extreme elevation of the ventral valve; cardinal process prolonged into a median septum, which extends to the base or front margin of the shell, and occasionally bifurcates at this lower extremity. *Area* large and triangular in the typical species.

Distribution, 3 species. Silurian, United States.

Streptorhynchus, King, 1850 (see p. 380).

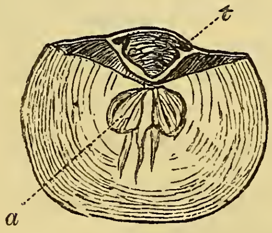

Fig. 25.

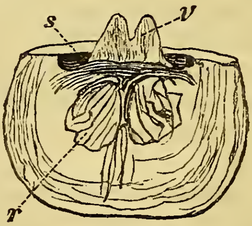

Fig. 26.

Streptorhynchus pelargonatus.

Fig. 25.—Interior of the ventral valve; *t*, teeth; *a*, cardinal muscular impressions.
Fig. 26.—Interior of the dorsal valve; *s*, sockets; *v*, cardinal process; *r*, adductor scar.

Etymology, *strepto*, I bend or twist; *rhynchos*, a beak.

Types, S. pelargonatus, Schloth. sp.; S. Devonica, D'Orb. sp.

* See p. 379.

Shell inequivalved, convex or concavo-convex, externally striated; hinge line rather shorter than the width of the shell; dorsal valve semicircular, with a small narrow area. Ventral valve with a prolonged and oftentimes bent beak; area triangular, with a fissure covered by a convex pseudo-deltidium. No foramen is observable, but the cardinal process is at times seen partially extending under the deltidium (Fig. 26).

Interior of ventral valve, with a strong hinge-work on either side at the base of the fissure, supported by a dental plate (Fig. 25, *t*); muscular scars two, elongated, oval, deeply excavated, separated by a wide mesial ridge (Fig. 26, *r*).

Interior of dorsal valve with a largely developed cardinal process, composed of two projections, grooved or bidentated towards the extremity of their outer surface; socket plates large, and partly united to the lower portion of the cardinal process; adductor scars quadruple, occupying more than a third of the length of the valve, and arranged in pairs, divided by a short rounded mesial ridge.

This genus is intermediate between Orthis and Strophomena.

Distribution, 6 species. Sil.—Perm. Europe, Asia, America, and Australia.

TROPIDOLEPTUS, Hall, 1859.

Etymology, *tropis*, a keel, and *leptos*, thin; the carinated ventral valve and shallow visceral cavity, in its analogy with *Leptœna*. (See "Reg. Rep.," 1856, p. 3.)

Type, Strophomena carinata, Conrad.

Shell transversely oval, or longitudinally semi-elliptical, articulating by teeth and sockets, hinge line about equal to the breadth of the shell. *Ventral* valve convex, with a linear area and triangular foramen in the margin of the area; from the inner edges of this proceed the dental lamellæ, which are separated from the area by a narrow groove strongly crenulated on the outer edge, and extending obliquely outwards, terminating in a low ridge which partially surrounds the muscular impression; *dorsal* valve concave; cardinal process prominent, wedge-shaped, supporting the bases of the crura; dental fossets crenulated, surface plicated; shell structure punctated.

Distribution, 2 species. Devonian. United States.

VITULINA, Hall, 1861.

Etymology, *Vitula*, a goddess.

Type, V. pustulosa. Devonian. New York.

Shell resembles that of *Tropidoleptus*, but the dental processes are not crenulated, nor distinctly separated from the area as in that genus.

AMPHICLINA, Laube, 1865.

Etymology, *amphi*, about, and *clino*, a slope.

Type, A. dubia, Münster (Producta).

Shell inequivalve circular, excavated, smooth; *ventral* valve convex, beak short; perforated; dorsal concave; hinge line very short and suboblique; area wanting; deltidium triangular, distinct; structure of the test fibrous, squamose; externally *Amphiclina* resembles some Leptænæ, the shell structure is very similar.

Distribution, 2 species. St. Cassian, Austria.

Calceola. "Within the last few years the researches of Professors Suess and Lindström have thrown considerable doubt as to this genus belonging to the Brachiopoda." . . "If a brachiopod it seems the most abnormal of all its genera."—Davidson (1865).

FAMILY VIII.—LINGULIDÆ.*

LINGULELLA, Salter, 1866.

Etymology, diminutive of *Lingula*.

Type, Lingula Davisii, M'Coy.

"*Shell* nearly equivalve, broad oblong, the ventral valve pointed, *with a distinct pedicle-groove*. Muscular sears strong, nearly as in *Obolus*, but the pair of anterior retractors are more linear than in Obolus, and the sliding muscles small, and not quite external as in *Obolus*."—(Salter.)

Distribution, 3 species. Lower Silurian. Ireland, Wales, Norway.

LINGULEPIS, Hall, 1863.

Etymology, *lingula*, a little tongue; *lepis*, a scale.

Type, Lingula pinniformis, Owen.

Shell thin, subovate, or subtrigonal; composition and structure as in *Lingula*. Ventral or larger valve with beak more or less produced and pointed; visceral scar trilobed, with a longitudinal raised mesial line or septum—lateral divisions diverging, and usually longer than the middle one; dorsal or smaller valve with the beak less produced than that of the other; visceral scar flabelliform.

