PROBLEMS ON BISERIAMMINOIDEA, MISSISSIPPIAN-PERMIAN BISERIALLY COILED FORAMINIFERA. A REAPPRAISAL WITH PROPOSALS

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Abstract

A reappraisal of the biserially coiled Palaeozoic Biseriamminoidea leads to revise the so-called primitive Biseriamminidae, the possibly transitional family Koktjubinidae and the typical Globivalvulinidae. The superfamily Biseriamminoidea belongs to the Foraminifera (class) Fusulinida (order) Endothyrina (suborder). The following Biseriamminidae are discussed: Biseriammina and Lipinella (Biseriammininae); Dariopsis, and Globochernella (Dariopsinae); the Koktjubinidae: Koktjubina, Dzhamansorina, and Admiranda. Globispiroplectammina, assigned by some authors to the Biseriamminoidea, is excluded from this group and related to Spireitlina. The stratigraphical distribution of the Biseriamminidae is limited to the Mississippian (Tournaisian and Visean); the Koktjubinidae can survive up to the Moscovian. The Globivalvulinidae (latest Tournaisian; late Visean-latest Permian) are subdivided here into four subfamilies: Globivalvulininae, Paraglobivalvulininae, Dagmaritinae, and Paradagmaritinae, especially developed in the late Middle and Late Permian. The following genera are listed: Biseriella, Globivalvulina, Tenebrosella, Charlotta, Siphoglobivalvulina, Retroseptellina, Septoglobivalvulina, Paraglobivalvulina, Paraglobivalvulinoides, Urushtenella, Sengoerina, Dagmarita, Bidagmarita, Louisettia, Paradagmarita, Siphodagmarita, Paradagmaritopsis, Paradagmaritella, Paradagmacrusta and Paremiratella. The biozones based on the Permian genera are generally short and precise, while the stratigraphical importance of Globivalvulina sensu lato must be clarified, especially during the Pennsylvanian. Some palaeobiogeographical data are provided, which prove the close relations of Iran and China, at least during the Late Permian but probably also during the entire Carboniferous and the Early and Middle Permian.

Key words: Foraminifera, Permian, Carboniferous, Taxonomy, Biostratigraphy, Palaeogeography.

Resumen

La revisión de los foraminíferos paleozoicos que presentan un enrollamiento biserial ha dado como resultado la enmienda de las familias Biseriamminidae, Koktjubinidae y de las formas típicas que se consideran aquí como Globivalvulinidae emend. Todas estas familias plantean muchos problemas de definición, límites genéricos y de mono o polifiletismo, es decir, de taxonomía en general. Los Biseriamminidae son parte de estas formas del suborden Endothyrina que poseen una pared microgranular sencilla o gruesa, a veces con aglutinado calcáreo. Se describen los siguientes géneros: Biseriammina, Lipinella, Dariopsis y Globochernella. Se han detectado tendencias intermedias entre los Koktjubinidae: Koktjubina, Dzhamansorina, Admiranda, que fueron muchas veces confundidas con Biseriella o Biseriammina sensu lato. La distribución estratigráfica de los Biseriamminidae queda
limitada al Tournaïsien y al Viséen; los Kockjubinidae son siempre raros, aunque están presentes desde el Viséen-Serpukhoviense hasta el Bashkirien-Moscoviense. El tercer grupo está constituido por la familia Globivalvulinidae, recientemente dividida en cuatro subfamilias: Globivalvulininae, Paraglobivalvulininae, Dagmaritininae y Paradagmaritininae. Los géneros siguientes son mencionados: Biseriella, Globivalvulina, Tenebrosella, Siphoglobivalvulina, Charliella, Retroseptellina, Septoglobivalvulina, Paraglobivalvulina, Paraglobivalvulinoïdes, Urashtenella, Dagmarita, Bidaigmarita, Louisettita, Crescetia, Siphodagmarita, Paradagmarita, Paradagmaritopsis, Paradagmaritella, Paradagmacrusta and Paremiratella. Finalmente, se indica la importancia bioestratigráfica y palaeobiogeográfica de los tres grupos, y los problemas que tendrán que ser resueltos en próximos trabajos.

Palabras clave: Foraminíferos, Permiano, Carbonífero, Taxonomía, Bioestratigrafía, Paleogeografía.

INTRODUCTION

The biserially coiled Foraminifera are rare from the Triassic to Holocene. Recently, Tyszka (2006, p. 8), in his review of the types of growth of Foraminifera, indicated: “even ‘coiled biserial’ forms, that seem to be nonexistent (...) are known from reality (sic) as Plectorecurvoides (...) or the whole superfamilly Cassidulinacea”. This author has only forgotten the existence of a group which was relatively widespread during the Carbonífero y Permiano, namely the Biseriamminida. Their ontogenesis is probably the most complicated to reconstruct among Palaeozoic Foraminifera but they can be compared with the modern Cassidulina or Cassigerinella (see Fig. 1. 1-5), and considered as “similar to a Textularia coiled along one of its great sides” (Reichel, 1946, p. 549). Several genera of the group remain problematic because of their rare occurrences in the geological series, and the difficulty to combine the complementary sections: axial, transverse, tangential to the apertures, and subaxial showing the elements of endoskeleton. The biostratigraphic value of this group was probably underestimated in the Carbonífero (e.g., Perret, 1993; Pinard & Mamet, 1998). In term of palaeobiogeography and biostratigraphy, the group seems to be fundamental during the Permiano (Gaillot, 2006; Gaillot & Vachard, submitted; Gaillot et al., submitted a, b). The Carbonífero genera of Marfenkova (1991) were neglected for a long time, but they now appear as potentially useful. The aim of this preliminary paper is a reappraisal of the group and a discussion of very important problems in its history: (1) the origins; (2) the Visean/Serpukhovian lineages; (3) the nomenclatural problem of the genus Globivalvulina and its limit with “Biseriella”; (4) some specific and generic problems of Pennsylvanian globivalvulinids; (5) the Pennsylvanian-early Cisuralian acme; (6) the decrease in diversity during the late Cisuralian-Early/Middle Guadalupian; (7) the possible causes of the flourishing during the Lopingiano and the behaviour of the group at the Permiano-Triássico Boundary.

PREVIOUS WORK

The history of the taxonomical description of group is well known (see Palmieri, 1988; Pinard & Mamet, 1998). The first species was created by Brady (1876) under the name Valvulina bulloides, and the genus Globivalvulina was erected by Schubert (1921). Chernysheva (1941) created the genus Biseriammina and the second species of Globivalvulina, G. parva, was later described by Chernysheva (1948). Then, five milestone studies were published by Reichel (1946), Plummer (1948), Morozova (1949) and Reitlinger (1949, 1950), mainly concerning the late Tournaïsien, middle Pennsylviano, and Early and Late Permiano species. The last important group of Carbonífero species of Globivalvulina were published by Konovalova (1962), and a synthesis was finally provided by Pinard & Mamet (1998). The genus Biseriella warmly advocated by Mamet,
Brenckle or Groves was often quoted in the studies during the seventies. An interesting but controversial contribution was given by Marfenkova (1991). Diverse Permian genera were described between 1965 and 1981 by Reitlinger (1965), Lys & Marcoux (1980) and by workers of the “Geneva school” (e.g., Bronnimann, Zaninetti, Altiner, Jenny-Deshusses) with new genera such as Dagmarita, *Paraglobivalvulina*, *Paraglobivalvulinoides*, and *Paradagmarita*. The genera *Tenebrosella* Villa & Sanchez de Posada, 1986 and *Verispira* Palmieri, 1988, later described, remain poorly mentioned in the literature. Recent contributions were published by Altiner (1997, 1999), Altiner & Ozkan-Altiner (2001), Mohtat-Aghai & Vachard (2003, 2005), and Brenckle (2005). A revision of the Late Permian taxa has been prepared by Gaillot (2006) and Gaillot & Vachard (submitted).

The great micropalaeontological treatises and/or important revisions successively analyzed the *Biseriamminidae* as follows:

1. Sigal (1951) in Piveteau’s Treatise assigned (p. 174) *Biseriammina* to the (Textulariida) *Lituolinae* while *Globivalvulina* was attributed (p. 164) to the Tetrataxinae.

2. Orlov’s Treatise (1959) listed only one family: *Biseriamminidae* with two genera: *Biseriammina* and *Globivalvulina*.

