

XL.—Notes on a Group of Russian Fusulinæ.

By HENRY B. BRADY, F.R.S.

[Plate XVIII.]

CERTAIN minute fossils of the Carboniferous Limestone of Miatschkovo, Toula, and elsewhere in Russia, variously treated by a succession of observers, seem scarcely yet to have found a settled or recognized position. Amongst a number of rock-specimens of Carboniferous age kindly sent to me some time ago by General G. von Helmersen of St. Petersburg, was a piece of the white limestone of Miatschkovo; and the following brief notice of its constituent organisms is intended to set at rest, as far as may be, some of the doubtful or debated points of the structure and affinities of the group to which they pertain.

The fossils referred to have been more or less described by Fischer, Rouillier and Vosinsky, Ehrenberg, D'Eichwald, and Abich, under the generic names *Fusulina*, *Nummulina*, *Borelis*, *Alveolina*, and *Orobias*, as follows:—

Fusulina cylindrica, Fischer von Waldheim, 1829, Bull. Soc. Imp. des Naturalistes de Moscou for 1829, p. 329; *Oryctographie de Moscou*, p. 126, pl. 13. figs. 1–5.

— *depressa*, id. ibid. p. 127, pl. 13. figs. 6–11.

Nummulina antiquior, Rouillier and Vosinsky, 1849, Bull. Soc. Imp. des Naturalistes de Moscou, vol. xxii. p. 337, pl. K. figs. 66–70, &c.

Borelis princeps, Ehrenberg, 1854, *Mikrogeologie*, pl. 37. § x. C. figs. 1–4.

— *sphæroidea*, ibid. D. fig. 1.

— *constricta*, ibid. figs. 5, 6.

— *labyrinthiformis*, ibid. pl. 37. § xi. fig. 3.

— *palæolophus*, ibid. figs. 4, 5.

— *palæophacus*, ibid. fig. 6.

— *palæosphæra*, ibid. figs. 7, 8.

Alveolina montipara, ibid. pl. 37. § x. C. fig. 5.

— *prisca*, ibid. § x. D. fig. 7, § xi. fig. 1.

Fusulina sphærica, Abich, 1858, *Mém. de l'Acad. Imp. des Sci. de St. Pétersbourg*, sér. 6, vol. vii. 1859; *Mém. phys.-math.* p. 528, pl. 3. fig. 13, a, b, c.

Orobias antiquior, D'Eichwald, 1800, *Lethæa Rossica*, vol. i. p. 353. Esp. 26.

— *æqualis*, ibid. p. 353, pl. 22. fig. 16, a–c.

Some of these forms had been mentioned by Ehrenberg in the 'Monatsberichte' of the Berlin Academy for 1843, *i. e.* previous to the publication of the 'Mikrogeologie;' but the figures of the latter work are more eligible for reference than the mere names or verbal descriptions which alone are given with the preliminary notice.

Most of the organisms in this list have been treated, in times past, both by Messrs. Parker and Rupert Jones and myself, as varieties of the genus *Fusulina*; but I hope to be able to demonstrate that they are all members of a series in which it may not eventually be difficult to trace every gradational link

from the elongate fusiform contour of the type (*F. cylindrica*) to a compressed lenticular form having the general aspect of a Nummulite.

The specimen of Carboniferous Limestone to which I have referred was a whitish-grey mass, granular and friable in some parts, more compact in others, and almost entirely composed of fossils of small size. A piece, the size of a walnut or somewhat less, was disintegrated by crushing and then washed. Many specimens were doubtless broken in the process, but no gentler treatment was of any avail. As they exist in the rock, a considerable proportion of the organic remains are already more or less in fragments, and the surfaces of most of them are waterworn; notwithstanding which a good number, perhaps from a hundred to two hundred, remained in very fair condition for examination. A few of the more characteristic of these are represented in Pl. XVIII. They have been carefully drawn by Mr. Hollick from the objects themselves, and give a fair idea of the whole. Many additional intermediate forms might have been taken from the collection, had more extended illustration been needful. When it is considered that this series of figures was drawn from a few specimens out of the many that existed in a very small fragment of material, it will be evident that the mass of the deposit, if properly examined, would furnish any number of gradational links between the two extremes of form. The only notable break in the series, as represented in the Plate, is between the normal fusiform variety (figs. 1-4) and the elliptical modification (fig. 5); but amongst the broken specimens are fragments that show that transition forms do exist, and that there is no gap that might not readily be filled by the examination of a larger quantity of material.