Distribution, 4 species. Silurian, America.

* See p. 390.

Trimerella, Billings, 1863.

Shell allied to that of *Obolus*, from which it differs in the possession in the interior of each valve of three longitudinal septa of variable length, which support a horizontal or concave plate.

Distribution, 2 species. Silurian. Canada.

Obolella, Billings, 1861.

Etymology, diminutive of *Obolus*.

Synonym, (?) Keyserlingia, Pander.

Type, Obolella chromatica, Billings.

"*Shell* ovate, circular or subquadrate, convex or plano-convex; ventral valve with a false area, which is sometimes minute, and usually grooved for the passage of the peduncle; dorsal valve either with or without an area; muscular scars in the ventral valve, four; one pair in front of the beak near the middle, or in the upper half of the shell, and the others situated one on each side near the cardinal edge; shell calcareous; surface concentrically striated, sometimes with thin extended lamellose edges."

"In general form these small shells somewhat resemble *Obolus*, but the arrangement of the muscular impressions is different. In *Obolus* the two central scars have their smaller extremities directed downwards, converging towards each other; but in this genus the arrangement is exactly the reverse."—(Billings.)

Distribution, 12 species. Lower Silurian. United States, Canada, England, Spain.

CLASS PTEROPODA.*

Hermiceratites, Eichwald, 1840.

Shell cylindrical or semi-cylindrical, elongated, straight, with a dark brown corneous epidermis, furnished with a straight, median siphuncle, which does not traverse any chambers.

Fossil, 3 species. Middle Silurian. Russia.

Salterella, Billings, 1861.

Dedicated to Mr. J. W. Salter, late Palæontologist to the Geological Survey of Great Britain.

Shell small, slender, conical, straight, consisting of many

* See p. 346.

cones placed one within the other; the transverse section of the tubes is circular or subtriangular; the surface is transversely or longitudinally striated.

Fossil, 3 species. Lower Silurian. Canada.

PHRAGMOTHECA, Barrande, 1867.

Type, P. Bohemica. Upper Silurian. Bohemia.

Shell like that of *Pterotheca*, but chambered.

CLASS CONCHIFERA.*

[FAMILY ANOMIADÆ.]

The genera included are: ANOMIA (*Limanomia*) (p. 408), PLACUNOMIA (p. 409), PLACUNA (p. 409), CAROLIA (p. 410), PLACUNOPSIS (p. 410), and PLACENTA (p. 410).

FAMILY I.—OSTREIDÆ.†

The genera enumerated are OSTREA (*Gryphœa*, *Exogyra*) and

PERNOSTRŒA, Munier-Chalmas, 1864.

Derivation from *Perna* and *Ostrea*.

Example, Ostrea Luciensis, D'Orbigny.

Shell more or less thick, adherent by the left valve, subcircular, squarish, or trapezoidal, nearly equilateral, inequivalve; test foliaceous, subnacreous, resembling that of *Ostrea*, no fibrous cortical layers; umbones obsolete; hinge line diverging more or less broad, with 4 to 8 vertical ligamental furrows, some long and deep, others short and rudimentary. Muscular impression subcircular or semilunar, deeper in the fixed valve than in the other.

The species of this genus, with the exception of the ligamental pits, have nearly all the characters of *Ostrea*; they serve to link the families *Ostreidœ* and *Aviculidœ*.

Distribution, 7 species. Middle Lias—, Forest Marble. France, England.

[FAMILY PECTINIDÆ.]

The genera are PECTEN (*Neithea*, *Pallium*), HEMIPECTEN (p. 412), HINNITES (p. 412), LIMA (p. 412), SPONDYLUS (p. 413), PEDUM (p. 414), PLICATULA (p. 414), and the following additional genera and sub-genera:—

* See p. 393. † See p. 407.

Pernopecten, Winchell, 1865.

Derivation, *Perna* and *Pecten*, from a combination of some of the characters of the two genera.

Type, Aviculopecten limæformis, White and Whitfield.

Shell subequivalve, inequilateral, auriculated; hinge line straight, with a central triangular cartilage pit and a transverse plate, with smaller lateral cartilage pits diminishing in size and depth from the centre outwards.

Pernopecten agrees with *Amusium* in its subsymmetrical ears, cardinal cartilage pit, and in the absence of radiating ridges, but differs in its straight hinge line and lateral cartilage pits.

Fossil, 7 species. Carboniferous limestone. Michigan, Belgium, Nassau. Probably others referred to *Avicula*, *Pterinea*, and more especially to *Aviculopecten*, *Amusium*, and *Pecten*.

Aviculopecten (p. 417) does not possess the prismatic of the *Aviculidæ*, but the peculiar corrugated tubular structure of the *Pectinidæ* (Meek). It bears the same relations to existing *Pectens* as *Pterinea* does to existing Aviculas.

Plicatula (see p. 414).

Sub-genus, *Harpax* (Parkinson, 1811), Deslongchamps, 1858.

Example, Harpax Parkinsoni, Brown.

Hinge of attached valve consisting of a flattened triangular plate, traversed by a central more or less perpendicular ligamental furrow, exterior to which are slightly marked diverging sulci to receive the elevated borders of the ligamental groove in the other valve; the outer borders of the plate form lengthened and elevated dental processes. Hinge plate of free valve traversed mesially by the ligamental groove, the borders to which are elevated and but slightly diverging; exterior to these are strongly impressed grooves to receive the dental processes of the other valve.