3. Loeblich & Tappan in Moore’s Treatise (1964, p. C338) described the unique family *Biseriamminidae* synonymized with *Globivalvulinidae*, and composed of *Biseriammina*, *Globivalvulina*, and *Olympina* Reichel (1946). This latter is in fact a nodosarioid similar to *Robuloides*.

4. Conil et al. (1980) only took into account the Visean *Biseriamminidae*: *Biseriammina*, *Lipinella*, *Biseriella* and *Globispiropectammina*.

5. Zaninetti & Altiner (1981) considered one family (Biseriamminidae) subdivided into two subfamilies: *Biseriammininae*: *Biseriammina*, *Globivalvulina*, *Paraglobivalvulina*, *Biseriella*, *Globispiropectammina*; and *Dagmaritinae*, with *Dagmarita*, *Paradagmarita* and *Louisettita*.

6. Contrary to the Treatise of 1964, the second monumental work of Loeblich & Tappan (1987) was of fundamental importance because the authors did not consider the Palaeozoic literature (especially Russian) as a hotchpotch of synonyms. Loeblich & Tappan (1987) subdivided the family *Biseriamminidae* into three subfamilies: *Biseriammininae* Chernysheva, 1941 (with *Biseriammina*, *Biseriella*, *Globispiropectammina*, *Globivalvulina*, *Lipinella*, *Paraglobivalvulina*, *Paraglobivalvulinoides*); *Dagmaritinae* Bozorgnia, 1973 (with *Dagmarita* and *Paradagmarita*) and *Louisettitinae* Loeblich & Tappan, 1984 (with only *Louisettita*).

7. Rauzer-Chernoussova et al. (1996) described the superfAMILY Biseriamminacea belonging to the order *Palaeotextulariina*, with three families: Biseriamminidae, Dagmaritidae and Louisettitidae. The Biseriamminidae are composed of *Biseriammina*, *Biseriella*, *Globispiropectammina*, *Globivalvulina*, *Lipinella*, *Paraglobivalvulina*, *Paraglobivalvulinoides*; Dagmaritinae Bozorgnia, 1973 (with *Dagmarita* and *Paradagmarita*) and Louisettitinae Loeblich & Tappan, 1984 (with only *Louisettita*).
THE ORIGINS OF THE LINEAGES

The origins of the group are peculiarly obscure with unsolved questions about the mono- or polyphyletic and recurring features in wall microstructures (i.e., granular versus microgranular wall). Because of the particularity of the biserially coiled development combined with the spectrum of microstructural types of wall, we accept the monophyletism of the group, and therefore, the lineage Biseriamminidae, Koktjubinidae and Globivalvulinidae. Another question is: Are related forms like Biseriamminidae, Globivalvulinidae, Palaeotextulariidae and Tetrataxidae constituting a homogenous monophyletic suborder of Fusulinida: Palaeotextulariina Hohenegger & Piller, 1975, different from Endothyrina or Tournayellina? The Palaeozoic foraminiferal coilds differ sensibly from those of other periods, because biseriate coiled tests are numerous, whereas trochospiral forms are only known in the superfamily Tetrataxoidae. In fact, these particular types of coiling could justified the reality of the suborder Palaeotextulariina Hohenegger & Piller, 1975 (more than of the poor arguments of its authors, moreover). Nevertheless, because the lineages with a terminal biseriate coiling have many unlinked initial coiled parts (e.g., endothyrid, chernyshinellid, haplophragmellid), this order is not admitted here. It is more likely that numerous Endothyrina and Tournayellina exhibit a terminal biseriate part and Biseriammina is related with a simple granuliferelloid Endothyrina (i.e., a representative of the superfamily Haplophragmelloidea sensu Rauzer-Chernousova et al., 1996). Consequently, Biseriammininoidea should belong to the suborder Endothyrina, as well as Tetrataxoidae and Palaeotextularioidae.

After its first appearance datum (FAD) in the late Tournaisian with Biseriammina uralica Chernysheva, 1941 and Globivalvulina? bristolensis Reichel, 1946, the group seems to disappear almost completely during the early-middle Visean (e.g., Conil et al., 1980), although some forms are rarely present (Meissami et al., 1978; Marfenkova, 1991).

The genus Biseriammina is especially poorly known and it was not re-found in the Tournaisian of Urals, where subsequent detailed studies were nevertheless performed (e.g., Malakhova, 1956; 1975a, b; Lipina, 1965; Brenckle, 1997a). Two explanations are possible: (1) Biseriammina is very rare (only one true microphotograph of B. uralica was provided in the literature; i.e. Grozdilova et al. (1975, Pl. 1, Fig. 7) re-illustrated here Fig. 2.1 and a Biseriammina sp. sensu Ganelina (1966, Pl. 12, Fig. 17), while many illustra-

1) Traditionally, the authors admit the lineage Biseriammina-Globivalvulina? bristolensis- Globi-
Figure 2—Biseriamminidae and Koktjubinidae. 1. Biseriammina uralica Chernysheva, 1941 according to Grozdilova et al., 1975 (Pl. 14, Fig. 7), transverse section. 2. Endothyra (Birectoendothyra) schlykovae Poyarkov in Lipina, 1970, holotype, subtransverse section (from Lipina, 1970, Pl. 1, Fig. 13) considered here as a possible equivalent of Biseriammina, Badamski Horizon, late Tournaisian, Tian-Shan. 3. Palaeospiroplectammina (?) sibirica (Lebedeva, 1954) sensu Lipina 1965 (Pl. 24, Fig. 19), as another possible equivalent of Biseriammina, holotype, subtransverse section, lower part of Denisov limestones, Kuznetsk Basin. 4. Lipinella notata Malakhova, 1975b (from Pl. 3, Fig. 14, holotype, Ust-Grekhovsky horizon (early Viséan), southern Urals (Khudolaz river), Russia. 5-6. Dariopsis curvisepctum Malakhova, 1975b, 5, transverse section (= Pl. 2, Fig. 7), 6, axial section (= Pl. 2, Fig. 12), Gusikhinsky horizon, southern Urals, Russia. 7. Globochernella braibanti Hance, 1983 (= Pl. 2, Fig. 10), holotype, transverse section, Braibant, Condroz (Belgium), early Viséan (Cf4). 8. Globochernella overlauoi Hance, 1983 (= Pl. 2, Fig. 5), holotype, transverse section, Braibant, Condroz (Belgium), early Viséan (Cf4). 9. Koktjubina? sp. 1 = Globospiroplectammina (sic) windsorensis (Mamet, 1970) sensu Brenckle, 1997b (= Pl. 4, Fig. 13), late Viséan, Battleship, Nevada (USA). 10. Dzhamansorina grata Marfenkova, 1991, paratype, transverse section, middle-late Viséan, Kazakhstan. 11. Admiranda convexa Marfenkova, 1991, holotype, axial section, Serpukhovian, Kazakhstan. 12-18. Dzhamansorina sp. 1 (= Globospiroplectammina sp. nov. of Laloux, 1988), 12, transverse section (= Pl. 1, Fig. 14), 13, frontal subaxial section. (= Pl. 1, Fig. 15), 14, transverse section (= Pl. 1, Fig. 16), 15, sagittal subaxial section (= Pl. 1, Fig. 19), 16, transverse section (= Pl. 1, Fig. 21), 17, transverse section (= Pl. 1, Fig. 22), 18, Sagittal axial section (= Pl. 1, Fig. 20). 19-21, Koktjubina? sp. 2, 19 = Biseriella? exotica sensu Rich (1980, Pl. 4, Fig. 16), Chesterian, Bangor Limestone, Alabama, USA. 20-21 = Biseriella parva sensu Rich, 1980. 20, axial section = Pl. 5, Fig. 7, 21, Transverse section = Pl. 5, Fig. 10, Chesterian, Bangor Limestone, Alabama, USA. 22-23, Dzhamansorina sp. 2 = Biseriella parva sensu Rich, 1982. 22 = Pl. 1, Fig. 17, 23 = Pl. 1, Fig. 18 (compare also with “undetermined Biseriamminidae” sensu Mamet, 1970, Pl. 1, Fig. 5), latest Viséan or earliest Serpukhovian, Georgia (USA). Scale bars: 0.100 mm.
valvulina? parva-Globivalvulina bulloides- the diverse forms of globivalvulinids. The Koktjubinidae are not included in this lineage but can correspond to another branch diverging from Biseriammina (Fig. 3A). On the other hand, the transitional stages are apparently absent (a) between Biseriammina and Globivalvulina? bristolensis; (b) between G.? bristolensis and G.? parva (see Conil et al., 1980 for this latter absence).