As a matter of convenience, many of the trivial names in the foregoing list may be employed with propriety for the salient forms of the group; but it is to be understood that such names have only varietal significance, and that no truly specific or hereditary distinctness can be claimed for the successive modifications of so compact a series. I propose to notice these salient varieties in order, commencing with the recognized type, *Fusulina cylindrica*.

Fusulina cylindrica, Fischer. Pl. XVIII. figs. 1-4.

Fusulina cylindrica, Fischer, Bull. Soc. Imp. des Nat. Moscou, *loc. cit.*

— *depressa*, id. *ibid.*

Atveolina prisca, Ehrenberg, Mikrogeologie, *loc. cit.*

— *montipara*, id. *ibid.*

The typical form of *Fusulina*, as delineated by Fischer, is

largely represented in the Miatschkovo rock. Of our Plate, figs. 1 and 2 are from perfect specimens, figs. 3 and 4 from worn and broken ones; the latter correspond pretty accurately with one of the drawings in the 'Oryctographie.' The size of the specimens also answers to the dimensions given by Fischer. The shell-wall is somewhat thick in comparison with that of many varieties; and the chambers show more or less tendency to subdivision into chamberlets, but not to the extent to which the same character may be observed in several of the larger members of the genus.

Ehrenberg's figures of *Alveolina prisca* and *A. montipara* are sufficiently marked representations of this typical form—the one being very slightly smaller, the other a little larger, than the dimensions appended to the original description. Slight variations in size and proportional contour are of course only individual peculiarities.

Fusulina constricta (Ehrenberg).

Borelis constricta, Ehrenberg, Mikrogeologie, loc. cit.

Under the above name Ehrenberg figures an oddly shaped *Fusulina*, somewhat less than 4 millims. in length, and rather under 3 millims. in diameter at its broadest part, rounded at the ends, and irregularly constricted near the middle. Dr. Carpenter * associates the figure with the *F. hyperborea* of Salter †; and Messrs. Parker and Jones ‡ refer it to the same arctic species. It is quite possible that their estimate may be correct; but there is an alternative view which is worth consideration. The specimens described by Mr. Salter are very large, not less than 14 millims. in length; and the central constriction is gradual and rounded. These appear to be normal (not exceptional) characters in the *Fusulinae* of the Carboniferous Limestone at Dépôt Point, their arctic locality. Ehrenberg's specimen is a great deal smaller: but that is not all; the thinning towards the centre is altogether irregular, and it appears much more like the effect of a weathering or wearing of the surface than as a character of the original shell. Nearly all worn specimens of *Fusulina* show the effects of attrition most near the middle, where the test is thinnest owing to the room occupied by the aperture; and it seems more probable, all things considered, that *F. constricta* constitutes an intermediate variety of the type, shorter and less fusiform than *F. cylindrica* and longer than *F. princeps*, and

* Introd. p. 305.

† In 'Belcher's Arctic Voyage,' 1855, vol. ii. p. 380, pl. xxxvi. figs. 1-3.

‡ Ann. & Mag. Nat. Hist. 1872, ser. 4, vol. x. p. 258.

that the apparent constriction of the particular specimen figured in the 'Mikrogeologie' is due to external causes—in other words, that the shell may originally have been cylindrical or nearly so.

Fusulina princeps (Ehrenberg). Pl. XVIII. fig. 5 (& 6?).

Borelis princeps, Ehrenberg, Mikrogeologie, loc. cit.

— *paleosphæra* (?), id. ibid.

The finer of the subspherical modifications of the Fusuline type, as found in the Miatschkovo beds, have the broadly elliptical contour of *F. princeps*, a form well illustrated by Ehrenberg's figure. The *Borelis paleosphæra* of the same author is represented in his plate by a cast of the interior of a somewhat unsymmetrical specimen. The peculiarity in this case is probably quite accidental; and it is surely not worth while to regard it as more than a mere individual variation.

