

the anterior fifth. In front and beneath the beak (fig. 4, *a*) a rather strong cervical ridge runs obliquely for a third of an inch; and behind the beak two strong ridges, terminating on the posterior margin in projecting spines, run down the posterior slope. Above these the posterior upper angle is perfectly square; beneath them the lower edge is strongly emarginate; the ventral margin arched; and the anterior angles both abrupt and square (the upper one even acute), from the deep emargination which truncates the whole anterior side. Surface marked with concentric ridges, not very closely placed, nor very distinct in all parts.

Though we have but a single valve of this curious fossil, it must not be neglected. It is strongly characterized; and in every part it seems to have the characters of the genus *Ceratiocaris* exaggerated. The subcardinal ridge is so much stronger than in any species of *Ceratiocaris* I am acquainted with, that I am compelled to give a new name.

I am indebted to R. H. Valpy, Esq., F.G.S., of Ilfracombe, for acquaintance with this fossil. He found it some time ago in the pebbles, on the banks of the Otter, and suggests the trivial name. It is not unlike a Bivalve Shell. Mr. Henry Woodward made the drawing from which our woodcut is executed, and I am indebted to him for again calling my attention to the specimen.

Ribeiria pholadiformis, Sharpe, Quart. Journ. Geol. Soc., vol. ix. pl. 9, fig. 17, may very possibly be a Crustacean of this group, with a remarkably thickened dorsal region and strong interior cervical ridge. It has been variously assigned to the *Anatinidæ*, among Bivalves, and the *Calyptroidæ*, among Univalves, neither of which groups seems very fit to receive it. I do not think we have quite got at the true affinity yet; but suggest the above, the more willingly in this place, as *Ribeiria* is a characteristic member of the mid-European Silurian fauna to which the Normandy fossils and the contents of the pebbles at Budleigh Salterton belong.

ON THE RECENT AND TERTIARY SPECIES OF THE GENUS
THECIDIUM.

BY THOMAS DAVIDSON, F.R.S., F.G.S., &c.

THE object of the present communication is to review and compare the characters of the Tertiary and Recent species of *Thecidium*, the true characters of which have been discovered only within the last few years. The genus was first named

Thecidea by DeFrance* in 1821, and corrected into *Thecidium* by George Sowerby† in 1823.

The shells of this genus are all small, none of the many species at present known being more than three-fourths of an inch either in length or breadth. Their shape is very varied, and they have existed from the Triassic period up to the present time. A single species only has been described from the Trias. The Jurassic forms are numerous, and have been fully described and illustrated by M. E. E. Deslongchamps,‡ Mr. C. Moore,|| and myself.§ The Cretaceous forms have likewise been admirably described and figured by M. Bosquet,¶ Professor Suess,** and others; but the Tertiary forms have not hitherto received that full attention they deserve. The recent *Thecidium Mediterraneum* has been figured by several naturalists; and it is to M. Lacaze Duthiers that we are indebted for the most complete description of the animal we at present possess.†† It may, however, be as well to observe that nine years prior to M. Duthiers' researches, Mr. S. P. Woodward and myself had published an enlarged illustration of the interior of the dorsal valve, accompanied by the following explanation: '*Thecidium* has a calcareous loop, folded into two or more lobes, lying in hollows of corresponding form, excavated in the substance of the smaller valve. This loop, or apophysary ridge, supports the brachial membrane, whose thickened and ciliated (cirrated) margin is apparently attached to the inner sides of the grooves. The cilia (cirri) are very long, especially the outer series, which are directed inwards in the dried specimens.'‡‡ We were thus moreover enabled to show that D'Orbigny's supposition that *Thecidium* was unprovided with 'oral arms' was erroneous, and that consequently his term 'Abrachiopodes' could not be admitted.

The interior arrangements of the smaller or dorsal valve

* Defr. in *Fér. Tabl. Syst.*, 38, 1821. See also De Blainville, *Manual Malac.*, 516, 629, 1825; *Diet. Sc. Nat.* liii., 1828; and Risso, *Europe Mérid.*, 393, 1826.

† *Genera of Recent and Fossil Shells.* 1820–24.

‡ *Mémoires de la Société Linnéenne de Normandie*, vol. ix., 1853, and vol. x., 1855.

|| *Proceedings of the Somersetshire Archæological and Natural History Society*, 1854. See also 'Geologist,' vol. iv. p. 193, pl. ii. 1861.

§ *A Monograph of British Jurassic Brachiopoda*, 1851.

¶ *Monographie des Brachiopodes fossiles du Terrain Crétacé supérieur du Duché de Limbourg*, 1859.