2) As G.? bristolensis and G.? parva are very similar in coiling and size (and also herein G.? aff. bristolensis: Fig. 4. 6-8), and both distinct of Biseriammina (as already partly indicated by Palmieri, 1988, p. 32), a double origin can be proposed. The first lineage would comprise forms mainly with coarsely granular wall; the Biseriamminidae with the Biseriammininae and Koktjubininae. The second lineage would be composed of forms exhibiting a microgranular wall: the Globivalvulinidae. Some exceptions exist with Dzhamansiornina in the first lineage and Globivalvulina granulosa in the second one. This intermediate hypothesis (Fig. 3B) is admitted here.

3) As Pseudotaxis is morphologically related to “Biseriella” (e.g., Mamet, 1974; Laloux, 1988), with a FAD slightly preceeding that of this latter, and because many confusions between Pseudotaxis and “Biseriella” exist (e.g., different illustrations of Laloux, 1988; Conil et al., 1980; Vdovenko, 2001; as previously mentioned by Vachard & Beckary, 1991 and Brenckle, 2005), another filiation is possible (Fig. 3C): (a) on one hand, the late Tournaissian Pseudotaxis eominima is the ancestor of “Biseriella?” bristolensis (corresponding thus to an independent genus whose purely morphological characterization seems to be very difficult nowadays), (b) on other hand, the late Viséan Pseudotaxis brazhnikovae gave rise to the latest Viséan “Biseriella” parva, and then, to the Serpukhovian Globivalvulina and therefore, to the true Globivalvulinidae. Conversely, a derivation of Biseriammina from Granuliferella or another genus belonging to the Haplophragmellidae sensu Rauzer-Chernousova et al. (1996) is favored here. After that, from Biseriammina arise the other Biseriamminidae and the Koktjubinidae.

**HOW MANY LINEAGES IN THE VISÉAN?**

After its FAD in the late Tournaissian, the group is very rarely mentioned in the early-middle Viséan interval (e.g., Mamet, 1970; Meissami et al., 1978;
Conil et al., 1980; Laloux, 1988; Marfenkova, 1991; Devuyst, 2006). Nevertheless, during this period, the Biseriamminidae might be represented by some poorly known genera: e.g., Lipinella, Dariopsis, and Globochernella.

Lipinella Malakhova, 1975b (= Urtasella Malakhova, 1979 nomen vanum fide Loeblich & Tappan, 1987) from the early Viséan of southern Urals looks like the late Tournaisian (Kizelovsky horizon) Biseriammina of the same areas, because of their nautiloid, compressed tests with a weakly endothyroid, almost planispiral, biseriate, involute coiling. Their walls are brownish, calcareously agglutinated, or coarsely granular. Lipinella only differs from Biseriammina by the absence of sutures and a more inflated profile (see Conil et al., 1980, p. 84). In all

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the classification of Foraminifera, these criteria are considered as specific and not generic. The other *Biseriammina* or equivalents of Mamet (1970) and Brenckle (1997b, 2004) are generally late Visean in age (early Asbian-Brigantian) and correspond to the first acme of the group. *Biseriammina? windsorensis* Mamet, 1970 is a late Visean representative in Nova Scotia (eastern Canada). *Biseriammina* sp. 1 sensu Vachard, 1977 (p. 156, Pl. 6, Figs. 14-15; see also Vachard, 1974, PI. 23, Figs. 14-16) is probably a composite of several sections of *Consobrinella* and *Latiendothyranopsis*. In the latest Visean, these primitive small forms are more abundant (Conil et al., 1980; Vachard & Berkli, 1992; Cozar & Somerville, 2004, 2005, Somerville & Cozar, 2005; Okuyucu & Vachard, 2006). According to P. Cozar (pers. comm. October 2006), several *Koktjubinidae* and "Biseriella" are found in profusion in the late Visean of Ireland. A detailed study of those forms would help in solving some phylogenetic problems, and defining a more complete lineage at the Visean/Serpukhovian boundary.

Two early Visean foraminiferal taxa are possibly linked to *Biseriammina* (or so enigmatic at least).

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**FIGURE 5**—Hypothetical lineages of *Globivalvulina* and related taxa near the Visean-Serpukhovian boundary. All the reproduced specimens are re-illustrated herein Figs. 2, 4 and 6.
FIGURE 6—(continued). 18-20, *Globivalvulina bulloides* (Brady, 1876), type material selected by Brenckle (2005, Pl. 7, figs. 18, 20 and 21 respectively). 18, transverse section, lectotype selected by Brenckle (2005) contrary to the rules of ICZN. 19, paralectotype, axial section. 20, paralectotype, axial section previously illustrated by Brady (1876, Pl. 14, Fig. 4) and the logical lectotype to choose. All specimens from the Pennsylvanian of Iowa (USA). 21, *Globivalvulina moderata* Reitlinger, 1949, holotype (Fig. 4a), transverse section re-illustrated by Brenckle (2005, Pl. 8, Fig. 8), Bashkirian of Bashkorotostan (Russia). 22-23, *Globivalvulina granulosa* Reitlinger, 1950, 22, holotype (Pl. 17, Fig. 5), transverse section re-illustrated by Brenckle (2005, Pl. 8, Fig. 3), 23, paratype, axial section (see Brenckle, 2005, Pl. 8, Fig. 14 and Reitlinger, 1950, Pl. 17, Fig. 6). Myachkovian (late Moscovian) of southern Pre-Timan (Russia). 24, *Tenebrosella asturica* Villa and Sanchez de Posada, 1986, holotype (= Pl. 1, Fig. 1), axial section, Villanueva de Pria, Asturias, northern Spain, early Moscovian. 25, *Globivalvulina mosquensis* Reitlinger, 1950, paratype (Reitlinger, 1950, Pl. 16, Fig. 3, Brenckle, 2005, Pl. 8, Fig. 9), subtransverse section, Moscovian of Moscow Basin (Russia). 26, *Globivalvulina syzranica* Reitlinger, 1950, axial section (paratype Pl. 16, Fig. 9), Syzran (Russia), Myachkovian (late Moscovian). 27, *Globivalvulina minima* Reitlinger, 1950, holotype, transverse section. Rzhev river (Russia), Kashirian (early Moscovian). Scale bars: 0.100 mm.
FIGURE 7—Early Permian *Globivalvulina* from Spitsbergen (1-6, Treskelodden Fm, Treskelen Peninsula (Creek IV), Hornsund, 7-13, Treskelodden Fm, Hrørnetjellet Mt., Hornsund). 1, 6, *Globivalvulina sikhanensis* Morozova, 1949. 1, ZPAL F.56/V14-20, sagittal section. 6, ZPAL F.56/V14-16, sagittal section. 2, *Verispira* sp., ZPAL F.56/V14-4, axial section. 3-5, *Globivalvulina* cf. *syzranica* Reitlinger, 1950, 3, ZPAL F.56/V14-12, tangential axial section. 4, ZPAL F.56/V14-13, tangential axial section. 5, ZPAL F.56/V14-1, tangential axial section. This specimen is also similar to a *G. graeca* (for example the Fig. 36C of Reichel, 1946) and the misinterpreted *G. granulosa* of Groves, 1992 (especially Pl. 4, Figs. 22 and 24). 7-8, 10-12, *Globivalvulina pergrata* Konovalova, 1962. 7, ZPAL F.56/H38-3, oblique sagittal section. 8, ZPAL F.56/H38-6, oblique sagittal section. 10, ZPAL F.56/H43-1, sagittal section. 11, ZPAL F.56/H43-4, oblique section. 12, ZPAL F.56/H41-3, oblique section. 9, 13, *Globivalvulina* ex gr. *bulloides* (Brady, 1876). 9, ZPAL F.56/H36-10, sagittal section. 13, ZPAL F.56/H43-7, tangential axial section. The specimens of *Globivalvulina gaptankensis* Harlton, 1928 illustrated by Warthin (1930, Pl. 1, Figs. 17 a-b) seem to be very similar but their internal structures remain unknown (in the same paper *G. gaptankensis* is synonymized with *G. biserialis*, and both with *G. ovata* by Galloway and Ryniker, 1930; nevertheless, more recent revisions are missing). Scale bars: 0.100 mm.
They are *Dariopsis* Malakhova, 1975b (Fig. 2. 5-6) and *Globochernella* Hance, 1983 (Fig. 2. 7-8), from the early Viséan of the eastern slope of Southern Urals (Gumbeisky and Gusikhinsky horizons), and early-middle Viséan (Cf4-Cf5) of Belgium (Hance, 1982, 1983), respectively.

