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### XXXV.—On the characteristic fossils of the chalk formation Communicated by Prof. J. Nicol

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row subterminal black-brown band; tail and underside of body white, scarcely black varied; whiskers thick, black, white at the base; upper cutting-teeth with a distinct subcentral longitudinal groove.

*Young.* Fur ——— ?

*Cercolabes prehensilis*, var. Waterhouse, N. H. Mamm. ii. 414.

The skull of the Bolivian specimen is much larger, wider over the orbits and much higher from the palate to the nose and forehead than in the Brazilian specimens: the grinders are considerably smaller, and it has the peculiar groove on the upper grinders, but the latter may be an accidental or individual peculiarity.

The following measurements in inches and lines of three skulls in the Museum collection will show these peculiarities. No. 1 is the skull of the Bolivian specimen; No. 2 that of the Brazilian specimen: these animals are nearly of the same size. No. 3 is a skull of a skeleton from the Brazils.

	No. 1.		No. 2.		No. 3.	
	in.	lin.	in.	lin.	in.	lin.
Skull: Length, entire .....	4	2	3	5	3	7½
Width at orbit .....	2	4	2	2	2	3
—— over orbit .....	2	4	1	6½	1	8½
—— at nose .....	1	1½	1	1	0	11½
Height from palate to tip of nose ...	1	5	1	1½	1	2
—— from palate to top of forehead .	2	2	1	9½	1	10
—— of teeth series .....	0	9½	0	9½	0	10

There is a specimen in the Museum which Mr. Waterhouse has described as a variety (Hist. Mamm. ii. 415). It is very distinct in appearance from either of the above, but best agrees with the specimen from the Brazils in the blackness and slenderness of the whiskers and the smoothness of the upper cutting-teeth, and the blackness of the tip of the tail, but differs in the general colours being much blacker, and in the underside of the body and tail being nearly black and only very slightly grizzled, and especially in the tips of some of the spines on the sides being yellow. I strongly suspect it will prove a third species, to which the name of *C. tricolor* might be attached.

# XXXV.—On the characteristic Fossils of the Chalk Formation.

By L. VON BUCH\*. Communicated by Prof. J. NICOL.

THROUGHOUT all the members of the chalk formation, three chief forms of organic beings seem especially adapted to serve as characteristic fossils. These are the *Ammonidæ*, the *Trigoniæ*, and

\* From Betrachtungen über die Verbreitung und die Grenzen der Kreide-Bildungen. Bonn, 1849.

the *Exogyra*. A few words explaining the general character of these forms may not prove unacceptable.

### 1. THE AMMONIDÆ.

It is well known, that the Ammonites, still so remarkably abundant in the lowest cretaceous beds, or the Néocomien, rapidly decrease in the higher strata; so much so, that even in the upper chalk they no longer occur, and that every trace of them has since vanished from the surface of the earth. There is however something very remarkable in the manner of this disappearance. The greater number of the Ammonites seem to suffer from the disease which at length expels them from creation. The whorls in many no longer lie exactly in one plane, but the one side projects somewhat forwards and draws the other after it. Soon after they even lose the power to attach themselves closely to the previous whorl; and these are now unconnected (F. A. Römer, Kreide, p. 135), when the *Crioceras*, which is only found in the chalk, is formed. The formation of such unattached whorls soon exceeds the power of the animal to bend its body, and thus to contract itself into such protecting limits,—it is compelled to extend itself lengthwise, and the singular forms of the *Toxoceras*, the *Ancyloceras*, the *Ptychoceras*, finally those of the *Hamites*, and of the *Baculites*, straight like a staff and directed perpendicularly upwards, are produced, and are the last attempts of the animal to maintain its existence. Subsequently nothing appears in nature which can remind us of this kind of Cephalopod. All these forms therefore, diverging from the perfect Ammonite, mark in the most decided manner one or other portion of the cretaceous formation,—they are *leading forms*, which, where they occur, exclude the supposition of any other formation.