** *Ueber die Brachial-Vorrichtung bei Thecidium*, 1853; *Sitzungsber. Akademie der Wissenschaften*, vol. xi. p. 991.

†† *Histoire Naturelle des Brachiopodes vivants de la Méditerranée*, *Annales des Sciences Naturelles*, 4e Sec. Zool., vol. xv., 1861.

‡‡ *Annals and Mag. Nat. Hist.*, 2nd series, vol. ix., May, 1852, p. 374; and *Manual of the Mollusca*, by S. P. Woodward, p. 221, 1856.

are extremely variable in the different species composing the genus; in some they are very complicated, while in others they are comparatively simple; but it is not the object of the present communication to review the whole genus, or to give a description of its many and varied species, these details having been published in the admirably illustrated memoirs already named; we will therefore at once proceed with the description of the two recent species, so as to be able afterwards to establish a comparison between them and the Tertiary forms hitherto discovered.

THECIDIUM MEDITERRANEUM, *Risso*. Pl. I., figs. 1, 2, 3; and Pl. II., figs. 5 to 10. *Thecidea Spondylea*, *Sacchi*.—In external form this small shell is somewhat pyriformly ovate, very variable in shape, and in life it is attached to marine objects by a portion of the back of its beak. The dorsal or smaller valve is thin, semicircular, and slightly convex at the umbone, flattened near the margin; the hinge-line is straight and shorter than the breadth of the shell, a small triangular hinge-area being likewise observable. The ventral or larger valve is more or less regularly pyriform, very convex; thickened, and somewhat depressed longitudinally along the middle. The beak is much produced, callous, and, when well shaped, triangular; but more often somewhat irregular, on account of the position and extent of its attached surface. The area is large, triangular, and flat, with a slightly elevated, but flattened deltidium. Shell-structure punctate. The interior arrangements have been already described by several naturalists, but a glance at the accompanying illustrations will convey to the reader's mind a much clearer impression than words could effect. In the interior of the *dorsal valve* an oblong or squarish concave, prominent, cardinal process exists between the dental sockets (Pl. I. fig. 2, *m*); and outside of each of the socket-depressions is seen an oval muscular scar (*w*), which *M. Duthiers* attributes to his 'lateral adductor muscles' ('adjustors' of *Hancock*). A broad, thickened, sloping, granulated margin encircles the valve, and forms a bridge (*n*) over the small, deep, visceral cavity, and close to the basis of the cardinal process. The granulations are larger and most prominent as they recede from the outer margin. This inner denticulated or granulated margin follows in a parallel manner the margin of the shell from the bridge-shaped process (*n*), until it reaches near to the middle of the front at *c*, where it suddenly stops to become inflected upwards. At the point *c* the inner margin is again directed upwards, producing a second parallel curve, when at *E*, by another downward curve, it forms a third short parallel concave curve, until reaching the point (*F*) near the centre of the valve, where it combines with the similar inflections of the other half of the shell, so as to produce, on the median line, an upwardly produced tongue-shaped process (*G*), the angular extremity of which is directed towards the middle of the bridge-shaped process (*n*). These four symmetrically bent ridges or lobes

constitute M. E. E. Deslongchamps' 'ascending apparatus,' the central portion (F and G) being likewise more elevated than the other parts, and overlies a portion of the visceral cavity.

The parallel grooves, or spaces left between the ridges above described, are partially occupied by a lamella, in the shape of a double crescent (*i* and *k*), of which the larger branches (*i*) partly occupy the large cavities left between the first and second ridges; these being on their inner sides intimately united with the sides of the grooves; while the shorter branches (*k*) are freely suspended over the visceral cavity and occupy the spaces left between the third and fourth ridges of the ascending apparatus. To these crescent-shaped lamellæ M. E. E. Deslongchamps has given the name of 'descending apparatus.'

The interior of the *ventral valve* is concave and deep, with a small, longitudinal, rounded, mesial elevation; the hinge-line is straight, and on either side at the base of the deltidium are situated strong hinge-teeth for the articulation of the valves. The beak is hollow, but there exists on the median line, and far back in the cavity, a small elevated septum, to each of the sides of which is attached a very thin small concave plate (Pl. I. fig. 3 *b*), to which, according to M. Duthiers, the adductor muscle, or 'occluser' of Hancock, was attached. On the bottom of the valve, a little lower down, and on either side of the mesial elevation, and partly under the cavity of the beak, a large pyriform scar is observable, to which the 'divaricator muscles' of Hancock were attached (*c*); and, lastly, outside of these on the bottom of the valve, and near the angles of the hinge-line, there exists a small oval scar (*a*), which is believed to have been produced by the 'ventral adjustor' of Hancock. The whole remaining surface of the interior of the shell is closely covered with numerous granulations or asperities.

