THE FUSULINID GENERA FUSULINA, FUSULINELLA AND WEDEKINDELLA.

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The generic name *Fusulina* was introduced by Fischer-de-Waldheim in 1829[1] but the type species, *F. cylindrica,* was first described in 1837.[2]

The name *Fusulina cylindrica* was subsequently used in other parts of Europe and in America, and, until after 1900 practically all the American fusulinids were identified as *F. cylindrica.* Meanwhile the real nature of Fischer-de-Waldheim's types long remained uncertain since the brief original description was not supplemented by an adequate restudy of the types or of material from the original locality. The current interpretation of *Fusulina* really dates from the work of Valerian von Möller[3] who, forty years after the publication of Fischer-de-Waldheim, redefined the genus *Fusulina* and proposed 3 additional genera—*Schwagerina, Hemifusina* and *Fusulinella.*

In his diagnosis of *Fusulina* Möller states that the shell is fusiform and that its septa are more or less strongly fluted and the outer wall porous. (The structure which he described as "porous" is that now known to be alveolar.[4]) *Fusulinella* was stated to have the same general form but to differ from *Fusulina* in having the septa but slightly folded and in having a decidedly different wall structure. Our Figure 1 illustrates these contrasted types of wall structure.

The alveolar texture is characteristic of most fusulinid genera, such as *Schwagerina, Triticites, Neoschwagerina* and the late Carboniferous and Permian *"Fusulina."* The fusulinellid structure, on the other hand, is seen in *Fusulinella* and *Staffella.* After Möller's work, *Fusulina* was generally assumed to have a wall like *Schwagerina,* but Lee,[5] after a study of material from Moscow, redescribed the species as *Girtyina*

[1] Bull. Soc. Imp. Nat. Moscou, p. 330.

[2] G. Fischer-de-Waldheim; Oryctographie du Gouvernement de Moscou 1830-37 (1837), p. 126, Pl. XII, figs. 1-5.

[3] Uber Fusulinen und ähnliche Foraminiferenformen des russischen Kohlenkalks. Neues Jahrb. f. Min. etc., Jahrg. 1877, pp. 138-146.

[4] Dunbar, Carl O., and Condra, G. E.: The Fusulinidae of the Pennsylvanian System in Nebraska. Nebraska Geol. Surv. Bull. II, Second Series, p. 15-21, 1927 (1928).

[5] Lee, G. S.: Fusulinidae of North China. Paleontologica Sinica, Series B, vol. 4, p. 32, 1927.

cylindrica and called attention to the fact that the wall is very thin and has the fusulinellid structure. Lee regarded *Girtyina* as only a subgenus of *Fusulina* and failed to follow up the logic of his discovery. Article 9 of the International Rules of Zoological Nomenclature requires that "if a genus be divided into subgenera, the name of the typical subgenus must be the same as the name of the genus." Obviously no name but *Fusulina* can be used in either a generic or subgeneric sense for the species *F. cylindrica* so long as the genus *Fusulina* is in good standing.

During the course of a monographic study of the Fusulinids of the Coal Measures of Illinois we have been extremely fortunate in finding among the unworked foreign collections

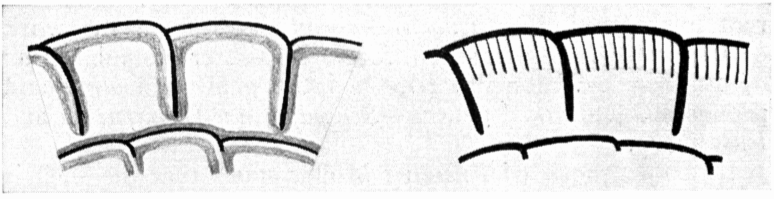

Fig. 1. Diagrams to show the contrast in the fusulinellid wall structure (left) and the alveolar structure (right) of the more advanced fusulinids. Each represents part of a sector of a sagittal section. In the first the tectum is underlain by a clear diaphanotheca and the entire chamber is then coated with a denser layer of secondary deposit. In the alveolar wall the tectum is underlain only by the slender, pendant lamellae which intersect to form the prismatic alveoli of the keriotheca.

in Peabody Museum a collection of fusulinids from Mjatschkowa, the type locality of *Fusulina cylindrica.*

The geological relations at Mjatschkowa are such that there can be no reasonable doubt of the authenticity of our specimens, which may be regarded as topotypes. Mjatschkowa is located on Moskova river about 18 or 20 miles to the southeast of Moscow. In the days of Fischer-de-Waldheim it was already the site of an important stone quarrying industry and the extensive quarries along the river bluffs were described by that author on page 86 of the Oryctographie. The locality was further described by Murchison, Verneuil and Keyserling[6] and illustrated by a cross section showing the white Mjatschkowa limestone near the river level, overlain by Jurassic sands and shale. This is the white limestone of which

[6] The Geology of Russia in Europe, vol. 1, 1845, p. 80.

the city of Moscow is largely built. Fischer-de-Waldheim indicated that at the time of his writing only a few feet of the upper part of the limestone was exposed (p. 86).