It is truly remarkable, that in the same manner as the *Ammonidæ* vanish from the world, in the same manner exactly do the *Nautilidæ* make their appearance in the oldest strata. The entirely straight *Orthoceratites* are the most ancient of all known Cephalopods; they endeavour, at least when young, to attach themselves to the previous whorl, an attempt which, however, must be given up in its further growth, when the animal can only increase lengthwise;—the *Lituite* is produced;—the *Clymenia* succeed in attaching themselves throughout to the previous whorl, in a continuous spiral entirely situated in one plane; the *Nautilus* finally—of which a weak remnant, the *Nautilus pompilius*, has continued to the present time—surrounds all the previous whorls with the last one, and thus withdraws itself more perfectly from the attacks of its enemies. The Ammonite vanishes through a series of forms intermediate between it and the

outstretched Baculite; the Nautilus on the other hand arises through a similar series of forms from the long-extended Orthoceratites.

Very many Ammonites of the chalk possess another peculiarity by which they are easily recognized, and consequently also the formation in which they are found. The plications (*Falten*) or ribs on the sides become always stronger and thicker the nearer they approach the back; in the Jura Ammonites they become weaker unite from below upwards; on the margin of the back itself they are often so much expanded (*aufgebläht*) that they do not pass over the back and cannot unite with each other from the two sides. The siphon then remains (*bleibt zurück*) in a deep furrow. The secondary plications (*Hülfstrippen*) are of equal strength with the chief plications, especially on the margin of the back, but they disappear even on the middle of the side and rarely unite with the chief plications. This gives the whole form an unhandsome, almost clumsy aspect, which distinguishes it very much from the handsome Jura Ammonites. Instances may be taken from very different families: *Am. Syriacus*, *interruptus*, *Rhotomagensis*, *denarius*, *varicosus*, Sow. &c. This formation evidently arises from the endeavour of the upper half of the animal to move quicker forwards on the back than the lower ventral portion can follow. It is just this endeavour also that produces the singular form of the Scaphites. On more close investigation it would evidently be pronounced a disease of the Ammonite, were not the form too constant, and did it not show too complete an agreement in widely distant regions. It is universally seen in all Scaphites, that they only then first forsake the regular form of an Ammonite when the last septum is formed. The shell suddenly expands immoderately, the former law of the increase of the whorls is entirely suppressed, the lateral ribs and prominences are disproportionately separated from each other, new ribs run down from the back and push themselves strongly forwards. The ventral side separates itself entirely from the whorl, and the shell grows in a straight, no longer spiral direction; yet not long; the expanded portion again contracts, the last chamber appears as if drawn together, it anew curves round towards the centre, but by this contraction the life of the animal is soon terminated. If it is a disease of the Ammonites, then it is a real epidemic which has attacked the Ammonites in the cretaceous period, for the Scaphites are far from rare, of very various forms, and almost peculiar to the middle cretaceous strata; hence they must be especially regarded as characteristic fossils for the cretaceous formations. And these deposits even on the Missouri are no less marked by them than by the large Inocerami. For one of the most beautiful Scaphites, the *S. Nicolletii*, which

has not yet been figured, was brought from the Black Hills in lat.  $46^{\circ}$ \*, by F. Römer.

## 2. THE TRIGONIÆ.

Not only by their numbers, but still more by the richness of their specific divisions, by the peculiar prominence of individualization, do the species of the remarkable genus *Trigonia* attain their maximum point in the lower chalk. They do not long maintain themselves at this elevation; like so many other races they quickly decline again, and the only species of *Trigonia* still living, in the warm waters of the Pacific near the Fidji islands, is but a very miserable remnant of the fine forms which are still preserved in the rocky strata. From this multiplicity of forms many might easily be selected as fully characteristic of the chalk; these would however be isolated, and found not universally, but perhaps only in a few localities. On the contrary, that remarkable family of *Trigoniæ*, which Agassiz has named '*Trigonia scabræ*,' is dispersed over every land where the chalk occurs, and such a *Trigonia* is alone sufficient to determine the age of the formation in which it occurs. The peculiar and prominent characteristic of these forms is a remarkably produced ventral margin, when the area of the posterior side is brought, as usually happens, into a concave position. This is produced by the very oblique angle at which the posterior and anterior sides meet at the hinge, an angle which seldom exceeds  $60^{\circ}$ , whereas in other families these two sides meet at a right angle. Along with this all the *Scabræ* appear much intumescend at the hinge, and fall quickly off with some degree of acuteness before attaining the posterior termination. The sides are adorned with ribs, running down perpendicularly, of which only a few curve round below the hinge and become united on the anterior surface. These ribs are divided, crenulated, by more or less acute divisions, placed close together, and they are also sometimes slightly curved towards the posterior area, when the side of the shell declines somewhat more quickly backwards. From such minute distinctions Agassiz and D'Orbigny have formed many distinct species, *Trigonia scabra*, *aliformis*, *carinata* and others. However, the characters on which these various species have been founded have no fixed limits, but pass insensibly into each other; the numerous crenulations of the *Trigonia carinata* are easily lost on the *Tr. scabra* and *aliformis*; the depression of the posterior part of *Tr. aliformis* is very often altogether wanting. On the other hand, the number of the ribs, with nearly equal size, continues almost constant. Eighteen to twenty ribs are almost invariably counted on the sides of these *Tri-*

