

beneficent agency still in operation—first, in conserving our coal strata by lowering them so as to admit of deposition, to a vast amount, taking place above them; and again in uplifting them so as to bring them, and indeed every other economic stratum of our island, within easy access to meet our varied and ever-increasing needs.

## II.—ON THE ANOMALOUS MODE OF GROWTH OF CERTAIN FOSSIL OYSTERS.

By JOHN W. JUDD, F.G.S.

(PLATE IX.)

IN that rich storehouse of fossils, the Cornbrash, there occur, as all geologists who have been in the habit of collecting from it are aware, several species of the genus *Ostrea*, two of which are large and conspicuous shells. One of these is the everywhere abundant and very characteristic plicated form known as *O. Marshii*, Sow. (*O. flabelliformis*, Lamk. ?); the other, which is far less common, but by no means rare, is flat and smooth, and sometimes considerably elongated in form. This latter species does not appear to have received a name in this country, but it may not improbably be identical with the *O. exarata* of Goldfuss (*Petrifacta Germaniæ*, Theil ii. z. 5, tab. 72, fig. 9), a shell first obtained from the *Unteroolith* of Gräfinberg.

If we look over any collection of specimens of this Cornbrash Oyster, we shall almost certainly be struck with the appearance of some detached upper valves, which exhibit on their outer surfaces markings very different from those belonging to any known species of Oyster, and unmistakably resembling those which characterize totally different classes of shells. The interiors of these valves, however, exhibit no peculiarity whatever, but have the smooth surface with the impression of the single adductor muscle, which characterizes that group of the Mollusca to which the Oysters belong. Occasionally the markings on the outer surfaces of these oysters appear to be nearly as distinct and sharply defined as those of the shells which they imitate. The shell of which the markings appear to be most frequently copied in this manner is a clavellate *Trigonia*, itself a tolerably abundant fossil of the Cornbrash, and known as *T. Scarburgensis*, Lycett; but specimens of the oyster bearing the markings of *Ammonites Herveyi*, Sow., and other common Cornbrash shells, are by no means rare.

Of course the first suggestion which offers itself to the mind, in attempting to account for these appearances, is that the oysters are merely impressed with the features of the objects to which they happened to grow attached. But a moment's consideration suggests a fatal objection to this explanation; we are required to account for the production, not of a *cast*, but of a *facsimile* of the shell copied. In the case of a remarkable oyster in the British Museum, which bears the markings on the back of an Ammonite of the group of the

*Ligati*, an attempt to meet this difficulty has been made by the suggestion that the oyster had grown on the *inside* of a dead Ammonite shell. Setting aside the inherent improbability of this explanation, it is evident that it will not serve us in the case of oysters taking the markings of *Trigonia*, as the inner surfaces of these latter bear no resemblance whatever to their outer.

So remarkable is the appearance of shells of one genus bearing the *superficial* markings of those of a totally different group, but otherwise retaining all their essential characters, that I was at one time even tempted to speculate whether we might not have here in the Oolitic rocks an actual case of *mimicry*, possibly for protective purposes, similar to those which obtain so frequently among many living animals. The collection and careful examination of a large series of specimens, while it has dispelled this idea, has led to the true explanation of the phenomenon—an explanation which is not a little curious and interesting.

Among the thin-shelled *Ostreidæ* (*Anomia*, *Placunopsis*, *Placuna*, *Plicatula*, etc.), we frequently find specimens that have grown attached to shells or other foreign bodies in which, owing to its tenuity, the whole organism, lower valve, animal and upper valve, has become moulded on to and taken the markings of the surface on which it lies. In Plate IX. two examples illustrating this are shown. Fig. 1a, 1b, represents the upper and under sides respectively of a specimen of *Placunopsis Jurensis*, Mor. and Lyc., which has grown attached to the side of *Goniomya V-scripta*, Sow. This specimen, which was obtained from the Cornbrash of Scarborough, by the late Mr. Bean, is now in the British Museum. In Fig. 2 is shown a still more curious specimen; it was obtained by Dr. Lycett from the Inferior Oolite of Rodborough Hill, near Stroud, and is in the Museum of Practical Geology, Jermyn Street. This specimen is a *Placunopsis*, of a species not yet described, which has grown upon a clavellate *Trigonia*; the surface of its upper valve exhibits the peculiar markings of the *Placunopsis* in combination with those of the *Trigonia*.