This limestone was the subject of a monographic study by Trautschold[7] who gives the following stratigraphic details:

"The walls of the quarries at Mjatschkowa have a height of 20 meters, of which the upper half consists of the Jurassic beds, the lower of the Mountain Limestone. The sequence [of the Limestone] from the top down is as follows:

1.	Greenish-white, soft, broken, impure limestone	0.3 meters
2.	Yellowish, hard, argillaceous limestone with uneven fracture	0.7 meters
3.	Yellowish, unfossiliferous, dolomite mottled with red, scarcely effervescing with acid and breaking with conchoidal fracture	1.5-2.0 meters
4.	Hard greyish-white limestone with rough irregular fracture	1-2 meters
5.	Softer, white compact limestone, finely crystalline and breaking with an uneven granular fracture	1.2-1.5 meters
6.	*Fusulina limestone*	1 meter
7.	Yellowish-white, compact hard limestone, finely crystalline and breaking with an uneven granular fracture	1 meter
8.	Snow-white, soft limestone	1 meter

In part III of his monograph (1879, p. 141) Trautschold discusses *Fusulina cylindrica,* which he says makes up one of the lower beds [No. 6] at Mjatschkowa, but he does not describe the minute structure of the shell.

Our material consists of a number of pieces of the Fusulina limestone collected by the late Prof. L. V. Pirsson who visited Moscow and Mjatschkowa in 1897. The stone is white coquina largely made up of the small fusulinids. As noted by Trautschold the material is rather unsatisfactory for study because the shells are coated, outside and in, by a film of calcareous deposit which tends to obscure their details.

In the original description of the fusulinids from Mjatschkowa Fischer-de-Waldheim recognized 2 species. Of these, *F. cylindrica* was described first and was said to be about 1/6 inch long and 1/12 inch in diameter at the middle. The second species, *F. depressa,* was said to be very similar but a little larger. The distinction is inadequately drawn and it is uncertain whether *F. depressa* is distinct or merely a synonym of *F. cylindrica.* The question is unimportant in the present consideration since we find the abundant speci-

[7] H. Trautschold: Die Kalkbrüche von Mjatschkowa. Pts. I-III. Moscow. 1874-79.

mens to agree closely in size and form with the more adequately described *F. cylindrica. A number of thin sections of these specimens show without exception the fusulinellid rather than the alveolar ("fusulinid") type of wall structure.* The evidence of the nature of *F. cylindrica* is to be fully presented in a forthcoming bulletin of the Illinois Geological Survey, but, in view of the present widespread interest in the fusulinids, it is thought wise to give other workers the advantage of this information without further delay.

This discovery necessitates rather drastic modifications of current conceptions and nomenclature of the fusulinids. Obviously the elongate fusulinids of the Permian, which have strongly fluted septa and an alveolar wall, can no longer bear the name *Fusulina.* New names are being proposed for these by Dunbar and Skinner. It is clear also that *Fusulina* becomes typical of the group now known as the *Fusulinellinae* and that *Fusulinella* is either a synonym of *Fusulina* or a closely allied genus or subgenus.

We are inclined to preserve both names. As the study of the early Pennsylvanian fusulinids progresses the group characterized by a fusulinellid type of wall is assuming greater and greater importance and many species are being discriminated. Of these the fusiform species fall into 3 groups, as follows (omitting for the present the oriental tribe of *Boultonia*):

1. Fusiform to subcylindrical shells with septa strongly and rather evenly fluted from pole to pole. Walls thin and secondary deposition light. Tunnel angle commonly large. Antetheca porous in some if not all species. Shells of the type of *Fusulina cylindrica* Fischer-de-Waldheim.
2. Fusiform shells with the septa plane across the equatorial region but fluted toward the poles. Chomata strongly developed and secondary deposition massive. Shells of the type of *Fusulinella bocki* Möller.
3. Small, slender, fusiform shells with plane septa. Chomata strongly developed and commonly, but not invariably, grading laterally into a heavy basal deposit that tends to completely fill the polar extremities of the chambers. Shells of the type of *Fusulinella euthysepta* Henbest.