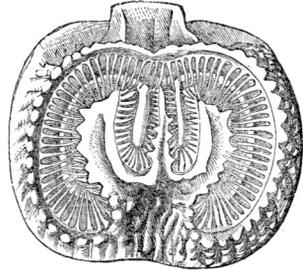
Such are the principal shell-characters of the recent *Thecidium Mediterraneum*; and, although the comparisons we shall shortly endeavour to establish between these and the fossil species cannot extend to the animal itself, it will be as well to refer to some few observations upon the subject, especially in relation to the muscles, mantle, and oral arms, which we will in a great measure extract from M. Lacaze Duthiers' interesting memoir, as these details cannot fail to prove of interest to Palæontologists, and have not yet been alluded to in any English work.

Relative to the *muscles*, M. Duthiers informs us that there are three pairs, six muscles in all, possessing distinct directions and functions. Of these six muscles, two (Pl. II. figs. 7, 8, 9, *a*) are lateral, short, wide, and easily observable, and serve without doubt for the occlusion of the shell. These are M. Duthiers' 'muscles adducteurs lateraux ou externes,' and which, Mr. Hancock informs me, would represent his 'adjustors,' but that the function of this pair of muscles does not appear to be exactly similar to the 'adjustors' of *Waldheimia*, in which they move the shell upon the pedicle; for in *Thecidium* they assist at once in closing the valves, and in preventing

any irregular or lateral movements, which, from the central position of the oclusors, might be liable to take place. In fact, he believes that the function of the 'adjustors' in *Thecidium* is modified much as it is in the same muscles of *Lingula*; and he is therefore inclined to conjecture that the two valves of the former are not so firmly hinged as they are in the other articulated forms. The second pair (*b* of the figures already named) are those nearest to the median line; these are termed 'muscles adducteurs internes' by M. Duthiers, and correspond with, or are equivalent to, Mr. Hancock's 'anterior and posterior oclusors.' In the *ventral valve* these muscles would be fixed to the bottom of the valve, nearly under the extremity of the tongue-shaped 'ascending shelly process' already described, and be again attached to the two thin shelly processes (Pl. I. fig. 3, *b*) which we have described as existing in the cavity of the beak. The function of these muscles (as stated by M. Duthiers) would also be to effect a closing of the valves, but less efficaciously than the preceding pair. The third pair, which M. Duthiers designates 'muscles abducteurs' (Pl. II. figs. 7, 8, 9, *c*), are Mr. Hancock's 'divaricators,' and their function would be to open the valves. They form large impressions on the bottom of the ventral valve, on either side of the central septum (Pl. I. fig. 3, *c*), and have their other end attached to the extremity of the cardinal process of the dorsal valve. M. Duthiers has had the opportunity of studying a vast number of individuals of this *Thecidium* in the living state; and he mentions that, contrary to what we find to be the case in *Terebratula*, the animal opens its shell very widely; the dorsal valve rising on its hinge at right angles to the ventral valve, as the lid of a snuff-box (Pl. II. figs. 9, 10). The animal is also sensible to light and darkness; and it draws down its smaller valve with the rapidity of lightning at the approach of any danger. M. Duthiers observes that the *mantle* is exceedingly thin, and does not possess round its margin any of those long setæ which exist in *Terebratula* and *Lingula*, and that the genital lobe (the one which corresponds to the concave or ventral valve) is very different to the other, and possesses in its thickness, or in its central portion (that is to say, towards the deep and concave portion of the valve), very thick calcareous plates (Pl. II. fig. 6, *o*), the analogues of the plates and spicula occurring in the mantle of *Terebratula*; also that these plates in *Thecidium* participate in the character of the shell itself, being smooth on their under surface and covered on their upper side with asperities similar to those which cover the entire surface of the bottom of the valve. These plates are very thick, and form a ceiling or vault over the cavity which contains the organs of reproduction; and they have been carefully described and figured by M. J. Bosquet, M. E. E. Deslongchamps, and myself, as seen in several fossil species, and in particular in *Thecidium vermiculare* from the Upper Cretaceous beds of the Duchy of Limbourg.

The so-called 'oral arms' of *Thecidium* are stated by M. Duthiers to resemble those of other Brachiopoda, except that they are not free, but adhere in all their extent. He states that the swollen basis

certainly presents a canal similar to that which exists in the other animals of the same group, and that this longitudinal canal is present in all their length, being almost confounded with the mantle, or with the margin of the body—for this last is located in the insertion of the arms; that again these ‘arms’ insert themselves by their basis, not on the intermediate or internal lamella or ‘descending crescent shaped processes,’ but on the edge of the ‘ascending apparatus.’ Their direction is that of the lamina on which they are supported; and they arrive, after having described the inflections



Interior of the Dorsal valve of *Thecidium Mediterraneum*, with the animal; magnified.

already indicated, at the median point of the tongue-shaped process (Pl. I., fig. 2, G), where we can see their two extremities located. This arrangement is shown in the annexed woodcut, which is the one published by Mr. S. P. Woodward and myself in the ‘Annals of Nat. Hist.’ for May, 1852. The cirri of the ‘arms’ are long and flexible.