If we were to find the upper valve of a *Placunopsis*, like either of those we have been describing, lying detached in the rock (which we seldom or never do), it would resemble, in the character of its outer surface, the oysters to which we have referred; but its inner surface would differ altogether by following all the foldings and wrinklins of the outer, instead of being perfectly smooth.

Occasionally we find specimens of our Cornbrash oyster with both valves preserved. A good example of this is shown in Plate IX., Fig. 3. The specimen which is in the British Museum was collected by W. Cunningham, Esq., at Weymouth. 3a shows the upper valve displaying very distinctly the characteristic tubercles of the *Trigonia*; 3b, the lower valve, in which precisely the same markings are exhibited in reverse or as a cast. On separating the two valves, we find the interiors quite smooth, and exhibiting no trace whatever of the prominent markings of the exterior.

If we consider the characters presented by this specimen, at the

same time bearing in mind the features presented by the attached thin-shelled *Ostreidæ*, like *Placunopsis*, and also the mode of growth of the shell in the oysters by the deposition of successive laminæ from the mantle of the animal, we are led to realize the exact manner in which the singular examples to which we have referred have been produced.

This we have illustrated by the ideal section, Fig. 4, which represents a *Trigonia* shell (*a*), upon which an oyster (*b*) has grown. At an early stage of its growth the valves of the oyster would be represented by 1-1, 1'-1'; these being then nearly in apposition, and the animal like them extremely thin, and partaking of all the undulations of the surface of the *Trigonia*. In this state the oyster would exactly resemble the specimen of *Placunopsis* represented in Fig. 2. The subsequent growth of the oyster was almost entirely confined to an increase of the thickness of the shell. The two first-formed laminæ, 1-1, 1'-1', would not be in any way altered by the shell's subsequent growth, though they would be thrust gradually farther and farther apart. The successively deposited layers of shelly matter would naturally be less and less conformed to these exterior laminæ, and thus these markings becoming continually fainter on the interior of the shell, would at last be obliterated altogether. The successive stages of growth of the two valves are represented in the diagram by the lines 2-2, 2'-2'; 3-3, 3'-3'; 4-4, 4'-4'; 5-5, 5'-5'; and 6-6, 6'-6'. Of course, as the animal increases in thickness as well as the shell, an excessive deposition of shelly matter will have to take place at the edges of the valves, and this is always observed to be the case in the specimens of which we are speaking.

That this is the true explanation of the remarkable appearances to which we have directed attention in this note is confirmed by an examination of sections of these oysters, and also by the successive removal (by the aid of dilute acid) of the several laminæ of which the shells are composed.

It is evident that the oysters which present these mimetic markings over nearly the whole of their surfaces must, in their early stage of growth, have increased very slowly vertically, but rapidly laterally, like *Placunopsis*, so that the shell must have attained almost its full diameter before it began to increase greatly in thickness.

As an example of the singular objects which are sometimes produced in consequence of the peculiar mode of growth of these oysters, we have figured a specimen obtained by the late Dr. Porter from the Cornbrash, near Peterborough. In this case two oysters have grown side by side on the back of a large example of *Ammonites Herveyi*, Sow., and at last have so pressed upon each other that they have become united at their edges. The curvature of the Ammonite shell, with the markings of its surface, have been reproduced on this double specimen, the ribs of the former appearing as casts on its under side (5*b*) and in relief on its upper side (5*a*); 5*c* represents a section of this singular specimen.