Whatever taxonomic rank be assigned to these three types they seem to represent three natural groups of species. The second is undoubtedly the least specialized and probably the ancestral radical. The first specialized in the direction of deep and regular septal fluting and of thin walls. Some of its species attain a relatively large size but they all have very thin walls and rather light chomata. The third group retained plane septa but developed a slender form and thick secondary wall deposits. These groups are admittedly closely related and in so far as their evolution from a common ancestor is recorded some species will be found which can be classified only with some uncertainty. Our experience has shown that they are generally distinct and for this reason we propose to regard each as a distinct genus. *Fusulina* will then be redefined in keeping with the original work of Fischer-de-Waldheim, *Fusulinella* will be restricted in its scope, and the new name *Wedekindella* will be used for species of the type of *Fusulinella euthysepta*. If the three stocks be regarded merely as subgenera these names will be used as subgenera of *Fusulina*.

Some of the changes in nomenclature necessitated by the rediscovery of the true nature of *Fusulina* are vexing. Fortunately the family name *Fusulinidae* will stand, but unfortunately the two subfamily names, *Fusulinellinae* and *Fusulininae*, introduced by Staff and Wedekind in 1910,[8] cannot be retained in their present sense because *Fusulina* must be transferred from the second to the first subfamily. The second subfamily will now include an unnamed genus ("*Fusulina*" of authors but not of Fischer-de-Waldheim), *Triticites*, and *Schwagerina*. As the last genus was the first to be described and as it is well known and is typical of the essential structure shown by the group we propose the name *Schwagerininae* for this subfamily.

The first subfamily now includes *Fusulina*, *Fusulinella*, *Staffella*, *Boultonia* and *Wedekindella*. Obviously the name Fusulininae should be used for this subfamily which includes the typical genus *Fusulina*. It is unfortunate that this name is now in use for the other subfamily. Confusion would be avoided if we could abandon it and preserve the name Fusulinellinae in its present sense. That, however, is undesirable

[8] Staff, H. von, and Wedekind, R.: Der Oberkarbone Foraminiferens Spitzbergens. Geol. Inst. of Upsala Bull. X, p. 112, 1910.

for two reasons. First, because the generic name *Fusulinella* may have to go into the synonymy of *Fusulina* (in which case the subfamily name would have to be altered to Fusulininae) and, second, because the typical subfamily and its family ought to derive their names from the same genus. While the rules of nomenclature do not require the observance of the rights of priority in taxonomic names above the genus, and do not cover the case before us, the logic which requires the typical subgenus to bear the same name as its genus would also demand that the subfamily which includes the typical genus of a family should also draw its name from this genus. After all, the serious embarrassment will be that of changing our conception of the genus *Fusulina* and this we cannot avoid. The emendation of the subfamily will cause but little more immediate confusion and will make for clarity in the future. With the emendations suggested, the classification of the Fusulinidae may now be expressed as follows:

Family *Fusulinidae* Möller

Subfamily *Fusulininae* (Staff and Wedekind) emend. Dunbar and Henbest

Primitive fusulinids mostly of small size ranging in form from discoidal to fusiform or subcylindrical, distinguished by having a non-alveolar wall which consists of a tectum underlain by a thin diaphanotheca which in turn is coated by secondary deposits.

Genus *Fusulina* Fischer-de-Waldheim (1829)—Shells fusiform to subcylindrical. Septa strongly fluted from pole to pole. Secondary deposits generally thin.
Genotype, *Fusulina cylindrica* Fischer-de-Waldheim.

Genus *Fusulinella* Möller (1877)—Shells fusiform. Septa plane across the middle of the shell but with slight flexures near the poles. Chomata strongly developed.
Genotype, *Fusulinella bocki* Möller.

Genus *Wedekindella* Dunbar and Henbest (nov.)—Shells small, slender and fusiform. Septa not fluted. Secondary deposits very heavy, commonly tending to completely fill the polar extremities of the chambers.
Genotype, *Fusulinella euthysepta* Henbest.