Fossil, 16 species. Lias and Lower Oolites. France and England.

Terquemia, Tate, 1867.

Dedicated to M. O. Terquem, an eminent palæontologist.

Example, T. Heberti, Terquem, Mem. Soc. Géol. de Fr., vol. viii. p. 106, t. 13, f. 1—3, 1865.

Synonym, Carpenteria, E. Deslongchamps, 1858 (*non* Gray, 1856.

Shell inequivalve, subequilateral, attached by the umbonal portion of the *right* valve; the left valve slightly concave, smooth, and ornamented posteriorly, as also the free portion of the right valve, by concentric plications or radiating ribs. Hinge area triangular, transverse, striated in the same direction, edentulous, sometimes produced in the middle line; ligamental furrow median, longitudinal, straight, rather narrow. Muscular scar near the posterior margin; pallial line wanting. Externally the shells of this genus resemble those of *Hinnites* and *Ostrea*.

Fossil, 5 species. Lower— Upper Lias. France, Germany, Great Britain.

FAMILY II.—AVICULIDÆ.*

Sub-family 1.—PTERINEINÆ. Cartilage contained in a series of linear furrows nearly parallel to the cardinal margin; hinge-margin broad, flat; anterior muscular scar moderately developed and deep. Extinct.

Genus :—PTERINEA (probably includes the Silurian and Devonian species referred to *Avicula*).

Sub-genus :—*Eopteria*, Billings ; *E. Typica*, L. Sil. Newfoundland. Valves equally convex, hinge with an external (?) ligament.

MONOPTERIA, Meek, 1865.

Type, Gervillia longispina, Cox. Coal Measures. Kentucky. Hinge edentulous; anterior muscular scar faint, as in *Avicula*.

MYALINA (see p. 421). AMBONYCHIA (p. 417), (?) ACTINODESMA, and PTEROPERNA (p. 416). *A. Casei* (*Megapteria*, Meek), Lower Silurian, Indiana, differs from the typical forms of the genus in the great development of its posterior wing.

Sub-family 2.—AVICULINÆ. Cartilage pit single, defined; anterior muscular scar very small.

Genera :—AVICULA (*Maleagrina*, *Malleus*), VULSELLA (p. 416); AUCELLA (p. 416), MONOTIS (p. 417), HALOBIA (p. 417), POSIDONOMYA (?) CARDIOLA (p. 417); EURYDESMA (p. 417).

Sub-family 3.—PERNIIDÆ. Cartilage contained in a series of transverse furrows. Anterior muscular scar generally very small.

Genera :—PERNA (p. 418), CRENATULA (p. 418), HYPOTREMA (p. 418), GERVILLIA (p. 418), BAKEWELLIA (p. 418), and INOCERAMUS (p. 419), and the following additional genera :—

* See p. 415.

HÖRNESIA, Laube, 1865.

Dedicated to Director Dr. Moriz Hörnes.

Type, Gervillia socialis, Sckloth, St. Cassian.

Differs from the typical Gervilliæ by the peculiar structure of the hinge, and by a more or less lengthened septum going through the cavity of the umbones. The genus is intermediate between *Cassianella* and *Gervillia*.

NAYADINA, Munier-Chalmas, 1863.

Type, N. Heberti, Munier, Cenonamian, Aubeterre.

Shell resembling a transverse *Vulsella*, rostrated posteriorly; the internal fibrous layer is wanting.

ELIGMUS, E. Deslongchamps, 1856.

Etymology, *ἐλιγμός*, a sinuosity, in allusion to the sinuosities of the borders of the post-apical opening.

Type, E. polytypus, E. Deslong. Fig. 27

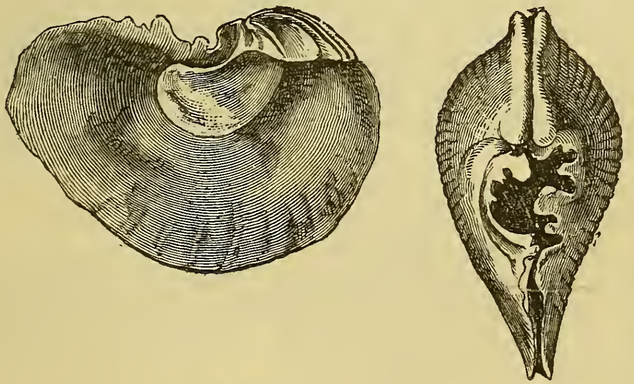

Fig. 27.—Eligmus Polytypus.

Animal unknown.

Shell free, or perhaps attached by a byssus, nearly equivalve, inequilateral; ovate or cylindrical, more or less compressed; anterior extremity inflated, and shorter than the attenuated posterior one. Test rather thick, foliaceous. Umbones inflated, slightly depressed or flattened, diverging and directed backwards. Valves closed at both extremities, with an unsymmetrical (byssal?) sinus, *s*, behind the umbones; ornamented by oblique, radiating carinated ribs. Hinge short, straight, edentulous; ligamental area triangular, with a superficial pit, *l*. Muscular scar single, situated on the free end of a spoon-shaped process, *p*, which originates from beneath the umbonal cavity, pallial line wanting.