In a paper on some fossil Foraminifera from Sumatra, published last year in the 'Geological Magazine'*, I described and figured certain large elliptical *Fusulinæ* as pertaining to *F. princeps*, their chief apparent divergence being in the matter of size. Since then M. Jules Huguenin has presented a paper to the Geological Society of London † on the same fossils, with the conclusion "that they belong to a new genus, to which perhaps the North-American *Fusulina robusta* also belongs." I can find no sufficient reason for this decision, either in respect of the Sumatran or the American species.

Quite recently I have had the opportunity of examining the extensive collection of *Fusulinæ* made by my friend Dr. Guido Stache of Vienna in the Carpathian Mountains, and the similarly beautiful series brought home by Dr. Richthofen from China, at present in the hands of my friend Dr. Schwager of Munich for description. These collections reveal new and unsuspected modifications of the type to an extent that must considerably alter our views as to its range of variation; yet I doubt if even they can be said to afford ground for any true generic subdivision. The extremes of variation in *Fusulina* are scarcely wider apart than those of the isomorphous genus *Alveolina*; and the successive links in the series are not less closely connected. As in *Alveolina*, some specimens have thick, whilst others have characteristically thin shells; one set of varieties has simple chambers, another has the interior of the segments more or less subdivided; and, lastly, the

* Geol. Mag. decade ii. vol. ii. p. 532, pl. 13. fig. 6, a-c.

† June 7, 1876. Paper not yet published in full.

number of the segments in each convolution differs very widely in the several forms; but such characters, whilst they form a legitimate basis for specific or subspecific distinction, cannot be held to possess any higher significance. However this may be, it is clear that any alteration of the trivial name of the Sumatran species, if alteration be needful, is better left until the publication of the researches of the eminent German observers to whom allusion has been made.

Fusulina sphæroidea (Ehrenberg). Pl. XVIII. figs. 7-9.

Borelis sphæroidea, Ehrenberg, Mikrogeologie, *loc. cit.*

— *labyrinthiformis*, id. *ibid.*

Fusulina sphaerica, Abich, Mém. de l'Acad. St. Pétersbourg, *loc. cit.*

The transition from the elliptical and prolate specimens to the oblate or drum-shaped, and even to the complanate varieties with rounded margins, is most easy and gradual, as may be seen by reference to figures 5 to 9 inclusive of Plate XVIII. The interval between the two extreme forms might be bridged by a much more numerous series had their connexion needed more copious demonstration. Ehrenberg's drawing of *Borelis sphæroidea* represents a fossil with nearly the contour of fig. 8, or between that and fig. 6, its dimensions being nearer those of the specimen from which the latter was taken. His *B. labyrinthiformis* appears to be only a section of a cast of the chambers of a somewhat similar drum-shaped form.

Dr. Hermann Abich, of Tiflis, in his paper "Vergleichende Grundzüge der Geologie des Kaukasus," *loc. cit.*, describes and figures a precisely similar oblate-spherical variety. Through the kindness of Dr. Abich, I have had the opportunity of examining specimens of this form from the Mountain Limestone of Armenia and Azerbeïdjan; and they leave no doubt whatever on my mind that it is identical with Ehrenberg's species. Not only are the two alike in general external characters and contour, but the internal structure, as far as can be made out (for it is very badly preserved in both), is precisely similar. The size of average specimens from the two localities is about the same, those from the Caucasus probably attaining somewhat the larger dimensions.

Fusulina æqualis (D'Eichwald). Pl. XVIII. figs. 10-13.

Borelis palæolophus, Ehrenberg, Mikrogeologie, *loc. cit.*

— *palæophacus*, id. *ibid.*

Orobis æqualis, D'Eichwald, Lethæa Rossica, *loc. cit.*

The figures in the 'Mikrogeologie' to which the names *Borelis palæolophus* and *B. palæophacus* are appended repre-

sent casts of the chambers of a symmetrical lenticular Foraminifer. Why two specific names should have been given to specimens which differ in no material particular it is difficult to say. There can, however, be no question that both pertain to small (probably young) examples of the fossil subsequently described by D'Eichwald as *Orobias æqualis*; and it is manifestly right that the specific name employed by the latter author, associated as it is with the description and figures of the external as well as the internal characters of the adult organism, should be employed for this particular form, in preference to any term founded on mere casts of the interior of what are possibly immature specimens.