Genus *Boultonia* Lee (1927)—Shell small slender, fusiform. Nucleoconch endothyroid (unsymmetrical) and outer whorls with regularly fluted septa. (Lee described 2 species, one of which, *B. rawi,* is apparently a *Wedekindella*

but his genotype, *B. willsi,* is certainly distinct from our genus and is more like the true Fusulina.)

Genotype, *B. willsi* Lee.

Genus *Stafella* Ozawa (1925)—Shells lenticular or sphaeroidal with the axis of coiling the smallest diameter. Septa plain.

Genotype, *Fusulinella sphaerica* Abich.

Subfamily *Schwagerininae* Dunbar and Henbest (nov.)

Fusiform, subspherical or subcylindrical shells having an alveolar wall consisting of tectum and keriotheca and without secondary deposits other than chomata. Aperture generally simple, median and slit-like but in some advanced types consisting of a row of pores along the base of the septa. Chomata present throughout all the volutions or only in the juvenile whorls.

This subfamily includes *Schwagerina* Möller, *Triticites* Girty and 3 unnamed genera which are being described by Dunbar and Skinner, one of which will cover the type currently identified as Fusulina.

Subfamily *Doliolininae*[9] Dunbar and Henbest (new name).

Shells fusiform to globular, consisting of many volutions and having multiple small, rounded apertures in a row along the base of the septa. Wall structure as in the Schwagerininae. Septa not fluted. Parachomata strongly developed.

Genus *Doliolina* Schellwien (1903)—Having the characters of the subfamily.

Genotype, *Schwagerina lepida* Schwager.

[9] This subfamily was named *Verbeekininae* by Staff and Wedekind for the genus *Verbeekina* Staff. Staff had erected this genus for *Schwagerina verbeebi* Geinitz which he believed to differ from *Doliolina* in lacking parachomata. Ozawa and Deprat both reaffirmed the presence of parachomata as Schellwien had previously figured them. Contrary to the opinion of Schwager, Schellwien, Staff, Douvillé and Deprat, Ozawa thought the wall structure of *Doliolina* to be non-alveolar and proposed to separate Doliolina and Verbeekina on that ground. Dunbar and Condra (1927, p. 68) expressed doubt of Ozawa's last contention but, pending further investigation, tentatively recognized the genus *Verbeekina* and the subfamily *Verbeekininae.* Before his lamented death Ozawa wrote Dunbar under date of Jan. 16, 1929, "As you discussed in your paper, the separation of *Doliolinia* and *Verbeekina* is unnecessary. I have examined the original specimens of Schwager at the Museum of Natural History of Berlin and I found that *Doliolina lepida* Schwager is quite another thing from the specimens I had identified with it." Since *Verbeekina* is a synonym of *Doliolina* the subfamily name must be altered accordingly.

Subfamily *Neoschwagerininae* Dunbar and Condra (1928).

Highly organized fusulinids with alveolar walls which develop septula as pendent growths from the keriotheca. Apertures multiple.

This group includes *Neoschwagerina* Yabe, *Yabeina* Deprat, *Sumatrina* Voltz and *Cancellina* Hayden.

The contrast in the arrangement previously accepted and that now proposed may be summarized in tabular form as follows:

Current Arrangement		Proposed Arrangement
Family Fusulinidae	=	Family Fusulinidae
Subfamily Fusulinellinae St. and W.	=	Subfamily Fusulininae St. and W. (Emend. D. and H.)
Genus *Fusulinella* Möller	=	Genus *Fusulina* Fisher-de-Waldheim (non-Möller) Genus *Fusulinella* Möller Genus *Wedekindella* Dunbar and Henbest
Genus *Boultonia* Lee	=	Genus *Boultonia* Lee
Genus *Staffella* Ozawa	=	Genus *Staffella* Ozawa
Subfamily *Fusulininae* St. and W.	=	Subfamily *Schwagerininae* Dunbar and Henbest
Genus *Fusulina auctoris* (non Fisher)	=	New Genus (to be described)
Genus *Triticites* Girty	=	Genus *Triticites* Girty
Genus *Schwagerina* Möller	=	Genus *Schwagerina* Möller
Subfamily *Verbeekininae* Staff and Wedekind	=	Subfamily *Doliolininae* Dunbar and Henbest
Genus *Verbeekina* Staff Genus *Doliolina* Schellwein	=	Genus *Doliolina* Schellwein
Subfamily *Neoschwagerininae* Dunbar and Condra	=	Subfamily *Neoschwagerininae* Dunbar and Condra

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