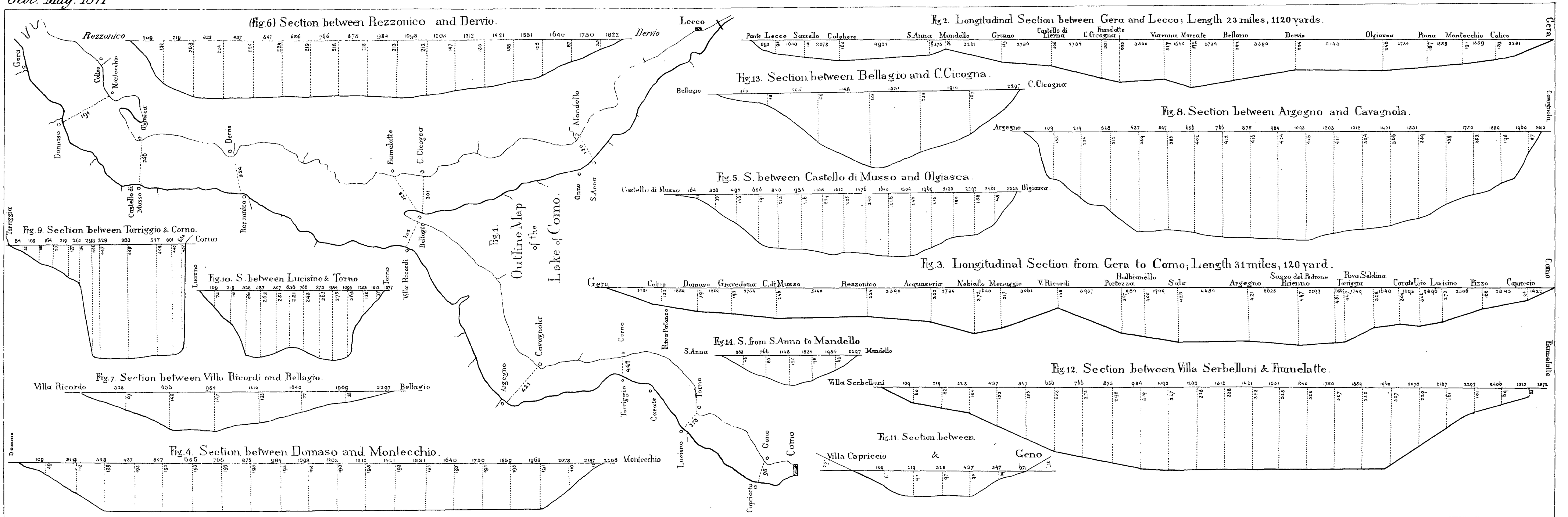
Besides the species to which we have been referring, other oysters

exhibit, in a greater or less degree, a tendency to this mode of growth. Conspicuous among these is the well-known *O. deltoidea*, Sow., of the Kimmeridge Clay. In the British Museum (Northern Gallery, Room V., Table Case 2) there is exhibited an interesting series of these shells from Boulogne, which have grown upon different portions of several species of Ammonites.

Other oysters, which are only attached during a short portion of their existence, sometimes display the characters we have been describing in the portion of the shell first formed. Thus the plicated *O. gregaria*, Sow., of the Coral Rag, sometimes exhibits on the central ridge of its attached and free valves respectively, the cast and facsimile of the surface of a coral to which it has been attached.

That the Gryphoid oysters, which normally become free at a very early stage of their existence, sometimes remain attached during a considerable portion of their life, is well known, and has been referred to by Mr. Jones in his interesting paper, "On *Gryphæa incurva* and its Varieties," in the Proceedings of the Cotteswold Club, vol. iii., p. 81. The aberrant forms thus produced have even been mistaken in some cases for distinct species of oysters. These *Gryphææ*, with large surfaces of attachment, sometimes strikingly exhibit the phenomenon which we have described in this note. In the British Museum there are two specimens of *Gryphæa dilatata*, Sow., from the Oxford Clay of Weymouth, each of which has grown on the outside to a Trigonion, till it has attained about one-half of its diameter. The portion of the shell formed during the period of attachment shows clearly the markings of the Trigonion in cast and facsimile, while the interior is quite smooth. In another example we find a small Trigonion shell with its outer surface still embedded in the incurved beak of a *Gryphæa*; on the inner surface of the attached valve of this latter there are no traces of the markings of the Trigonion, but these are beautifully reproduced on the exterior of the free valve.