Distribution, 3 species. Inferior Oolite, and Great Oolite. Maine-et-Loire, Calvados, Balin, Galicia.

The internal process of *Eligmus* has no analogy with that of the *Myæ* and *Anatinæ*, which in them supports the cartilage, and is an internal prolongation of the hinge; whilst that of *Eligmus* gives attachment to the adductor muscle, and arises from beneath the hinge. *Eligmus* is related through *Vulsella Turonensis*, Dujardin, to *Vulsella;* the test, however, is not fibrous, and M. Munier supposes that the internal nacreous layer has been destroyed by fossilization.

CASSIANELLA, Beyrich, 1861.

Synonym, Gryphorhynchus, Meek, 1864.

Type, Avicula gryphœata, Münster.

Shell thick, sub-hemispherical; right valve flat or convave, the left very gibbous; no defined byssal *sinus*. Umbones sub-central, hinge line equalling the greatest length of the shell, in both valves with a wide well-defined cardinal area; ears sub-equal, not produced. Hinge with several small irregular teeth near the middle. Surface striated.

Fossil, 6 species. Upper Trias— L. Lias. Austria, Bavaria, Himalayas.

Sub-family 4.—*Pinniinæ*.

Genus:—PINNA. Sub-genus, *Aviculopinna*, Meek.

Type, Pinna prisca, Münster. Permian.

Shell nearly or quite equivalve, beaks not terminal. The general aspect of the shell seems to be intermediate between *Pinna* and *Avicula*.

TRICHITES (see p. 420).

FAMILY III.—MYTILIDÆ.*

MODIOLARIA, Beck (Jeffreys, 1863) (see p. 422).

Derivation, allied to the genus *Modiola* of Lamarck.

Example, Mytilus discors, Linné.

Synonyms, Lanistes, Humphreys; Lanistina, Gray.

Animal with the mantle folded in front into a wide incurrent tube, and behind into a conical excurrent tube; foot strap-shaped.

Shell rhomboidal, sculptured by two rows (one on each side)

* See p. 420.

of striæ, which radiate from the beaks, leaving the middle portion smooth, umbones incurved, hinge edentulous or crenulated, hinge-plate finely notched.

Distribution, Temperate and Arctic seas. The four British species occur fossilised in the Red and Coralline Crags and newer Tertiaries. Several species in the Upper Triassic and Jurassic formations, referred to *Modiola*, appear to belong here.

Crenella, Brown (see p. 422).

Etymology, diminutive of *crena*, a notch.

Example, Mytilus decussatus, Montagu.

Animal with the mantle open in front, and folded behind into a sessile excurrent tube; foot cylindrical, the free end being disk-like and issuing out of a sheath.

Shell oval or rhomboidal, nacreous, cancellated; umbones straight, ligament small, hinge of each valve furnished with an upright tooth, which is crenulated, as well as the hinge plate.

The animal does not spin a thick byssus, like *Modiolaria*, but secretes only a single thread for attachment, and by means of which it holds itself suspended in the water.

Distribution, 5 species. Low-water mark to 150 fathoms. Norway, Iceland, Greenland, New England, Britain, France.

C. rhombea occurs in a fossil state in the Coralline Crag, Sutton.

Prasina, Deshayes, 1863.

Type, P. Borbonica, Desh. Isle of Bourbon.

Shell oblong thick cordiform, valves closed, margins entire inequilateral; lunule deep circular, projecting into the interior of the right valve, left valve in the same place furnished with dentiform tubercles; hinge line simple, arched; ligament external, narrow; muscular scars two, unequal, sub-central.

Anthracoptera, Salter, 1863.

Etymology, *anthrax*, coal, and *pteron*, a wing.

Example, A. Carbonaria, Dawson, sp.

This genus includes the so-called *Myalinæ*, but they have not the thick hinge-plate of the shells of that genus, and species which have been described by Ludwig as belonging to *Dreissena*. The form of the shell is triangular.

Fossil, 7 species of marine origin. Coal Measures. Great Britain, Nova Scotia, Westphalia.

FAMILY IV.—ARCADÆ.*

LIMOPSIS. Sub-genus, *Trigonocœlia*, Nyst.

Shell approaches *Leda* in form, and differs from *Limopsis* in the absence of the expanded ligamental area.

Fossil, 7 species. Eocene. Paris basin, Belgium, England, United States.

CTENODONTA, Salter, 1851 (p. 427).

Type, Tellinomya nasuta, Hall.

Synonym, Tellinomya, Hall.

Shell closed, differs from *Isourca* in not having the ligamental area, the ventricose character, large and often subspiral beaks; the surface of the shell is smooth or marked by lines of growth, but never cancellated; hinge teeth small and numerous.

Fossil, 40 species. Silurian—Carboniferous. Europe, N. America, Bolivia.

It is probable that most of the Palæozoic species referred to *Nucula* belong to *Ctenodonta*.

PALÆARCA, Hall, 1858.

Synonyms, Megalomus, Hall, 1852; Cyrtodonta, Billings, 1858; Cypricardites, Conrad, 1841.

Example, C. Canadensis, Billings.

Shell equivalve, inequilateral; umbones near the anterior end or terminal; general form obliquely tumid, transversely sub-rhomboidal ovate; posterior extremity larger than the anterior, and usually broadly rounded; two to eight oblique anterior teeth beneath, or a little in front of the umbones; two to four remote lateral teeth parallel with the hinge line; pallial line simple; muscular scars two, anterior sometimes deeply excavated; posterior superficial; ligament external.