My own specimens, from the Miatschkovo limestone (figs. 10-13), are of intermediate dimensions, much larger than Prof. Ehrenberg's, but generally smaller than D'Eichwald's. Fragments of larger specimens of similar contour were met with; and it is probable that the species may have considerable range in size. Many of the specimens are split (fig. 12) in Nummuline fashion; and the fractured surface scarcely differs in any appreciable degree from that of the typical fusiform shell when broken across the centre. The smooth specimens, figs. 17 and 18, represent pretty closely the external features of those figured by D'Eichwald, except that the two faces are not quite equally convex.

Fusulina antiquior (Rouillier and Vosinsky).

Nummulina antiquior, Rouillier and Vosinsky, Bull. Soc. Imp. des Nat. de Moscou, *loc. cit.*

Orobias antiquior, D'Eichwald, Lethæa Rossica, *loc. cit.*

The salient character of the species described under this name appears to be its bilateral asymmetry; one surface is greatly more convex than the other; and the margin of the test is rounded. My material has yielded no specimens precisely corresponding to the original drawings; but examples unsymmetrically built in various ways are by no means uncommon. Perhaps the nearest approach to Rouillier and Vosinsky's figures are numbers 17 and 18 of the Plate; and these specimens are in reality somewhat flatter on the underside than the drawings make them appear. But those described by the Russian authors were of far finer dimensions, and had the inequality of the two sides much more strongly marked. That they presented no true Nummuline structure was satisfactorily ascertained by D'Eichwald, who founded a new genus, *Orobias*, for their reception on this account.

Such are the general indications afforded by the study of this little group of fossils from the Miatschkovo limestone. The chief thing to be regretted is that so little can be learnt from them with respect to the minute structure of the test. They are all comparatively thick-shelled; but the finer characters are completely obscured by mineral infiltration, and even the tubulation of the walls can scarcely ever be traced. The position of the genus *Fusulina*, whether more nearly related to the Nummuline or the Rotaline types of Foraminifera, is still an occasionally debated point; and though the subject has been treated by Dr. Carpenter* with much clearness, and the value of the characters *pro* and *con* in each case has been stated by him in a way that leaves little to be desired, it is still important that evidence should be obtained as far as possible from each section of the genus.

In general terms it may be said that, in the perforation of the shelly investment, *Fusulina* occupies a place between the Rotaline and the Nummuline types, whether as to the size of the tubuli or their distance apart; and in both of these particulars it approximates more nearly to the former than to the latter group. The absence of double septal lamellæ, and consequently of supplementary skeleton and its attendant canal-system, form *primâ facie* evidence against Nummuline affinity. On the other hand, the usually perfect bilateral symmetry of form and the position of the aperture on the median plane are essentially Nummuline features. Practically, therefore, the decision on the question depends on the amount of significance to be attached to the canal-system as a basis of classification; and to form a correct estimate on this point it is needful to look beyond the genus *Nummulina* and its immediate allies.

Amongst the Rotalinæ, for example, at least three genera present quite unmistakable evidence of this higher organization: *Rotalia*, *Calcarina*, and *Tinoporos* can be shown each of them to have a characteristic system of interseptal passages. The modifications of these three types may be traced in series from their simpler to their more complex forms—that is, from minute varieties, with thin shells and single septal walls, to more massive representatives, having a supplementary skeleton developed to a greater or less degree and furnished with a system of ramifying canals.