\* A description of this new species is then given by the author.—  
TRANS.

*gonia*, of about  $2\frac{1}{2}$  inches in size, as well in France as in England and America. This is also the case with the Mexican *Trigonia*, described (Bulletin de Bruxelles, tom. vii. no. 10) by MM. Nyst and Galeotti, which they have named *Tr. plicato-costata*. It is not distinct from the *Trigonia crenulata* of Lamarck and Agassiz, and when of the same size has the same number of ribs on the side. When thus limited and again referred to the oldest name proposed by Sowerby of *Trigonia aliformis*, this remarkable *Trigonia* is dispersed over the whole extent of America, and everywhere characterizes the middle chalk. Even the *Trigonia thoracica* described by Morton from Alabama is now recognized by him as *Trigonia aliformis*. M. Galeotti relates that the *Trigonia* discovered and published by him occurs in the marls of a very extensive limestone formation in the middle of the great and principal Cordillera of Anahuac, twelve French miles W.N.W. from the town of Tehuacan in the district of Puebla, and four to seven thousand feet above the sea level. In that place it is so abundant and large that it may be considered the chief and most characteristic fossil of the whole formation. It is wonderful, says Galeotti, to find in one place such vast accumulations of fossil shells, fragments of so many Ammonites several feet in diameter, or of gigantic stems of corals; so much so, that perhaps there is no other locality on the whole surface of the earth, where over several square miles such an immense mass of organic remains are dispersed. Some Ammonites are figured by Galeotti and described by Nyst, but neither the description nor the figure gives a clear view of the whole; they remind us chiefly of the *Ammonites Carderoni* of D'Orbigny. This same *Trigonia* again appears in South America, in the mountains of S. Fé de Bogota, whence they were first brought to us by Von Humboldt (Pétréf. recueillies en Amérique, p. 8. f. 10). It occurs here dispersed over a wide space, from Socorro on the north to Tocaymo on the south of Santa Fé. It also shows the same depression of the lower border, the same acute angle, scarcely exceeding  $60^\circ$ , of the anterior and posterior margin, the same number of perpendicular plications on the sides, and the same crenulations on the plications. It seems therefore without sufficient foundation that some naturalists believe this *Trigonia* to be a new species. D'Orbigny has quoted it with some doubt as *Trigonia subcrenulata*\*, and Lea under the name of *Trigonia Tocaymaana*†. Since now the mountains of Santa Fé are proved most distinctly by the organic remains inclosed in the strata to belong to the middle cretaceous series, as I have endeavoured to prove in the description of Humboldt and

\* Coquilles de Colombie par M. Boussingault: Paris, 1842, p. 52. pl. 4. f. 7-9.

† Trans. Amer. Phil. Soc. 2nd ser. vol. vii. p. 6. pl. 9. f. 8.  
Ann. & Mag. N. Hist. Ser. 2. Vol. v.