We need not, for the purpose we have in view, follow M. Duthiers much further in his observations in connection with the anatomy of the animal of *Thecidium*, but conclude by stating that the French zoologist believes, together with some other naturalists, that the respiration was probably effected partly by the ‘arms,’ which bear a great analogy to the gills of other Mollusca; and that he has not been able to discover any anal aperture—a fact strongly urged by Messrs. Huxley, Hancock, and Gratiolet, for *Terebratula* and *Rhynchonella*.

M. Duthiers is of opinion that the sexes are distinct, or in other words that there is a male and female animal; but Mr. Hancock still considers this to be uncertain, and is disposed to the opinion that the sexes are combined in the same animal.

Thecidium Mediterraneum occurs in large numbers in many parts of the Mediterranean from towards the extremity of the Gulf of Bône to near Cape Rosa, &c., living attached to corals and other marine objects, and ranging in a depth of between 40 and 80 fathoms. Mr. S. P. Woodward has detected the same shell in Sir Charles Lyell’s collection of Miocene fossils from the Grand Canary Island; and lastly, Mr. Barrett procured two living examples of *Thecidium Mediterraneum* at 60 and 150 fathoms near Jamaica, and of one of his specimens we give a figure (Pl. II., fig. 5).

2. *THECIDIUM BARRETTI*, Woodward, MS. Pl. II., figs. 1, 2, 3. —Shell small, somewhat pyriformly ovate, attached to marine objects by a portion of the back of its beak. Dorsal valve semicircular, flattened, and slightly convex at the umbone. Ventral valve somewhat pyriform, very convex, deep, and thickened; beak moderately produced; area triangular, but more or less irregular on account of the position and extent of its attached surface.

The interior of the dorsal valve is slightly concave, with an oblong, square-shaped, prominent, cardinal process, between the dental sockets. A broad, thickened, raised, granulated margin encircles the valve, and forms a bridge over the small, deep, visceral cavity, close to the basis of the cardinal process; the granulations are larger and more prominent on the inner margin. On reaching the front, near the middle, the margin suddenly curves upwards on either side, and unites so as to form a central Δ -shaped ascending process, the attenuated extremity of which is directed towards the middle of the bridge-shaped process already described. The descending apparatus consists of two oval pectinated ridges (Pl. II., fig. 2, *i*, *k*), united close to the extremity of the central angular ascending process, and following at a little distance the curves of the inner margin of the same ascending process. Proportions variable; length and breadth about two lines.

In external shape this *Thecidium* cannot be distinguished from the Mediterranean species; but its interior is very different, and resembles by its simple arrangements that of several Jurassic forms, such as *Thecidium Moorei*, *Th. triangulare*, &c.

Thecidium Barretti was obtained by the late Lucas Barrett at 60 fathoms on the north-east coast of Jamaica, and was found by him fossil in the newest Pliocene beds of the same country.

TERTIARY SPECIES AND VARIETIES OF THECIDIUM.

Three so-termed species have been found in the Tertiary strata; one of these was discovered by Sign. Michelotti in the Middle Miocene of the hills near Turin; and this he designated *Thecidea testudinaria*. The same shell was also found by Sign. Meneghini in the Miocene beds of Parlascio in Tuscany. Another, *Thecidium Adamsi*, Macdonald, occurs in the Miocene beds of Malta; and a third, not yet described, was found by Ad. von Koenen, in the Lower Oligocene beds (next above the London Clay) at Latdorf, near Bernburg, in the North of Germany.

Having obtained by the kindness of Sign. Michelotti several specimens of the Turin shell, also many examples of the Maltese *Thecidium* from Dr. Adams, and a few specimens of that from Latdorf from Messrs. von Koenen and Bosquet, I have been enabled to study and compare all their external and interior details with all possible attention, and of these I now offer carefully enlarged illustrations.

1. THECIDIUM MEDITERRANEUM, var. LATDORFIENSE.

Pl. I., figs. 6–9.

In external shape, dimensions, and internal characters, this THECIDIUM so exactly resembles the recent species that a lengthened description would be only repeating what we have already written.

A glance at the carefully enlarged illustrations in Pl. I. will, I trust, bear out the view here taken. This *Thecidium* does not appear to be rare in the Lower Oligocene beds of Latdorf, near Bernburg, in North Germany. As far as we at present know, this would be the oldest type or representative of the Mediterranean species.

2. *THECIDIUM MEDITERRANEUM*, var. *TESTUDINARIUM*, Michelotti, sp.
Pl. I., figs. 4 & 5; Pl. II., fig. 4.