Although Goldfuss has figured some specimens of oysters with the markings of other shells, such anomalous objects are generally excluded from the plates which illustrate palæontological treatises. An exception is found in the magnificent "Der Jura" of Professor Quenstedt, a work which is the result of the most patient, minute, and exact observation, and which may be quoted as the most faithful delineation of the characters of a single formation in a given area with which geological science has as yet been enriched. In this work we find figured under the name of *O. falcifer* (Atlas zum Jura, tab. 37, fig. 1) an oyster from the Upper Lias, which exhibits the sigmoidal markings of the shell of *Ammonites falcifer*, Sow. Prof. Quenstedt does not appear to have noticed the remarkable character of the smooth surfaces of the interior of these oysters; but he remarks that the animal was probably very thin, and in this respect allied to that of *Placuna*. In the same work, tab. 6, fig. 9, tab. 11, fig. 9, and tab. 23, fig. 6, there are represented other examples of Ostreiform shells which have taken the markings of the shells to which they have grown attached.



Drawn by C. L. Griesbach.

OUTLINE MAP AND SECTIONS OF THE LAKE OF COMO. ——— TO ILLUSTRATE PAPER BY JOHN BALL, ESQ. F. R. S.

Whitman & Bass, Litho.

## EXPLANATION OF PLATE IX.

Fig. 1a, b. Upper and under side of *Placunopsis Jurensis*, Morris and Lycett. Cornbrash, Scarborough.

Fig. 2. *Placunopsis*, sp. nov. Inferior Oolite, near Stroud.

Fig. 3a, b. Upper and under side of *Ostrea*, sp. Cornbrash, Weymouth.

Fig. 4. Ideal section of *Ostrea*, showing growth (see page 357).

Fig. 5a, b, c. Upper and under side, and section of *Ostrea*, which has grown on the back of *Ammonites Herveyi*. Cornbrash, Peterborough.

### III.—NOTICE OF SOUNDINGS EXECUTED IN THE LAKE OF COMO, WITH A VIEW TO DETERMINE THE FORM OF ITS BED.

By JOHN BALL, F.R.S.

(PLATE X.)

THOSE who have taken part in the recent discussions as to the origin of lake-basins are well aware that one of the chief causes which has retarded a settlement of the controversy is the ignorance prevailing as to the true form of such basins. Even as to the Swiss and Lombard lakes, constantly visited as they have been by men of science, the data are extremely scanty and no way reliable. A few soundings made by myself in the Lake of Como, in 1863, and referred to in a paper published in the *Philosophical Magazine* in the following December, increased my conviction of the importance of instituting careful and exact measurements of the form and dimensions of the beds of lakes, if we were to reason securely as to their origin. I expressed that conviction at the time to an active local naturalist, Don Baldassare Bernasconi, residing at Laglio. In 1865 Signor Gentili, one of the engineers of the Lombardo-Venetian Railway, being for some months on the Lake, proposed to undertake a regular survey of the bed of the Lake by means of a complete series of soundings, and devised an instrument for measuring the distances traversed horizontally in a boat, corresponding to each cast of the sounding line. Signor Gentili found two active coadjutors in the persons of the above-named ecclesiastic, and of Dr. Guiseppe Casella, also resident at Laglio, on the Lake.

The results were published by Signor Gentili in a paper inserted in the second volume of the *Memoirs* of the "Società Italiana di Scienze Naturali," and also in a little tract, entitled "Cenni Orografici sul Lago di Como," by MM. Casella and Bernasconi, both dated in 1866.

It is apparent that the authors of the second paper found cause for complaint as to the form adopted by Signor Gentili for the publication of results which had been mainly obtained through the labour and perseverance of his coadjutors.

An examination of the plans and sections contained in both papers displays a general agreement in the results, showing that they are derived from identical materials, along with some discrepancies easily accounted for when we recollect that some of the sections are executed independently, and do not follow the same line exactly.