Degenhardt's 'American Fossils' (Berlin, 1839), and as still more clearly appears from Alcide D'Orbigny's learned work on Bous-singault's collections, it follows that the strata discovered by Galeotti above Tehuacan must be joined, with all their organic remains, to the middle chalk. The collections made by Burkart, Councillor of Mines in Bonn, in the mountains of Guanaxuato, contain nothing opposed to this view. We do not again find this *Trigonia* further south in America, in Peru or in Chili, at least it has not yet been observed in the cretaceous strata so common in all this region. On the other hand it appears in other quarters of the globe. The enterprising and talented Director Kraus of Stuttgart has brought from Zwartkopp, Algoa Bay at the Cape of Good Hope, a *Trigonia* which in all essential characters agrees with the *Trigonia aliformis*—even the acute angle, under  $60^{\circ}$ , of the anterior and posterior margins, and the direction of the ribs with the fine crenulations on them. Herr Kraus has named this shell *Trigonia ventricosa*. It is almost surprising to find this same *Trigonia aliformis* in the chalk hills which appear as if blown by the winds over the vast peninsula of Hindostan, quite in the south, near the point at Verdachellum to the south-west of Pondichery, and nearly in the same circumstances as in Europe and America. Prof. Edward Forbes, the most distinguished palæontologist in England, affirms that he could find no distinction whatever between the Indian *Trigoniæ* and those from Black-down\*. Along with it *Cardium Hillanum*, *Pecten quinquecostatus*, *orbicularis*, *obliquus*, occur, so that Mr. Forbes has no difficulty in referring the strata of the hill of Verdachellum to the upper greensand and the gault, or exactly the place to which the thick beds of St. Fé de Bogota, of Tehuacan and of Alabama, must be referred. Still the Indian beds contain a great number of forms which are peculiar to them alone, and perhaps bear some relation to tropical conditions of climate, and which by themselves might be a reason for suspecting that these hills form a very highly developed tertiary formation. The *Trigonia* alone is sufficient to lead us to a better conclusion. It is a *characteristic fossil*.

### 3. THE EXOGYRÆ.

Still more even than the *Trigoniæ*, we may regard the *Exogyra* as a stamp impressed on the whole cretaceous formation. These singular oysters appear for the first time in the Jura deposits, but only small, hardly an inch in size, and in most cases (*Exogyra virgula*, *Knorrii*, *spiralis*, *auriformis*) scarcely larger than beans. Wherever they are several inches in size, it may be unconditionally assumed that they declare the formation to be cre-

\* Geol. Trans. 2nd ser. vol. vii. P. iii. p. 151. pl. 14. f. 3.



taceous. They then exhibit great diversity of form, but are at the same time so remarkably regular in their geological position, that each of the four divisions of the chalk may be distinguished by certain forms of *Exogyra*; and hence they are of the greatest importance for determining to which of these divisions of the chalk a particular bed belongs. The beak of all the *Exogyra* is very much twisted, sometimes turned round two or three times like a ram's horn. This twisting is always found on the right side of the deeper (lower) valve, when the hinge or beak is turned towards the observer. On this side of the beak also there always appears a more or less distinct, narrower or broader depression, which is continued from the margin to the beak. In the interior of the shell this depression forms a swelling on which the muscular impression is seen. Hence it is evidently the muscle that pulls up the mantle and along with it also the shell which it produces, and thus causes the furrow or depression on the exterior surface. This is a chief character of all the *Exogyra*, which is wanting in the *Gryphææ* and still more in the oysters. This also explains why the right side of the *Exogyra* is always the smaller one, and much less expanded than the left side.

All the *Exogyra* may be divided into two sections according to the form of this side with the muscle:—into those in which this side is vertical to the surface of greatest expansion in the shell, and then forms a sharp keel on the back,—and those in which this side expands somewhat in a wing-like form, with a rounded and not a projecting back; that is (1) the *Exogyra carinata*, and (2) the *Exogyra expansa*. Singularly enough these two divisions correspond to the geological occurrence of the genus;—the first section, or the *Exogyra carinata*, appearing especially in the lower; the other section, or the *Exogyra expansa*, mostly in the upper strata of the chalk deposits. These two divisions are represented in a remarkable manner by the *Exogyra Couloni*, or *aquila*, Goldfuss, and the *Ex. columba*; the first characteristic of the Néocomien, the second of the upper chloritic chalk [chalk-marl]. Throughout the whole of Europe this *Exogyra columba* is never looked for in vain, but in North America it has not yet been seen except in Texas, and there only of a small size (Römer). Its place appears to be supplied by the large, scaly, wide-expanded *Exogyra costata*, Say, which, according to Morton's statement, occurs wherever the cretaceous strata are found. On the other hand, the absence of *Exogyra Couloni* from this portion of America is quite in accordance with its position in the lower beds which are wanting in North America.