Thecidea testudinaria, Michelotti: *Annali delle Scienze del Regno Lombardo-Veneto*, 1840; and *Actes de l'Académie Hollandaise des Sciences*, 2e sér. vol. iii., 1847, p. 79, pl. 2, fig. 26.

This *Thecidium*, by its external shape and interior characters, appears to bear so much resemblance to the Mediterranean shell that I doubt much whether we should be justified in considering it more than a variety. Its beak and area are at times considerably developed; but such is sometimes found to be the case with the recent type. In all essential points the interior resembles that of *Thecidium Mediterraneum*. A small and the only difference I am able to detect consists in the central (tongue-shaped) 'ascending process' being a little narrower, and commencing a little lower down, or nearer the front, than is usually seen in the recent shell. This *Thecidium* does not appear to be rare in the Middle Miocene beds near Turin; but it appears to be difficult to obtain perfect examples showing the interior of the dorsal valve.

3. *THECIDIUM ADAMSI*, Macdonald [variety of *Th. Mediterraneum*?].
Pl. I., figs. 10–13.

Thecideum Adamsi, Macdonald; *Quart. Journ. Geol. Soc.*, vol. xix. p. 517, 1863.

This shell does not appear to have attained the dimensions of the preceding two varieties of *Th. Mediterraneum*. By its general shape and interior arrangements, it so closely resembles the recent Mediterranean form that I feel doubtful whether it should be considered more than as a small race or variety of *Thecidium Mediterraneum*. Its exterior shape and characters have been correctly described by Mr. Macdonald, who does not fail to observe 'that its nearest ally is the recent *Thecidium Mediterraneum*.' *Thecidium Adamsi* has often, although not always, moulded a portion of the back of its larger valve upon slender stems of some concentrically ribbed coral, which has been reproduced in relief, with all the original markings, on the flattened dorsal valve (Pl. I., fig. 10, *a, b*); but when the shell has been fixed to some flat or rugose marine object by a larger or smaller portion of the extremity of its beak, the dorsal valve exactly resembles that of the recent *Thecidium Mediterraneum* (Pl. I. fig. 11). The interior of the dorsal valve has not been quite correctly described or figured in the *Journal of the Geological Society*; I have therefore drawn this valve with great care from some perfect examples sent to me by Dr. Adams, of Malta; and these figures, I trust, will convey to the reader's mind the intimate resemblance this shell bears to the Mediterranean species; so much so indeed is this the case that

the description we have given of the interior of *Thecidium Mediterraneum* will suit *Thecidium Adamsi* equally well. In none of the examples I have been able to examine could I find what Mr. Macdonald describes and figures as the 'outer simple loop,' following the contour of the shell, but lying a little within the granulated margin (see Pl. I., fig. 14, *e*), these 'intermediate half-loops or hook-like processes (fig. 14, *f*) should not be represented as 'free,' for they adhere to the shell by their inner margin, as we have described to be the case in the recent species. Neither is the central ascending tongue-shaped process, nor the descending process, correctly drawn in the woodcuts illustrating Mr. Macdonald's description. I am at a loss to understand Mr. Macdonald's figure (*op. cit.*, p. 518, fig. 2), for it would seem to represent at the same time the interior of the dorsal and ventral valves, which in such a position would be a material impossibility.

Dr. Adams has informed me that this little shell is abundant in the lower part of the Calcareous Sandstone and in the upper portion of the Lower Limestone of Malta, and is usually associated with *Orbitoides*, *Cidaris*, *Echinus*, *Scutella*, and other forms likewise characteristic of the situation, and never found in any of the overlying beds.