Some species have a narrow area between or behind the beaks.

Distribution, 42 species. Silurian—Devonian. N. America and N. Wales.

Sub-genus, *Megambonia*, Billings, 1858.

Synonym, Vanuxemia, Hall, 1858.

Shell ovate, beaks terminal, or nearly so; anterior extremity reduced to a small auriculate expansion, or obsolete.

Distribution, 11 species. Silurian. N. America.

* See p. 424.

FAMILY V.—TRIGONIADÆ.*

? ISCHYRINA, Billings, 1866.

Type, I. Winchelli, Billings.

Shell equivalve, inequilateral, two strong ridges radiating from the beak in the interior of each valve.

Fossil, 2 species. L. and M. Silurian. Anticosti.

FAMILY VI.—UNIONIDÆ.†

ANTHRACOSIA, King, 1856 (see p. 470).

Etymology, *anthrax*, carbon, in allusion to the carbonaceous deposits in which the genus is usually found.

Type, A. Beaniana, King. Coal Measures, Newcastle.

Shell equivalve, inequilateral. *Teeth* one in each valve below the umbone, rather low and massive; crown of tooth of right valve excavated anteriorly and ridged posteriorly; crown of tooth of left valve ridged anteriorly and sloped posteriorly. *Umbonal ligamental fulcra*, each a furrow excavated in the hinge-plate, between the umbone and tooth. *Scars of the anterior set of pedal muscles*, situated above the anterior adductor muscular impressions.

Anthracosia differs from *Unio*, to which genus the majority of the Unioniform shells have been referred, in its simpler dental system and in the absence of supplementary pedal muscles. It has no relation to *Cardinia*, in which genus others of the Unioniform species have been placed; whilst other members of genus possessing the outward appearance of certain aviculoid forms of *Modiola* have been ranged in the genus *Myalina*.

Distribution, 61 species. Devonian—Carboniferous. Westphalia, Saxony, Russia, Belgium, Great Britain, N. America.

CARBONICOLA, M'Coy, 1855 (see p. 470).

Synonym, Prisconaia, Conrad, 1867.

Example, Unio acutus, Sow.

Cardinal tooth in right valve diverging obliquely towards the posterior side; lateral 1-1, long and lamellar; no lunate impression on the ventral margin of the anterior adductor as in *Unio*.

This genus is related to *Anthracosia*, but differs in having lateral teeth.

Distribution, about 20 species. Coal Measures. Europe, United States.

* See p. 430. † See p. 432.

FAMILY VIII.—HIPPURITIDÆ.*

Genus :—HIPPURITES.

Sub-genus, *D'Orbignya*, Woodward, 1862.

Type, H. bi-oculatus, Lamk. ; no " ligamental inflection " of the outer shell.

Fossil, 4 species. Middle Chalk. Europe.

Barrettia, Woodward, 1862, dedicated to Mr. Lucas Barrett, late Director of the Geological Survey of the West Indies.

Type, B. monilifera, Woodward. " Hippurite Limestone." Jamaica. No " ligamental inflection " as in *D'Orbignya*, but presents the further peculiarity of an indefinite number of pallial duplicatures extending all round the margin of the lower valve.

FAMILY XI.—LUCINIDÆ.†

LORIPES, Poli, 1791 (Jeffreys) (see p. 456).

Etymology, *lorum*, a strap ; and *pes*, a foot.

Example, Tellina lactea, Linné.

Animal with the margin of the mantle notched; incurrent tube long.

Shell almost equilateral, cancellated, or sculptured by flexuous striæ; lunule short; cartilage *quite internal;* teeth, one cardinal in the right, and two in the left valve; laterals remote, and sometimes indistinct.

Distribution, species. Atlantic, Mediterranean, West Indies.

Fossil, species. Eocene ——. France.

AXINUS, J. Sowerby, 1821 (see p. 431).

Synonyms, Thysaira, &c., Leach; Bequania, Leach; Cryptodon, Turton; Ptychina, Philippi; Thiatyra, G. Sowby.; Clausina, Jeffreys.

Example, Tellina flexuosa, Montagu.

Animal with the mantle margin thickened, open, not prolonged into tubes; foot long, sub-cylindrical, and very slender.

Shell globular, posterior side furrowed or angulated, umbones much recurved; lunule short or indistinct; ligament usually and to a certain extent external, placed in a groove on the hinge line, and outside the hinge-plate; teeth altogether wanting.

In *A. flexuosus*, the hinge-plate is indented in the right valve immediately below the beaks, and slightly reflected in the left,

* See p. 440. † See p. 455.

which gives that valve the appearance of having an indistinct or obscure cardinal tooth.

Distribution, 4 species. Europe.

Fossil, Tertiary. Two of the three British species occur in a fossil state in the Coralline Crag.

Sportella, Deshayes (see p. 457).

Example, Psammotea dubia, Defrance.

Shell oblong, smooth, depressed, sub-equilateral; valves closed. Hinge narrow, with two unequal, diverging teeth in the left valve, one in the other; the lateral teeth are wanting. Muscular scars large, oval, nearly equal; pallial line simple. Ligament external.