The Koktubinidae (Figs. 4, 6) were defined by Marfenkova (1991) but remain poorly known and controversial (e.g., Brenckle, 2005). The family is transitional between the Biseriamminidae and Globivalvulinidae regarding to many characters. Due to the type of wall, the relatively slow increasing in the height size of the last chambers, and the absence of valvulae, the Koktubinidae are considered here as closely related to the Biseriamminidae. Several Koktubinidae: *Koktubina* Marfenkova, 1991; *Admiranda* Marfenkova, 1991; and *Dzhamansorina* Marfenkova, 1991 were mentioned in the middle Viséan and Serpukhovian of Kazakhstan, Belgium, Ireland, SW Spain, Tarim, and U.S. Midcontinent. By contrast, they are relatively rare in southern France (Fig. 4.1-6). *Koktubina* has only one or two uncoiled pairs of chambers and a coarsely granular wall, occasionally calcareously agglutinated. The genus is composed of *Spiroplectammina exotica* Vdovenko, 1962; *Globivalvulina* sp. 1 sensu Massa & Vachard (1979, Pl. 4, Fig. 6, Pl. 5, Fig. 6); *Globivalvulina regularis* Okimura, 1972; *Koktubina venusta* Marfenkova, 1991; *Koktubina aff. exotica* sensu Brenckle, 2004; Biseriamminide indetermine N.° 3 sensu Vachard &

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<td>Paragiovivalvulininae</td>
<td>Septoglobivalvulina, Paraglobivalvulina, Urushtenella, Paraglobivalvulinoïdes</td>
</tr>
<tr>
<td></td>
<td>Dagmaritinae</td>
<td>Sengoerina, Dagmarita, Bidagmarita, Siphodagmarita, Crescentia, Louisettita</td>
</tr>
<tr>
<td></td>
<td>Paradagmaritinae</td>
<td>Paradagmarita, Paradagmaritella, Paradagmaritopsis, Paradagmacrusta, Paraemiratella</td>
</tr>
</tbody>
</table>

**Figure 8—Subfamilies (8A) and cartoons (8B) of Globivalvulinidae.** 1-Globivalvulina; 2-Septoglobivalvulina, 3-Paraglobivalvulina, 4-Siphoglobivalvulina, 5-Retroseptellina, 6-Dagmarita, 7-Siphodagmarita, 8-Louisettita, 9-Paradagmarita, 10-Paradagmaritopsis.
FIGURE 9—Late Permian globivalvulinites. 1-3, *Siphoglobivalvulina baudii* Gaillot and Vachard in Gaillot *et al.* (submitted b), 1, axial section, paratype (= Pl. I.43, Fig. 2 in Gaillot, 2006), Late Permian, Zagros (Iran). 2, subaxial section, paratype (= Pl. I.43, Fig. 11 in Gaillot, 2006), Late Permian, Zagros (Iran). 3, axial section, paratype (= Pl. I.5, Fig. 10 in Gaillot, 2006), Late Permian, Hazro (Taurus, Turkey). 4, *Charliella altnieri* Gaillot and Vachard (submitted), axial section, paratype, (= Pl. II.11, Fig. 12 in Gaillot, 2006), Late Permian, Zagros (Iran). 5, *Retroseptellina decrouezae* (Koylioglu and Altiner, 1989), transverse section (= Pl. III.7, Fig. 2 in Gaillot, 2006), Late Permian, Zagros (Iran). 6, *Retroseptellina nitida* (Lin, Li and Sun, 1990), transverse section, (= Pl. I.19, Fig. 18 in Gaillot, 2006), Late Permian, Zagros (Iran). 7, *Septoglobivalvulina cf. guangxiensis* Lin, 1978, subtransverse section (= Pl. I.4, Fig. 14 in Gaillot, 2006), Late Permian, Zagros (Iran). 8, *Paraglobivalvulina mira* Reitlinger, 1965, subtransverse section (= Pl. I.12, Fig. 20 in Gaillot, 2006), Late Permian, Zagros (Iran). 9, *Paraglobivalvulina sp.* 1, subaxial section (= Pl. I.19, Fig. 19 in Gaillot, 2006), Late Permian, Zagros (Iran). 10, *Paraglobivalvulinites septuliferus* Zaninetti and Altiner, 1981, subaxial section (= Pl. VII.1, Fig. 1 in Gaillot, 2006), late Changhsingian (latest Permian), Laren, Guangxi (South China). 11, *Urushtenella* sp., axial section with a characteristic wall and a morphology of *Paraglobivalvulina* (= Pl. III.5, Fig. 5 in Gaillot, 2006), Late Permian, Zagros (Iran). 12-13, *Dagmarita chanakchiensis* Reitlinger, 1965, 12, sagittal axial section (= Pl. II.12, Fig. 2 in Gaillot, 2006), Late Permian, Zagros (Iran). 13, frontal axial section (= Pl. II.12, Fig. 4 in Gaillot, 2006), Late Permian, Zagros (Iran). 14-15, *Bidagmarita sinica* Gaillot and Vachard in Gaillot *et al.* (submitted b), 14, sagittal axial section, holotype (= Pl. VII.3, Fig. 4 in Gaillot, 2006), Late Permian, Laren, Guangxi (South China). 15, frontal axial section, paratype (= Pl. VII.3, Fig. 5 in Gaillot, 2006), Late Permian, Laren, Guangxi (South China). 16-17, *Siphodagmarita vasleti* Gaillot and Vachard in Gaillot *et al.* (submitted a), 16, sagittal axial section, paratype (= Pl. VI.6, Fig. 22 in Gaillot, 2006), Late Permian, Hazro (Taurus, Turkey). 17, frontal axial section, paratype (= Pl. VI.6, Fig. 17 in Gaillot, 2006), Late Permian, Hazro (Taurus, Turkey). 18-19, *Louissetita extraordinaria* Gaillot and Vachard in Gaillot *et al.* (submitted b), 18, sagittal axial section, holotype (= Pl. VI.7, Fig. 10 in Gaillot, 2006), Late Permian, Hazro (Taurus, Turkey). 19, frontal axial section, paratype (= Pl. VI.7, Fig. 13 in Gaillot, 2006), Late Permian, Hazro (Taurus, Turkey). 20, *Crescentia* sp., subtransverse section (= Pl. III.13, Fig. 11 in Gaillot, 2006), Late Permian, Zagros (Iran). Scale bars indicated on the figure.
Berkhli, 1992; Globivalvulina sp. sensu Kulagina et al., 1992, Pl. 11, Fig. 24; Globospiroplectammina (sic) windsorensis (Mamet, 1970) sensu Brenckle, 1997b (Pl. 4, Fig. 12-16); Kottjubina (?) sp. sensu Okuyucu & Vachard, 2006, Fig. 7.20. These taxa were found in central and southern Kazakhstan; Montagne and Bangor Limestone (USA); Asbian of Taurus; late Visean of Nevada; Brigantian of eastern Morocco; and Asbian of Tarim (northern China).

The FAD of Dzhamansorina is coeval to that of Kottjubina (middle Visean) and it is impossible to identify the praecursor genus. Dzhamansorina shows a last uncoiled pair of hemispherical chambers with depressed sutures; the aperture is a large tunnel at the crossing of septa, and the microgranular wall is thin. The species of Dzhamansorina are: Dzhamansorina grata Marfenkova, 1991; D. kipshakensis Marfenkova, 1991; D. aff. minima (here Fig. 4, 1-2); Spiroplectammina minima Vdovenko, 1962; Globivalvulina sp. sensu Brazhnikova et al. (1967, Pl. 18, Fig. 13); undetermined Biseriamminidae sensu Mamet, 1970, Pl. 1, Fig. 5; Biseriella sp. sensu Mamet, 1976, Pl. 81, Figs. 13 (non Fig. 12 = other species); B. of the group B. parva (Chernysheva) sensu Armstrong & Mamet, 1977, Fig. 8; Globivalvulina aff. bristolensis sensu Meissami et al., 1978; Globivalvulina cf. parva sensu Massa & Vachard, 1979, Pl. 4, Fig. 5.