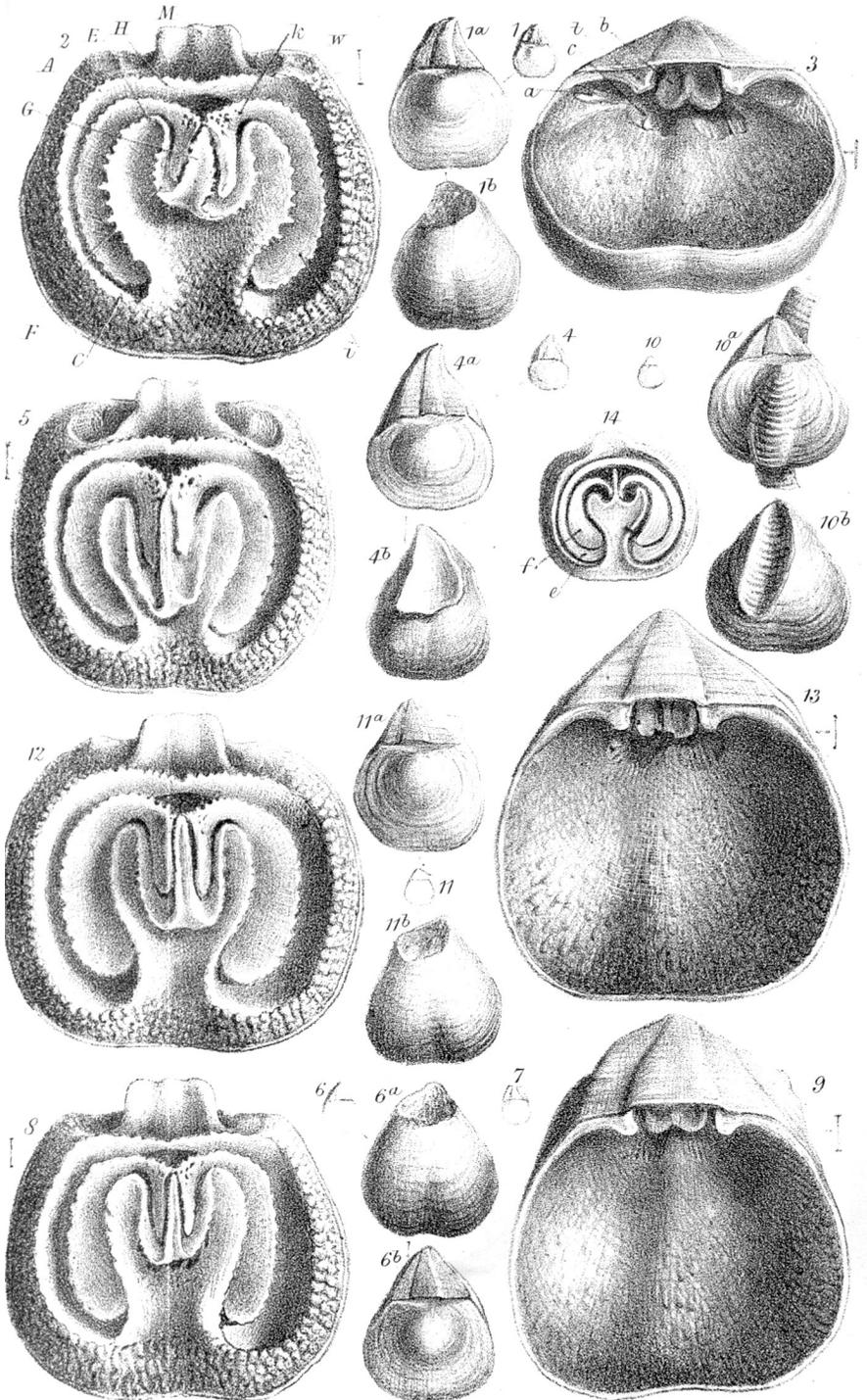
From the above it would appear that three of the four Tertiary so-termed species are constructed exactly on the same model; and of these we may look upon *Thecidium Mediterraneum* as the type, although the species appears to have first made its appearance in the Lower Oligocene period. Their structure is very different in detail from what we find in such shells as *Th. vermiculäre*, *Th. digitatum*, *Th. hieroglyphicum*, *Th. papillatum*, *Th. Mayale*, &c., from the Cretaceous and Jurassic periods, in which forms the ascending and descending apparatus are much more complicated. The arrangement seen in the Mediterranean type did not, however, originate in the Tertiary period, for we find in the Cretaceous formation one or two forms, such as *Th. affine* (Bosquet), which partake of the same character. The second Tertiary type (*Th. Barretti*) we have already shown to be also recent.

EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Thecidium Mediterraneum*, Risso, recent; Mediterranean; *a*, *b*, enlarged.
2. *T. Mediterraneum*. Interior of the dorsal valve enlarged. A, C, E, F, and G, 'ascending process;' H, bridge-shaped process; *i*, *k*, half-crescent or descending process; M, cardinal process; W, scar formed by the adjustors or 'muscles adducteurs lateraux ou externes' of M. Duthiers.
3. *T. Mediterraneum*. Interior of the ventral valve, enlarged, and a little turned up so as to show under the cavity of the beak; *b*, small concave plates ('coque' of M. Lacaze Duthiers) to