Fossil, 17 species. Tertiary. Paris basin.

Possibly some of the Liassic species referred to *Unicardium* belong to this genus.

Corbicella, Morris and Lycett, 1853.

Etymology, diminutive of *Corbis*.

Type, C. subæquilatera, Lycett.

Shell destitute of ornament, ovately elongated, rather compressed; anterior side small; hinge characters differ from those of *Corbis*, in the absence of the anterior lateral tooth, and in the oblique internal ridge passing downwards behind the anterior muscular scar.

Corbicella is intermediate between *Corbis* and *Tancredia;* and from the latter, to which it is more nearly allied, it is separated by its more ovate form, and by the absence of the posterior oblique angle, and in the possession of a lengthened hinge-lamina and depressed remote posterior lateral tooth.

Fossil, 7 species. Upper part of Inferior Oolite—Oxfordian. England; France.

[Family Kelliidæ.]

Lasæa, Brown, 1827.

Etymology, possibly a corrupt derivation of λαισήϊον, a shield.

Type, Cardium rubrum, Montagu.

Synonyms, Poronia, Recluz; Cylcadina, pars; Kellia, pars; Bornia, pars.

Animal with the mantle folded on the anterior side so as to form a wide but incomplete incurrent tube; the excurrent tube is inconspicuous, placed on the opposite side; foot long.

Shell minute and roundish oval; beaks straight; cartilage long, placed at the shorter end of the shell, contrary to that in *Kellia; left* valve with a minute thorn-like cardinal tooth; and in each valve two remarkably strong lateral teeth.

The genus is intermediate between *Montacuta* and *Kellia*.

Distribution. "The *LasϾ* usually inhabit the littoral zone, where they congregate in vast numbers at the roots of small sea-weeds, in the crevices of rocks, and in empty shells. *L. rubra*, a British species, is viviparous, and lives as much out of the sea as in it. Other species occur in various parts of the world."—Jeffreys.

Family XII.—Cycladidæ.*

In addition to the genera enumerated in W. M. ii., p. 461 *et seq.*, the following belong here:—

Galatea (see p. 486), and—

Fischeria, Bernardi, 1860.

Dedicated to M. Fischer, one of the editors of the *Journal de Conchyliologie.*

Type, F. Delesserti, Bern., inhabiting the rivers of the Gaboon, W. Africa.

Shell differs from that of *Galatea* in the rudimentary condition of the lateral cardinal teeth of the right valve, and by the elongated lateral teeth being compressed, as in *Cyrena;* and from *Cyrena* by its fewer cardinal teeth, depth of the pallial sinus, and by the absence of lateral teeth in the right valve.

Family XIII.—Cyprinidæ.†

Cypricardella, Hall, 1857.

Shell ovate, subelliptical, or subquadrate; concentrically striated; hinge of right valve with two cardinal teeth; the anterior tooth beneath the beaks; posterior tooth turned obliquely backwards, leaving a triangular pit, which is probably occupied by a tooth in the other valve. Anterior cardinal margin with a long narrow groove, apparently for the reception of a slender projection of the other valve; posterior side beveled from above, edge thin; ligament external, in a deep cavity; muscular scars distinct, shallow; pallial line simple.

Fossil, 4 species. Carboniferous. Indiana.

* See p. 461.   † See p. 463.

Anisodonta, Deshayes, 1860.

Type, A. conplanatum, Dh. Eocene. Paris basin.

Shell transversely elongated, compressed, inequilateral; hinge thick; a large conical and a triangular socket in each valve; ligament external. Anterior adductor scar very small, and comprised between two prominent ribs (one parallel and the other transverse to the anterior border); posterior scar subcircular, superficial; pallial line faint, entire.

Distribution, 2 species. Bourbon.

? Matheria, Billings, 1858.

Dedicated to Mr. Mather, of the Geological Survey of New York.

Type, M. tenera, Billings. Trenton limestone, Canada.

Shell transverse, equivalve; beaks near the anterior end; two small obtuse cardinal teeth in the left valve, and one in the right; ligament external.

Conchodon, Stoppani, 1865.

Etymology, *conchos*, a shell, and *odos*, a tooth.

Type, C. infraliasicus, Stop. Lower Lias. Lombardy.

Shell equivalve, symmetrical, very thick, cordiform, closed; beaks large, angulated, involute. Ligament internal, very long, marginal, attached to the posterior half of the hinge-plate. Hinge massive; in the right valve, one large rounded tooth in front (placed above a dental pit), and two transverse cardinal teeth; left valve with a large circular socket, bounded below by a curved lamellar tooth; two transverse and one curved teeth beneath the umbo.

Dicerocardium, Stoppani, 1865.

Etymology, *diceras*, having two horns, and *cardium*.

Shell equivalve, symmetrical, closed, free; umbones very prominent, elongated, or spiral. Hinge-plate broad, thick, separated by an interval of varying width from the edge of the valve, and prolonged into the umbonal cavity. Left valve with a compressed cardinal tooth, corresponding to a socket in the right valve; valves furrowed by ligamental grooves. Ligament external.

Fossil, 4 species. Upper Trias. Lombardy, North-West Himalayas.

CYPRIMERIA, Conrad, 1864.

Type, Cytherea excavata, Morton. Cretaceous. North America.