The taxa are known from middle Visean to Serpukhovian of Kazakhstan, eastern Morocco (Jerada Basin), southern France (this study), USA (see Rich, 1982), Canada (Nova Scotia, British Columbia: Mamet, 1976), and early Serpukhovian of Libya (Massa & Vachard, 1979). Because its wall is microgranular and its coiling tends to be planispirally biseriate, Dzhamansorina might be located at the beginning of the lineage, just before these primitive forms of Globivalvulina (e.g., G. ex gr. parva) denominated Biseriella by many authors. In this case, the individuality of Biseriella would be definitively established as a transitional stage between Dzhamansorina and true Globivalvulina. Nevertheless, as Dzhamansorina appears as more primitive than "Biseriella" bristolensis auctorum (by its more irregular coiling and the relatively deeply sutured chambers), the link of the Biseriella and primitive Globivalvulina, with "G." or "B." bristolensis becomes unlikely, and a new genus must be introduced to define generically "G." or "B." bristolensis (see above). From the middle Visean to late Serpukhovian, unpublished and literature data rather indicate the following lineage: Dzhamansorina kipshakensis (middle Visean)-Dzhamansorina aff. kipshakensis (late Asbian) (Figs. 4.5, 5.4)-Dzhamansorina aff. minima (late Asbian) (Figs. 4.1-2, 5.3)-Globivalvulina? ex gr. parva (Figs. 4.3, 5.6-13, 6.8-12) (late Brigantian)-G.? aff. bristolensis (Figs. 4.6-8, 5.9-10)-G.? parva (early Serpukhovian) (Figs. 5.11-12, 6.14-15)-G.? spp. sensu Perret (1993) (late Serpukhovian)-G.? minima (= kantiharesis = scaphoidea) (Fig. 6.27)-Globivalvulina moderata (Figs. 5.14, 6.21)-G. bulloides (Figs. 5.15, 6.18-20).

The taxonomic affinities of the genus Admiranda Marfenkova, 1991 (Fig. 2. 11) still remain unclear for us, although a taxon of Vachard & Berkli (1992, Pl. 1, Fig. 1) might be included within the Marfenkova's diagnosis. The relations between Dzhamansorina and Admiranda are expected to be similar to those between Globivalvulina and Dagmarita; i.e., a secondary-uncoiled taxon lately appeared within a coiled lineage. The difference with Ulanbela Marfenkova, 1991 is considered here as specific and not subgeneric.

Globospiroplectammina Vachard, 1977 was interpreted as a genus of Biseriamminoidea (e.g., Conil et al., 1980), and more precisely as Kottjubinidae. This interpretation is probably erroneous, because the initial part of Globospiroplectammina corresponds to a deviation of a biseriate test, that passes progressively to a Spiireitlina-type of coiling with a short initial part as seen in S. tokmovensis (Reitlinger, 1961) sensu Vachard & Krainer (2001, Pl. 1, Figs. 8, 11). This character is peculiarly obvious in a new material from southern France (Pille, Ph. D. in progress). Other genera can also be related to this informal group: Spiroplectamminoides Skipp, 1969; Rectogranuliferella Conil & Lys in Mansy et al., 1989; Palaeospiroplectammina sensu Lipina, 1965 (pars); Palaeospiroplectammina (?) sensu Conil, 1980; "Palaeospiroplectammina" sensu Michelsen, 1971; Spiroplectammina sensu Chernysheva, 1940; Spiroplectammina (?) sensu Lebedeva, 1954 and in Grozidilova & Lebedeva, 1954; Rectochernyshinella sensu Ganelina, 1966; Granuliferelloides McKay & Green, 1963; Corrigotubella Ganelina, 1966; Ammobaculites sensu Malakhova, 1956 (pars); and Haplophragmina sensu Conil & Lys, 1968 (non Reitlinger, 1950).

According to Brenckle & Hance (2005); Granuliferelloides, Corrigotubella and Lipinellina Loeblich & Tappan, 1985 (= Rectochernyshinella Lipina 1965 non 1960) are synonyms; according to Lane et al. (2005), Rectogranuliferella and Spiroplectamminoides are synonyms. These modifications are only partly justified and remain highly subjective (revisions of the holotypes are lacking). Michelsen (1971, p. 43) interpreted the initial chambers of "Palaeospiroplectammina" mellina (Malakhova, 1956)
corresponding to a multiseriate (triseriate) initial part; in fact, this initial stage is most probably coiled with few endothyroid chambers. “Palaeospiroplectammina” in this case differs notably from Palaeospiroplectammina Lipina, 1965 emend. Conil & Lys, 1977, but looks like Globispiroplectammina after the emendation by Vachard & Beckary (1991) (see also Fontaine et al., 1999, p. 464).

Some species analyses are presented below, concerning the plexus Globivalvulina? Biseriella, which appears during the late Visean.

Globivalvulina? ex gr. parva (Chernysheva, 1948) (Fig. 4. 3, Fig. 6. 8-12, 14-15, 27)

?1946 Globivalvulina kantharensis n. sp. Reichel, p. 554, 556, Text-Figs. 40 a-d.


1949 Globivalvulina scaphoidea n. sp. Reitlinger, p. 159, Pl. 1, Fig. 5.

1950 Globivalvulina minima n. sp. Reitlinger, p. 76-77, Pl. 16, Fig. 14.

1956 Globivalvulina sp.-Malakhova, p. 44, Pl. 4, Figs. 5-6.

non 1960 Globivalvulina parva n. sp. Loriga, p. 57 (= preoccupied) (in the same publication, this form is illustrated as Globivalvulina sp.: Text-Fig. 10 p. 157, that corresponds probably to Siphoglobivalvulina baudi Gaillot & Vachard in Gaillot et al. (submitted b), see below).

1962 Globivalvulina parva Chernysheva-Bogush & Juferev, p. 196, Pl. 8, Fig. 12.

1962 Globivalvulina minima Reitlinger-Bogush & Juferev, p. 196-197, Pl. 8, Fig. 13.

1963 Globivalvulina ex gr. minima Reitlinger-Chanton, Pl. 7, Fig. 5.

1967 Globivalvulina moderata Reitlinger-Brazhnikova et al., Pl. 18, Fig. 12, Pl. 22, Fig. 4, Pl. 25, Fig. 5.

1967 Globivalvulina minima Reitlinger-Sosipatrova, Pl. 4, Fig. 15.

p. 1968 Globivalvulina parva Chernysheva - Aizenverg et al., Pl. 16, Fig. 12 (non Figs. 11, 13 = Dzhamansorina aff. minima, herein).

1968 Globivalvulina moderata Reitlinger-Aizenverg et al., Pl. 16, Figs. 8-9.

1969 Globivalvulina parva Chernysheva-Manukalova-Grebeniuk et al., Pl. 13 (p. 197), Fig. 23, Pl. 8 (p. 235), Fig. 36, Pl. 13 (p. 245), Fig. 4.

1969 Globivalvulina minima Reitlinger-Manukalova-Grebeniuk et al., Pl. 5 (p. 181), Fig. 29, Pl. 8 (p. 187), Fig. 6-7, ? Pl. 1 (p. 221), Fig. 24 (ex gr.).


1971 Globivalvulina moderata Reitlinger-Clement et al., Pl. 1, Fig. 3.


1973 Globivalvulina minima Reitlinger-Ivanova, p. 196-197, Pl. 33, Fig. 13.

1973 Globivalvulina sp.-Ivanova, Pl. 19, Fig. 9.

v. 1973 Globivalvulina moderata Reitlinger-Perret, p. 321-322, Pl. 5, Figs. 4-5.

v.? 1973 Globivalvulina parva Chernysheva-Perret, p. 322, Pl. 5, Figs. 12-14 (with 3 references in synonymy).

v.? 1973 Globivalvulina aff. bulloides (Brady)-Perret, p. 322-323, Pl. 5, Figs. 10-11.

?1973 Globivalvulina moderata Reitlinger-Popova & Reitlinger, p. 55, Pl. 9, Fig. 32.