The series comprised in the genus *Rotalia* has, to begin with, a delicate thin-shelled variety (*R. nitida*, Will.), in-

* Introd. Foram. p. 306; and Monthly Micr. Journ., April 1, 1870, p. 182.

habiting estuaries and shallow water, perfectly simple in shell-structure, and in reality little other than a "starved" modification of *Rotalia Beccarii*. In the littoral and Laminarian zones of our northern seas the central or typical form (*R. Beccarii*, Linné) is common; but the specimens are small and seldom show any advance in organization on the estuarine variety beyond the occasional duplication of the septal walls. The larger outspread variety which occurs in the Adriatic (*R. ammoniformis*, D'Orb) exhibits this same tendency in perhaps a greater degree; and occasionally both single and double septal lamellæ may be seen in the same shell. In the fine, thick, externally granulate examples of the type met with in the West Indies, in the Levant, and elsewhere, distinguished by D'Orbigny as *R. corallinarum* (Modèle no. 84), not only is this duplication a constant character, but it is accompanied by considerable development of supplementary skeleton and a rudimentary system of inter-septal passages. Lastly, in *R. Schræteriana*, P. & J., the supplementary skeleton and the complicated canal-system become salient features, and denote the highest organization attained by the Rotalian type.

It is clear, therefore, that, from a morphological point of view, the canal-system is to be regarded chiefly as evidence that a certain stage of development in a closely connected series has been reached, and that, however valuable as affording collateral characters, it is not available as a basis of distinction amongst genera, still less in the construction of families or other groups of higher relative value.

Turning again to the Nummulinida, similar series may easily be found—such, for instance, as that commencing with the simple brackish-water Nonioninæ and culminating in the highly organized *Polystomella craticulata*—a chain in which the successive links are so similar to those of *Rotalia* that they may be placed in rank, side by side, as isomorphs.

The bearing of these facts upon the position to be assigned to the genus *Fusulina* is manifest. In their presence the chief argument for its association with the Rotalines falls to the ground, and the only plea for its separation from the Nummulines becomes untenable. On the whole, the sub-genus *Nonionina* yields the best key to the position and characters of *Fusulina*—a fact recognized by D'Orbigny thirty years ago, when he placed the latter genus between *Nonionina* and *Nummulina*. In modern systems, natural affinity has been more sought as a basis of classification than the artificial distinctions which served so good a purpose in the hands of the earlier naturalists; but in the pre-

sent case true relationship, as far as it can be traced, bears out the conclusion that had been arrived at on different grounds—namely, that *Fusulina* finds its most appropriate place in the family Nummulinida, though amongst the least highly organized members of the group.

In conclusion, these notes are brought forward as a slight contribution to the history of a single section of a large and important genus of Foraminifera; and no attempt has been made to invest them with a more general character. The material in the hands of Dr. Stache and Dr. Schwager will furnish a basis for much wider treatment of the subject; and care has been taken to avoid touching on the points that have specially occupied their attention, lest their results should in any way be forestalled.

EXPLANATION OF PLATE XVIII.

Note.—In figures 1, 13, 15, and 16 two views are given of the respective specimens. In each case, *a* represents the aspect in the line of view perpendicular to the axis, *b* the aspect from a point on the line of the central axis.

Figs. 1-4. Fusulina cylindrica, Fischer, typical form. *Figs. 3 & 4* are worn and broken specimens. All magnified 10 diameters.

Figs. 5 & 6. Fusulina princeps (Ehrenberg). $\times 12$ diam.

Figs. 7-9. Fusulina sphaeroidea (Ehrenberg). $\times 12$ diam.

Figs. 10-13. Fusulina æqualis (D'Eichwald). $\times 12$ diam. This form is often found split on the median plane; fig. 12 represents such a specimen.

Figs. 15 & 16. Represent worn specimens, scarcely more than casts, of varieties like those embraced in *F. sphaeroidea*. $\times 12$ diam.

Figs. 17 & 18. Somewhat unsymmetrical examples—the two sides, as measured from the median plane, being unequal in size and convexity. Such specimens lead up to the "*Nummulina*" *antiquior* of Rouillier and Vosinsky, which is doubtless a *Fusulina* of this sort, though of larger dimensions and with the asymmetry more fully developed. $\times 12$ diam.

Figs. 14, 19-21. Various worn, irregular, or otherwise unsymmetrical specimens. $\times 12$ diam.

XLI.—*Descriptions of two new Species of Cetoniidæ.*

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Lomaptera Jamesii, sp. n.

L. statura omnino *L. Wallacii*, viridis, nitidissima; elytris fascia lata prope basin læte rufa ornatis, regione suturali ante apicem transversim strigosa.