Shell lentiform; hinge of right valve broad, with a bifid oblique cardinal tooth and two oblique acute anterior teeth, with an intermediate pit for the reception of the tooth in the opposite valve.

DOSINIOPSIS, Conrad, 1864.

Derivation, *Dosinia*, a generic name, and *opsis*, like.

Type, D. Meekii. Eocene. United States.

Shell exteriorly like *Dosinia*. Cardinal teeth three in each valve; posterior tooth of right valve bifid; in the left valve, a thick rugose lateral tooth fitting into a cavity in the opposite valve; under the umbo is a pit; cartilage plate granulated; pallial sinus deep and angular.

Distribution, 3 species. Eocene. United States.

CONCHOCELE, Gabb.

Type, C. disjuncta, Gabb. Miocene? California.

Shell irregularly quadrate, very inequilateral, angulated posteriorly; presenting some analogies to *Edmondia*, *Unicardium*, and *Cardiomorpha*. Ligament external; hinge with a long, sharp tooth running from the beaks parallel with the cardinal margin, almost to the posterior end; pallial line simple.

ASTARTE. Subgenus, *Astartella*, Hall and Whitney, 1858. *A. vera*. Coal Measures. Illinois and Indiana. The anterior tooth of the right valve has a longitudinal pit in the summit.

[FAMILY CARDITÆ.]

WOODIA, Deshayes, 1860.

Dedicated to Searles V. Wood, a distinguished palæontologist of England.

Example, Tellina digitaria, Linné.

Shell small, rounded, equivalve, equilateral; valves closed, smooth, or ornamented with oblique, curved striæ; hinge thick; right valve with a single, large, median, triangular tooth, depressed or channelled in the middle; left valve with two narrow, unequal, diverging teeth; lateral tooth wanting or rudimentary. Ligament internal, small; muscular scars small, equal, oval or ovate; pallial line simple.

Distribution, 1 species. Mediterranean; also fossil in the

Crags of England, in that of Anvers, and in the Pleistocene deposits of Palermo.

Fossil, 8 species. Eocene, Miocene, Pliocene. France, England, Germany. *W. lamellosa*, Sandb., is inequilateral.

Lutetia, Deshayes, 1860.

Example, L. Parisiensis, Deshayes.

Shell small, orbicular, globose, equivalve; valves closed; border simple and entire; hinge narrow; cardinal teeth three in each valve, two diverging; the third large and obliquely placed between the others; muscular scars small, oval, submarginal, equal; pallial line simple; ligament external.

Fossil, 2 species. Eocene. Paris.

Goodallia, Deshayes, 1860.

Example, Erycina miliaris, Defrance.

Shell small, trigonal, equivalve, inequilateral; valves closed; cardinal teeth in the right valve two, diverging, separated by a triangular socket; in the left valve, one triangular, sometimes bifid; lateral wanting, or rudimentary; ligament *external*, very short; pallial line simple.

Fossil, 8 species. Eocene. Paris.

Goodalliopsis, Raincourt and Munier, 1863.

Type, G. Orbignyi, Rainc. and Mun. Eocene. Fercourt.

Shell oval, flattened, equivalve, inequilateral, smooth, slightly dilated in front, and compressed behind; valves closed; hinge with two cardinal teeth, separated by a triangular socket, in each valve; lateral teeth distinct and elongated, one in each valve. Other characters those of *Goodallia*.

Family XIV.—Veneridæ.*

Psathura, Deshayes, 1860 (see p. 456).

Etymology, ψαθυρὸς, friable.

Type, Erycina fragilis, Lamk. Eocene. Paris basin.

Shell oval, inequilateral, thin, transparent, fragile; hinge teeth, in the right valve, two equal and deeply bifid; left valve, two unequal, entire; ligament external; anterior adductor scar narrow, claviform; posterior subquadrangular; pallial simple, thus differing from *Clementia*, to which it is related by the hinge characters.

* See p. 472.

ISODOMA, Deshayes, 1860.

Type, I. cyrenoides, Deshayes. Eocene. Paris basin.

Shell transversely oval, very thin; hinge similar to that of *Cyrena*, but the pallial line is sinuous.

FAMILY XVI.—TELLINIDÆ.*

SOWERBYA, D'Orbigny, 1850 (see p. 478).

Dedicated to Sowerby, author of "British Mineral Conchology," &c.

Type, S. crassa, D'Orb., Prodrome I., p. 362.

Synonym, Isodonta, Buvignier, 1851.

Shell equivalve, subequilateral; right valve with two oblique, diverging, cardinal teeth separated by a mesial trigonal socket, and two lamellar lateral teeth separated from the hinge border by longitudinal grooves; left valve with a conical tooth between two oblique pits; laterals two; longitudinal lamellar and projecting, and united to the superior border; ligament external.

Fossil, 8 species. Lower Lias—Portlandian. England, France, Germany.

QUENSTEDTIA, Morris and Lycett, 1853 (see p. 481).

Dedicated to Professor Quenstedt, the veteran palæontologist of Wurtemberg.

Type, Pullastra oblita, Phillips.

Shell like that of *Psammobia;* hinge with an obtuse *transverse* cardinal tooth in the left, and a cardinal pit in the right; ligament external, in a narrow elongated groove; posterior adductor scar rounded, anterior elongated, sinuated; pallial sinus smaller than in *Psammobia* or *Sanguinolaria.*

Fossil, 3 species. Inferior Oolite—Great Oolite. England, France, Germany.