1973 Globivalvulina sp. C-Brenckle, p. 68, Pl. 10, Figs. 6-7.


1974 Globivalvulina minima Reitlinger-Wang, p. 254, Pl. 129, Fig. 15.

v. non 1974 Globivalvulina cf. parva (Chernysheva)-Vachard, p. 335-336, Pl. 23, Figs. 2-3 (with synonymy) (= Globivalvulina aff. bristolensis, see herein).

non 1976 Biseriella of the group B. parva - Mamet, Pl. 76, Figs. 3-4, Pl. 92, Fig. 4 (= two Koktjubinidae).

non 1977 Biseriella of the group B. parva (Chernysheva)-Armstrong & Mamet, p. 100-101, Pl. 35 Fig. 4 (another species with more whorls), nec Fig. 8 (= Dzhamansorina) (with 7 references in synonymy), nec Pl. 6, Fig. 5 (= Globivalvulina moderata).

?1976 Globivalvulina aff. minima Reitlinger-Sosina & Nikitina, Pl. 3, Fig. 20 (valvular projection poorly visible, may be G.? parva).
1976 *Globivalvulina* aff. *moderata* Reitlinger-Sosnina & Nikitina, Pl. 3, Fig. 14.
1976 *Globivalvulina* ex gr. *moderata* Reitlinger-Ektova, Pl. 8, Fig. 8.
1977 *Globivalvulina moderata* Reitlinger-Fomina, Pl. 4, Figs. 4-5.
1977 *Globivalvulina minima* Reitlinger-Lys & Leboulanger, Pl. 52, Fig. 12.


p. 1977 *Biseriella* of the group B. *parva* (Chernysheva)-Armstrong & Mamet, p. 100-101, Pl. 6, Fig. 5, Pl. 35, Fig. 4 (non Pl. 35, Fig. 8 = a koktjubinid).

v. non 1977 *Globivalvulina* cf. *parva* (Chernysheva)-Vachard, p. 156-157, Pl. 6, Figs. 16-17 (with 14 references in synonymy) (= *Globivalvulina*? aff. *bristolensis*, see herein).

1978 *Globivalvulina scaphoidea* (sic) Reitlinger-Lys et al., Pl. 2, Fig. 11, Pl. 3, Fig. 6.
1979 *Globivalvulina minima* Reitlinger-Reitlinger in Wagner et al., Pl. 10, Figs. 10-11.

p. 1979 *Globivalvulina* Reitlinger-Potievskaia in Wagner et al., Pl. 12, Figs. 7, 10 (non Pl. 10, Fig. 12 = truly *G. moderata*).

p. 1979 *Globivalvulina parva* Chernysheva-Brazhnikova in Wagner et al., Pl. 2, Fig. 15?, Pl. 5, Figs. 22-23 (non Pl. 3, Figs. 13-14 = *Dzhamansorina?* sp.).

v. 1979 *Globivalvulina* cf. *moderata* (Reitlinger)-Bensäid et al., Pl. 15, Fig. 14.
1980 *Globivalvulina minima* Reitlinger-Reitlinger, Pl. 4, Figs. 7-9.

non 1980 *Biseriella parva* (Chernysheva)-Rich, p. 79, Pl. 5, Figs. 2-3, 6-7, 10 (= *Koktjubina* sp.).

1980 *Biseriella* cf. *parva* (Chernysheva)-Conil et al., Pl. 24, Figs. 2-4, Pl. 28, Figs. 40-41 (or another “Biseriella”).

?1980 *Biseriella* sp.-Conil et al., Pl. 26, Fig. 3 (or *Dzhamansorina*).

?1981 *Globivalvulina* Reitlinger-Vachard in Vachard & Montenat, p. 70, Pl. 11, Fig. 10.
1981 *Globivalvulina parva* Chernysheva-Altiner, p. 283-284, Pl. 23, Figs. 18-23.

non 1981 *Biseriella parva* (Chernysheva)-Igo & Adachi, p. 107, Pl. 6, Figs. 3, 7 (= *Globivalvulina*?).

?1981 *Globivalvulina* Reitlinger-Lys, Pl. 3, Fig. 17.

non 1981 *Globivalvulina parva* Chernysheva-Zhao et al., p. 104, Pl. 17, Figs. 7-11 (= *G. moderata* or *G. kamensis*).

?1981 *Globivalvulina* Reitlinger-Zhao et al., Pl. 2, Fig. 6.


1984 *Globivalvulina moderata* Reitlinger-Chuvashov et al., Pl. 1, Fig. 25, Pl. 3, Fig. 23.

non 1984 *Biseriella parva* (Chernysheva)-Groves, Text-Fig. 6 p. 287, Text-Fig. 7 p. 289, Pl. 5, Figs. 1-6 (= ?*G. minima* and *G. scaphoidea*).

?1985 *Globivalvulina* aff. *moderata* Reitlinger-Lys, Pl. 1, Fig. 18 (or another species).
1987 *Globivalvulina minima* Reitlinger-Sinitsyna & Sinitsyn, Pl. 2, Fig. 22.

1987 *Biseriella* sp.-Luo, Pl. 2, Figs. 15-17.

non 1988 *Biseriella parva* (Chernysheva)-Groves, p. 381, 383, Figs. 14, 1-9 (= ? *Globivalvulina* kamensis or *G. bulloides* sensu lato) (with misinterpreted synonymy including *Globivalvulina* moderata, *G. scaphoidea*, *G. sp. 1, G. minima* and *G. kamen-esis*).

1988 *Globivalvulina moderata* Reitlinger-Groves, p. 381 (no illustration; with synonymy erroneously synonymized with “*Biseriella*” parva).

1988 *Globivalvulina minima* Reitlinger-Kulagina, p. 26, Pl. 3, Figs. 11-12, Pl. 4, Fig. 31.

?1988 *Globivalvulina moderata* Reitlinger-Kulagina, p. 26, Pl. 3, Fig. 17, Pl. 4, Fig. 25.

p. 1988 *Globivalvulina* sp.-Yanagida et al., Pl. 5, Fig. 12 (only; non Figs. 1-4, 6, 10, 13-14 = *Siphodagmarita, non* Fig. 5 = *Septoglobivalvulina?* sp.; non Fig. 7 =...
Retroseptellina globosa; non Figs. 8-10 = other species of Globivalvulina.

1989 Biseriella parva (Chernysheva)-Fewtrell et al., p. 56, p. 64, Pl. 3, 9, Fig. 4, Pl. 3, 12, Fig. 3.
1990 Globivalvulina minima Reitlinger-Lin, Pl. 3, Fig. 20.
1990 ?Biseriella moderata Reitlinger-Sebbar & Lys, Pl. 2, Fig. 3.
1990 Globivalvulina eogranulosa Reitlinger-Postojalko, Pl. 7, Fig. 31.

v. 1990 Globivalvulina minima Reitlinger-Vachard, p. 95 (no illustration).

1991 Globivalvulina kantharenensis Reichel-Lin et al., p. 86, p. 163, Pl. 11, Figs. 30-34 (all specimens don’t display the specific characters, and even might belong to Siphoglobivalvulina).

1991 Biseriella parva (Chernysheva)-Mametko, Pl. 9, Fig. 11.

1991 Globivalvulina moderata Reitlinger-Vachard et al., p. 677, Pl. 1, Figs. 16-17.

1992 Globivalvulina (Chernysheva)-Kulagina et al., Pl. 4, Figs. 2, 5, Pl. 13, Figs. 18?, 21?

1992 Globivalvulina moderata Reitlinger-Kulagina et al., Pl. 11, Fig. 25.
1992 Biseriamminide indeterminate N.° 2-Vachard & Berkli, Pl. 1, Figs. 10-11, Pl. 3, Fig. 5.

1992 Biseriella parva (Chernysheva)-Brakens, p. 150, Pl. 4, Figs. 8-13 (all these specimens exhibit developed valvular projections and probably belong truly to Globivalvulina).

1992 Biseriella of the group B. parva (Chernysheva)-Mamet et al., Pl. 13, Figs. 1-3, 5-6 (all these specimens belong truly to Globivalvulina: the Fig. 1, to G. moderata; the Figs. 2-3, 5-6, to a larger species maybe G. kamensis Reitlinger, 1950).

1993 Globivalvulina parva Chernysheva-Perret, p. 449-450, Pl. F4, Figs. 60-64 (with 18 references in synonymy) (Fig. 61 = Globivalvulina minima).
1993 Globivalvulina eogranulosa Reitlinger-Perret, p. 450-451, Text-Figs. 136-137 p. 446-447, Pl. F IV, Figs. 29-32, Pl. F XII, Fig. 15 (with synonymy).
1993 Biseriella parva (Chernysheva)-Vdovenko & Zhulitova in Makhlina et al., Pl. 4, Figs. 23-24, 28.