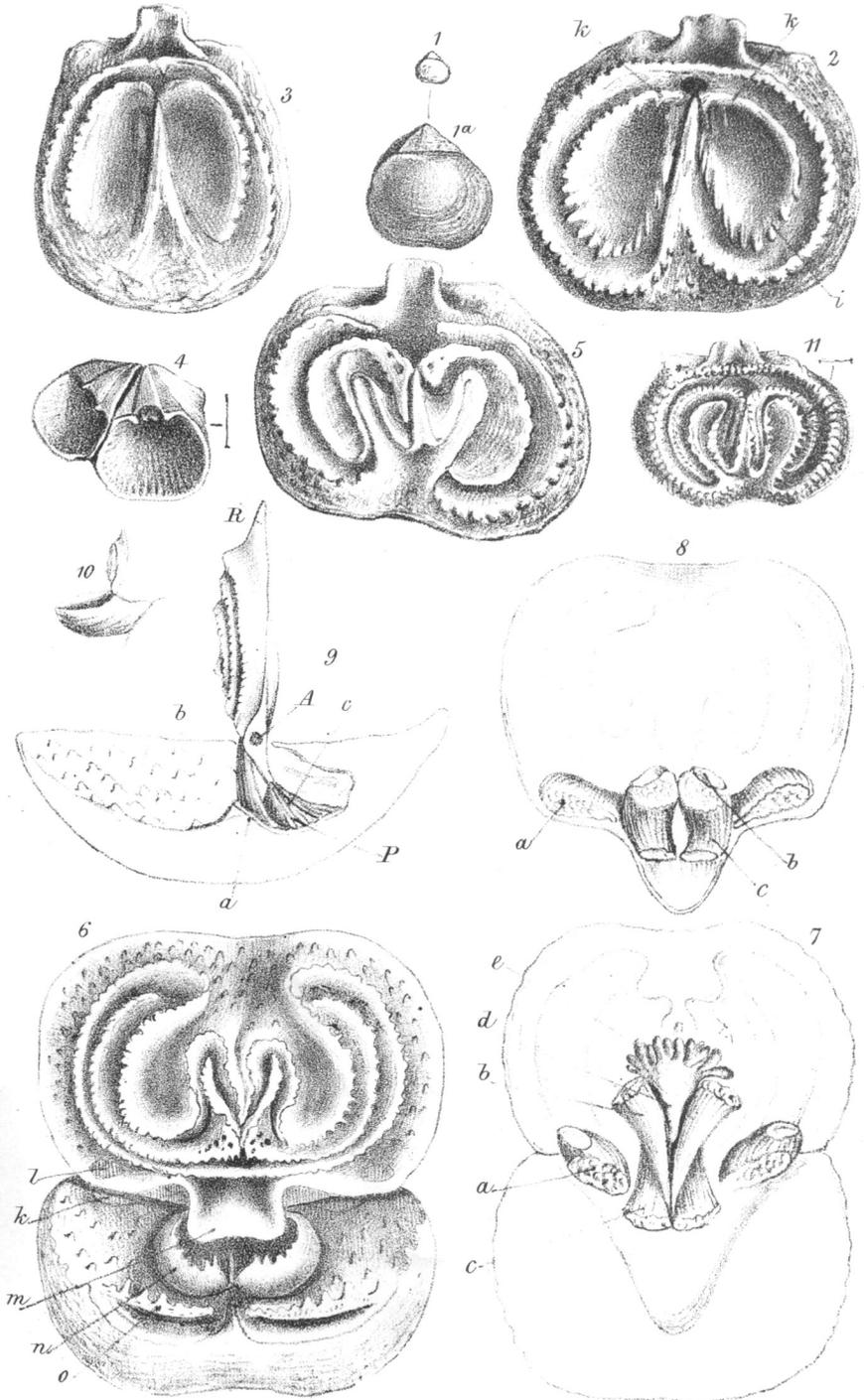
Plate 1



Thos Davidson del. et lith.

THECIDIUM: RECENT & TERTIARY.

W. West imp.



Tho^d Davidson lith.

THECIDIUM: RECENT & TERTIARY.

W West imp.

which were attached one extremity of the adductor or oclusor muscles; *c*, large scars produced by the divaricator muscles of Hancock, 'muscles abducteurs' of Duthiers; *a*, oval scars left by the 'ventral adjustor' of Hancock, 'muscle adducteur lateral' of Duthiers.

4. *T. Mediterraneum*, var. *testudinarium*, Michelotti; *a*, *b*, enlarged; 5. interior of the dorsal valve, enlarged. Middle Miocene, Turin.
- 6, 7. *T. Mediterraneum*, var. *Latdorfense*, from the Lower Oligocene beds of Latdorf, near Bernburg (6 *a*, 6 *b*, enlarged); 8. interior of the dorsal valve, enlarged; 9. interior of the ventral valve, enlarged.
- 10, 11. *T. Adamsi*, Macdonald: Miocene, Malta; *a*, *a*, *b*, *b*, enlarged.
12. *T. Adamsi*, interior of dorsal valve, enlarged.
13. *T. Adamsi*, interior of ventral valve, enlarged.
14. *T. Adamsi*, interior of the dorsal valve, after Macdonald's woodcut, Journ. Geol. Soc., vol. xix. p. 518, fig. 3. This illustration is not correct, as may be perceived by comparing it with fig. 12.

PLATE II.