? PALÆOMYA, Zittel, 1861.

Shell triangular, depressed, nearly equivalve, inequilateral; right valve with two cardinal teeth, the posterior larger and in front of the cartilage pit; left valve with a single cardinal tooth; a prominent posterior lateral tooth in each valve; muscular and pallial impressions very faint.

Fossil, 1 species. Coral Rag. Glos, Normandy.

* See p. 479.

Family XV.—Mactridæ,*

Includes Vauganella (p. 479), Lutraria (p. 479), Mactra (p. 477), Gnathodon (p. 478), Heterocordia, Anatinella (p. 479), Cardilia (p. 469), and

Pseudocardium, Gabb.

Type, Cardium Gabbi, Remond. Miocene and Pliocene. California.

Etymology, *pseudo*, false, and *cardium*, a generic name.

Shell thick, heavy, resembling *Lævicardium* externally; ligament internal; lunule cordate; left valve with a large cartilage pit and a V-shaped tooth, which articulates in a corresponding depression in the right valve; 2 lateral teeth in each valve, very strong and prominent.

Family XVIII.—Myacidæ.†

Poromya, Forbes, 1843 (see p. 491).

Passing into the genus *Mya*.

Example, P. granulata.

Synonyms, Eucharis, Recluz; Embla, Lovèn; *Cumingia parthenopœa*, Tiberri (*non* Thetis, Sby.).

Animal with unequal siphons, clothed with numerous filaments, foot narrow and slender.

Shell sub-orbicular, sub-equivalve, and inequilateral, thin, transparent, slightly nacreous within; valves closed, surface granulated; teeth, in right valve, a short but strong cardinal, and in the left a minute triangular cardinal and a ridge-like lateral on the posterior side.

Distribution, 10 species. Britain, Scandinavia, Mediterranean, Tropical America.

Fossil, 13 species. Eocene. France, Germany, England, United States.

Corbulomya, Nyst, 1846 (see p. 490).

Derivation, *Corbula* and *Mya*.

Examples, Corbula complanata, Sowerby; Lentidium Mediterraneum, Jan and Cristofori.

Shell oval, transverse, depressed, closed, inequivalve, sub-inequilateral; right valve the larger, with one pyramidal tooth,

* See p. 477. † See p. 489.

and a narrow and deep socket; left valve with two unequal teeth separated by a large socket. Ligament internal, pallial impressions simple, slightly inflected posteriorly.

Animal with the mantle united behind, margins of the mantle with duplicate foliaceous tentacles; foot compressed, triangular; siphons short, united at the base, the incurrent tube the larger and more elongated, the opening of which is surrounded by arborescent tentacles.

Distribution, 3 species. Mediterranean.

Fossil, 7 species. Eocene. France, Belgium, England.

ANTHRACOMYA, Salter, 1861.

Etymology, *anthrax*, coal, and *mya*, a generic name.

Synonym, Naiadites, Dawson.

Type, A. Adamsi, Salter.

Shell thin, equivalve, the right valve rather larger; valve close, oblong, wider behind, where there is a blunt siphonal ridge; rounded anteriorly, with a byssal sinus on the anterior ventral edge. Beaks small, anterior, and slightly prominent, with an obscure lunette; posterior hinge line with a narrow interior ridge; ligament external. Epidermis strongly wrinkled.

Animal unknown; probably had a closed mantle and respiratory siphons.

Distribution, 9 species. Coal Measures, associated with marine animals. Great Britain, Nova Scotia.

FAMILY XIX.—ANATINIDÆ.*

RIBEIRIA (see p. 497).

Mr. Billings describes in this genus, "beneath and in front of the umbo, a small aperture of a semicircular shape, which appears to be the entrance to a tubular passage running backwards over the transverse plate into the general cavity of the body." He regards it as a byssal orifice.

Mr. J. W. Salter referred this genus to the class Crustacea.

Fossil, 4 species. L. Silurian, Portugal; Canada, England.

FAMILY XXI.—PHOLADIDÆ.†

XYLOPHAGA (see p. 506). Sub-genus, *Xylophagella*, Meek, 1864.

Type, X. elegantula. Cretaceous. Dax.

* See p. 494. † See p. 503.

Shell having the form and ornamentation of *Xylophaga*, but possesses an oblique internal postero-dorsal ridge; burrows, apparently, without a shelly lining.

Martesia (see p. 505). Sub-genus, *Diplothyra*, Tyron, 1862. *D. Smithii*, Staten Island, burrowing in oyster-shells.

Shell with a double accessory valve; the principal plate directly over the umbones, with a smaller anterior one adjoining.

Teredo (see p. 506). Sub-genus, *Calobates*, Gould. (*T. furcelloides*, Gray). Siphonal palettes large, long, stilt-shaped; siphons adherent, only becoming free at the tips.

Distribution, 2 species. Burmack, Australia.

Nausitora, Wright, 1864. *N. Dunlopi* (freshwater, India). Siphonal palettes, outer surface convex, covered with thick scale-like striæ, inner flat or slightly concave.

Distribution, 2 species, burrowing in wood. Bengal. Australia.

INDEX TO APPENDIX.

The synonyms are printed in *italics*, and the pages where the genera are described are indicated by an asterisk (*).

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