1993 Globivalvulina moderata Reitlinger-Vachard et al., Pl. 1, Figs. 3, 14.
1996 Globivalvulina parva Chernysheva-Marfenkova in Einor, Pl. 41, Fig. 35.

non 1996 Biseriella parva (Chernysheva)-Cozar-Maldonado, Pl. 2, Fig. 12 (maybe Plectogyranopsis; Cozar pers. comm., December 2006).

1996 Globivalvulina ex gr. moderata Reitlinger-Proust et al., p. 348 (no illustration).
1997 Biseriella parva (Chernysheva)-Harris et al., Fig. 8, 26.
1997 Biseriella ex gr. parva (Chernysheva)-Brenckle et al., Pl. 1, Fig. 22 (probably G. minima).

1997 Biseriella parva (Chernysheva)-Ueno & Igo, Pl. 1, Fig. 9 (probably G. minima).


1998 Globivalvulina kantharenensis Reichel-Pinard & Mamet, p. 118, Pl. 27, Figs. 6, 9-12 (with 6 references in synonymy) (non Fig. 7 = G. shikhanensis).

1999 Biseriella parva (von Moller)-Berkhli, p. 110, 113 (no illustration).

non 2000 Biseriella gr. parva (Chernysheva)-Sebbar, Pl. 13, Fig. 17 (profile more inflated, sutures absent).


p.? 2000 Biseriella ex gr. parva (Chernysheva)-Cozar, Figs. 3, 7, 8, 9?

non 2001 Biseriella parva (Chernysheva)-Vdovenko, Pl. 4, Figs. 47-48 (= Pseudotaxis eomimima).

2002 Biseriella parva (Chernysheva)-Kulagina & Gibshman, Text-Fig. 3 p. 186 (no illustration).


2002 Biseriella parva (Chernysheva)-Pazukhin et al., p. 221 (no illustration).

2002 Globivalvulina minima Reitlinger-Shcherbakova & Shcherbakov, p. 313 (no illustration).
?2003 Biseriella parva (Chernysheva)-Kulagina et al., Text-Fig.7 p. 180 (no illustration).

v. 2003 Globivalvulina parva Chernysheva-Vachard et al., p. 654 (no illustration).

non 2003 Biseriella of the group parva (Chernysheva)-Brenckle & Milkina, Pl. 6, Figs. 1-3 (1 and 3 corresponds to another species of Biseriella, 2 is yet a Globivalvulina ex gr. moderata Reitlinger, 1949).

non 2003 Biseriella ex gr. parva (Chernysheva)-Cozar, Fig. 5P (= G.? aff. bristolensis; see herein).

non 2004 Biseriella ex gr. parva (Chernysheva)-Cozar & Rodriguez, Fig. 9. 7 (= G.? aff. bristolensis; see herein).

?2004 Biseriella cf. parva (Chernysheva)-Cozar & Somerville, Text-Fig. 4 p. 46 (pars), Fig. 10. 22 (oblique section, difficult to identify).

p.? 2004 Biseriella parva (Chernysheva)-Cozar & Somerville, Text-Fig. 6 p. 47 (pars), Text-Fig. 15 p. 61 (pars), Fig. 10. 24? (non Fig. 10.23 = G.? aff. bristolensis; see herein).

?2004 Globivalvulina kantharensis Reichel-Zhang & Hong, p. 70, Pl. 1, Figs. 22-23 (= Retroseptellina globosa) (with 6 references in synonymy).

v. 2005 Biseriella parva (Chernysheva)-Saïd, p. 178, p. 182? (ex gr.), p. 184, p. 186, p. 188, p. 189, p. 191, Fig. X. 1. 17 (typical although listed as “ex gr.”), 18, 22.


v. 2006 Globivalvulina scaphoidea Reitlinger-Insalaco et al., Pl. 1, Fig. 16.

v. 2006 Biseriella aff. parva (Chernysheva)-Okuyucu & Vachard, p. 547, Fig. 5. 17-19.

Description.—Small test, planispiral and inflated. Proloculus spherical and excentred. The five first chambers are closely arranged and their height remain smaller than the proloculus diameter. The sixth to ninth chambers increase markedly in width, very rapidly in height, and constitute the median part of the last whorl. Apertural face flat or slightly inflated. Valvula well developed in the last chamber, and often present in the two or three last ones. Diameter (D) = 0.170-0.240 (0.330) mm; width (w) = 0.110-0.150 mm; ratio w/D = 0.60-0.70; proloculus diameter = 0.025-0.045 mm; number of whorls: 1-1.5; number of chambers at the last whorl: 4-5 pairs; height of the last whorl = 0.060-0.110 (0.135) mm; wall thickness of the last whorl = 0.010-0.015 mm. The type of wall is not precisely known, since the type material of G. parva was not revised, but we dont forget that Chernysheva (1948) written: “the wall is microgranular sometimes with a thin and poorly developed radial layer” (see also Loeblich & Tappan, 1987).

Remarks.—According to Brenckle (2005), B. scaphoidea is difficult to distinguish from B. parva. According to Gaillot (2006), G. scaphoidea is synonym of G. kantharensis, a species considered as a true Globivalvulina by Pinard & Mamet (1998) or a Verispira by Palmieri (1988). If G. kantharensis, G. scaphoidea and G. parva were synonyms, G. kantharensis must be the prioritary name of the type-species. Furthermore, as for G. parva, Reichel (1946) indicated that a small clear layer was present in the wall of the last chambers of some specimens in the G. kantharensis type-material: “Test très finement granuleux, des traces de couche hyaline poreuse interne sont visibles dans les dernieres loges”. Consequently, the three taxa seem to constitute a group of species. This latter is often misinterpreted and it can generally be used to identify all the Visean-Serpukhovian “Biseriella”, some unquestionable Globivalvulina, and even koktubinids. That explains the relative imprecision about the biostratigraphic value of Globivalvulina? parva. It was considered as a marker of the late Serpukhovian E2/zone 18 by Mamet & Skipp (1971) and Mamet (1974), but the rare forms illustrated by Mamet, as well as those illustrated by Groves (1988) correspond to much more advanced species, already corresponding to unquestionable Globivalvulina. Conversely, the late Visean “Biseriella” parva of many authors belong in fact to the genus Pseudotaxis (see in connection with that, the compilation of Vachard & Beckary, 1991), other species of Biseriella (for instance, here, G.? aff. bristolensis), or Koktubina (for example, the Akerchi specimens mentioned in several publications, about central Morocco, by members of our team). Finally, the true B. parva can be indicative of the earliest Serpukhovian and or the latest beds of the Visean (see references in Okuyucu & Vachard, 2006). Nevertheless, according to the literature, many similar species are distributed up to the Moscovian: e.g., G. minima, G. moderata, and G. scaphoidea. The holotype of the first one of them, G. minima, corresponds
probably to an equatorial transverse section of G. parva whose the type material is only constituted by oblique transverse sections. Consequently, the type of section of G. minima shows the well developed valvular projection and the closely arranged first chambers which are not obvious in G. parva. Moreover, some G. minima show a differentiated wall; notably, the Turkish specimens of Altiner (1981) and some but not all of the specimens seen by us (see for example, that of Perret, 1993, Pl. F.IV, Fig. 53). G. scaphoidea has the same size and differs only by the shape of the late chamber. G. moderata is larger (D = 0.310-0.510 mm but has more chambers: 7-9 pairs), and it is transitional to G. bulloides or synonym of this species (see discussion in Groves, 1984 or Brenickle, 2005).


Occurrence of G. minima.—Middle Carboniferous of Russian Platform, Kazakhstan, North Tianshan, Primorye, Algeria (Bechar, Reggan, Illizi) and South China. Provinsky-Bashkirian of southern Urals and Alaska. Serpukhovian of Donets Basin (D1 to D72 limestones). Middle Serpukhovian-early late Serpukhovian of central Tien-Shan. Moscovian of Rhodes Island (Greece) and Ellesmere Island (Canada). Late Serpukhovian of Ardengost area (French Pyrenees). Earliest Bashkirian-early Moscovian of eastern Alborz (Iran). ? Morrowan of Idaho. Late Bashkirian-earliest Late Carboniferous in eastern Taurus (Turkey). Late Bashkirian of Thailand. Vereian of Spitsbergen.

Occurrence of G. scaphoidea/kantharenensis. —Bashkirian-Early Permian of Canadian Arctic. Early Permian of Cyprus, Afghanistan, Japan. Lopingian of South China, northern Thailand, Iran (Zagros).