- Fig. 1. *Thecidium Barretti*, Woodward, MS., *a*, enlarged. Recent, Jamaica.
2. *T. Barretti*, interior of the dorsal valve, enlarged; recent.
 3. *T. Barretti*, interior of the dorsal valve, enlarged; fossil.
 4. *T. Mediterraneum*, var. *testudinarium*, interior of the ventral valve, enlarged, Turin.
 5. *T. Mediterraneum*, interior of the dorsal valve, enlarged; recent, Jamaica. This and specimen figs. 1, 2, were dredged off Jamaica by the late Mr. Barrett.
- Figs. 1, 2, 3, and 5 are from drawings by Mr. S. P. Woodward.
6. *T. Mediterraneum*, after M. Lacaze Duthiers' figure. This is the interior of the dorsal and part of the ventral valves; *l* and *k*, impressions produced of his 'muscle adducteur lateral'; *m*, cardinal process; *n*, concave plates ('coque' of M. Duthiers), to the inner surface of which were fixed his 'muscles abducteurs'; *o*, lamellæ developed in the mantle of the ventral valve.
 7. *T. Mediterraneum*, after Duthiers. Animal of which the lobes of the mantle have been spread out, and viewed from the side of the shell so as to exhibit M. Duthiers' (*a*) 'muscles adducteurs lateraux,' Hancock's adjustors; *b*, Duthiers' 'muscles abducteurs medians,' Hancock's 'occlusors,' of which one extremity passes between the 'muscles abducteurs' (*c*) and the other is directed outwardly to make room for the intestine (*d*), which is the continuation of the lobes of the liver (*e*); *c* is Mr. Hancock's divaricator.
 8. *T. Mediterraneum*, after Duthiers. Animal separate from the shell and seen on the face which corresponds to the concave valve. *a*, lateral adductor muscle of Duthiers; *b*, median adductor muscle, of which we can see the extremity only which attaches itself to the bottom of the lamellæ under the beak of the ventral valve; *c*, abductor muscle, slightly curved, of which the two extremities can be seen.
 9. *T. Mediterraneum*, after Duthiers. Longitudinal section of a *Thecidium*, to give an idea of the manner in which the median muscles act: *a*, curved lamellæ, which are supported by and attached to a small septum under the beak in the ventral valve; *b*, 'median adductor muscle' of Duthiers = 'occlusor' (Hancock); *c*, 'abductor muscle' of Duthiers, which is attached by one

extremity to the bottom of the ventral valve, and by the other end to the extremity of the quadrilateral cardinal process of the dorsal valve. M. Duthiers states that one can thus establish the mechanism of the opening and occlusion of the shell; that when the animal wishes to open his shell, the power P is represented by the muscle (c), its point of application being at the extremity of the cardinal process of the ventral valve: the resistance R is the weight of this valve which has to be raised; the point of support is found in A ; we have, therefore, a lever of the first kind. If it were required to close the shell, the same analysis would be applied to the lateral muscles, by reversing, however, the power and the resistance, the point of support being always in the articulation A .

10. *T. Mediterraneum*, after Duthiers, twice the size of life, with its valves open.
11. *T. affine*, Bosquet. Interior of the dorsal valve enlarged, from the Upper Cretaceous formation of Limbourg.

III. ON SOME SPECIAL INDICATIONS OF VOLCANIC ACTION IN THE CARBONIFEROUS PERIOD AT BURNTISLAND, FIRTH OF FORTH.

By ARCHIBALD GEIKIE, F.R.S.E., F.G.S.

ON the northern margin of the Firth of Forth, opposite Edinburgh, a line of steep craggy slope sweeps round from behind the village of Burntisland to the shore about half a mile eastward. The highest and most precipitous portion rises to a height of 631 feet; and the space between its base and the shore is so short that when seen from a short distance, the hill seems to shoot almost directly out of the sea. Hence these heights form conspicuous landmarks all over the Lothians. Their scarred fronts and verdurous slopes bear all the characteristic features of the minor hills in the lowlands of Scotland—a union of brown mouldering crag, often steep and bold, with soft green hollows, and with shelving sides that are either cumbered with ruins from the cliff overhead, or dotted with bushes of golden gorse. Such scenery is to a geological eye eminently ‘trappean;’ it at once suggests beds of greenstone, basalt, and ash, with the other concomitants of ancient volcanic eruptions. And truly amid all the rich development of volcanic phenomena in these Lowlands, the rocks of the Burntisland shore deserve to stand up as conspicuous landmarks. They have been laid bare by rains and frosts and the waves of the Firth along some miles of the coast-line, where they can be studied, bed after bed, in the minutest detail. I know of no such section in any other part of the kingdom.

Just beyond the eastern outskirts of Burntisland the high grounds curve round to the shore, which they reach in a line of cliff known as the King’s Craig,—one that has a melancholy