Globivalvulina? aff. bristolensis Reichel, 1946 (Figs. 4. 6-8)


v. 1977 Globivalvulina cf. parva (Chernysheva)-Vachard, p. 156-157, Pl. 6, Figs. 16-17.

p.? 2000 Biseriella ex gr. parva (Chernysheva)-Cozar, Figs. 3. 7?, 8, 9?

?2003 Biseriella bristolensis? (Reichel)-Brenickle & Milkina, Pl. 3, Fig. 12.

2003 Biseriella ex gr. parva (Chernysheva)-Cozar, Fig. 5P.

2004 Biseriella ex gr. parva (Chernysheva)-Cozar & Rodriguez, Fig. 9. 7.

p. 2004 Biseriella parva (Chernysheva)-Cozar & Somerville, Fig. 10. 23 (non? Fig. 10-24 = difficult to identify).

Comparison.—This taxon of the late Brigantian of Montagne Noire differs from G.? bristolensis Reichel, 1946, by the entirely planispiral coiling, the shape of the chambers (triangular in G.? bristolensis, see Fewtrell et al., 1989, Pl. 3, 3, Fig. 2; with a less voluminous last chamber) and the different age (G.? bristolensis is characteristic of the late Chadian = latest Tournaisian = latest Ivorian = MFZ8).


HOW MANY SUBDIVISIONS OF GLOBIVALVULINA DURING THE PENNSYLVANIAN?

The Pennsylvanian-Cisuralian (Early Permian) forms are extensively described (e.g., Pinard & Mamet, 1998) and generally all attributed to the unique genus Globivalvulina. All these forms have a small, medium or large, subglobular test, entirely biseriate and planispiral, with a lobate periphery, undivided chambers, and an aperture simple protected by the valvular projection sometimes well developed. Based on the same criteria than Biseriella, many Moscovian globivalvulines must be considered as dif-
FIGURE 10 - Late Permian Iranese (Zagros) Biseriamminoidea. 1-5, Paradagmarita monodi Lys in Lys and Marcoux, 1978, 1, frontal axial section (= Pl. 1.15, Fig. 4 in Gaillot, 2006), Late Permian, Zagros (Iran). 2, subtransverse section (= Pl. 1.16, Fig. 2 in Gaillot, 2006), Late Permian, Zagros (Iran). 3, subtransverse section (= Pl. III.5, Fig. 14 in Gaillot, 2006), Late Permian, Zagros (Iran). 4, axial section (= Pl. III.6, Fig. 9 in Gaillot, 2006), Late Permian, Zagros (Iran). 5, subtransverse section (= Pl. III.25, Fig. 2 in Gaillot, 2006), Late Permian, Zagros (Iran). 23, subtransverse section with peripheric punctuations, paratype (= Pl. III.18, Fig. 3 in Gaillot, 2006), Late Permian, Zagros (Iran). 6-7, Paremiratella instabilis Gaillot and Vachard (submitted), 6, subtransverse section, paratype (not illustrated in Gaillot, 2006), Late Permian, Zagros (Iran), 7, subaxial section, paratype (not illustrated in Gaillot, 2006), Late Permian, Zagros (Iran). 8-10, Paradagmaritopsis kobayashii Gaillot and Vachard in Gaillot et al. (submitted), 8, frontal axial section, paratype, (= Pl. 1.9, Fig. 9 in Gaillot, 2006), Late Permian, Zagros (Iran). 9, sagittal axial section, paratype (= Pl. 1.9, Fig. 5 in Gaillot, 2006), Late Permian, Zagros (Iran). 10, oblique section, paratype (= Pl. III.2, Fig. 10 in Gaillot, 2006), Late Permian, Zagros (Iran). 11-13, Paradagmaritella flabelliformis (Zaninetti, Altiner and Catal, 1981). 11, sagittal axial section (= Pl. III.2, Fig. 10 in Gaillot, 2006), Late Permian, Zagros (Iran). 12, transverse section (= Pl. I.14, Fig. 12 in Gaillot, 2006), Late Permian, Zagros (Iran). 13, subtransverse section (= Pl. III.2, Fig. 8 in Gaillot, 2006), Late Permian, Zagros (Iran). 14-15, Paradagmaritella surmehensis Gaillot and Vachard (submitted). 14, transverse section, paratype (= Pl. 1.7, Fig. 13 in Gaillot, 2006), Late Permian, Zagros (Iran). 15, oblique section, paratype (= Pl. I.7, Fig. 14 in Gaillot, 2006), Late Permian, Zagros (Iran). 16-17, Paradagmaritella brevispira Gaillot and Vachard (submitted), 16, subtransverse section, paratype (= Pl. 1.8, Fig. 14 in Gaillot, 2006), Late Permian, Zagros (Iran). 17, subtransverse section, paratype (= Pl. 1.9, Fig. 13 in Gaillot, 2006), Late Permian, Zagros (Iran). 18-19, Paradagmarita zaninettiæ Gaillot and Vachard (submitted). 18, subtransverse section, paratype (= Pl. I.10, Fig. 15 in Gaillot, 2006), Late Permian, Zagros (Iran). 19, subaxial section, paratype (= Pl. I.10, Fig. 16 in Gaillot, 2006), Late Permian, Zagros (Iran). 20-21, Paradagmacrusta callosa Gaillot and Vachard (submitted), 20, transverse section, paratype (= Pl. I.12, Fig. 10 in Gaillot, 2006), Late Permian, Zagros (Iran). 21, subaxial section, paratype (= Pl. 1.12, Fig. 17 in Gaillot, 2006), Late Permian, Zagros (Iran). 22-23, Paradagmarita cf. monodi, 22, frontal axial section (not illustrated in Gaillot, 2006), Late Permian, Zagros (Iran). 23, sagittal axial section (not illustrated in Gaillot, 2006), Late Permian, Zagros (Iran).
different genera because they have a wall distinct from that of *Globivalvulina bulloides*. Nevertheless, only the very poorly known genus *Tenebrosepta* has been separated from *Globivalvulina* sensu lato, during this period.

The wall differs from black, microgranular to differentiated into two, three or four layers, but this differentiation does not affect all the chambers and/or correspond to fossildiagenetic features and cannot be admitted as generic criterion. Some groups of species exhibit sporadic addition of: (a) a yellow pseudofibrous inner layer (see *G. mosquensis* Reitlinger, 1950), or (b) are similar to the wall of an *Omphalotis* endothyroid (Vachard & Beckary, 1991), or (c) are granular with agglutinated particules: *G. granulosa* Reitlinger, 1950, and finally, (d) with an intermediary clear layer ("diaphanotheca" of authors): *G. bulloides* (Brady, 1876) of the authors. However, *G. granulosa* and *G. mosquensis* were included in the same group by Reitlinger (1950).

Some authors consider that the appearance of the "diaphanothecal" wall in *G. bulloides* is characteristic of the Early/Mid Carboniferous Boundary; nevertheless, *G. bulloides* appears in the late early Serpukhovian or Protvinsky (Kulagina & Gibshman, 2002, Text-Fig. 3 p. 186; Shcherbakova & Shcherbakov, 2002, p. 308).

Finally, the genus *Globivalvulina* is composed of several groups of species according to generally admitted foraminiferal criteria: wall structure, size, development of the valvulae, characters of the chambers, and shape of the apertural face. Unfortunately, these characters appear very variable among the specimens of the same population. The six main groups are:

First group: *G. ex gr. parva*. Small species (D < 0.350 mm) with unilayered dark wall, numerous chambers, few or no sutures, and valvula absent or developed only in the last chambers: *G. parva* Chernysheva, 1948; *G. minima* Reitlinger, 1950; *G. kantharensis* Reichel, 1946 = *G. scaphoidea* Reitlinger, 1949; *G. procera* Postoyalko, 1990; *G. eogranulosa* Reitlinger, 1949; *G. shikhanensis* Morozova, 1949; *Globivalvulina bristolensis* Reichel, 1946.

Second group: *G. ex gr. bulloides*. Medium size species (D = 0.350-0.500 mm), generally with five chambers at the last whorl, and some wall differentiation forming very rarely and very sporadically an intermediary clear layer ("diaphanotheca" of the authors), and well-developed valvulae: *G. bulloides* (Brady, 1876); *G. bulloides minima* Zolotova in Zolotova & Baryshnikov, 1980 (minima is preoccupied); *G. apiciformis* Zolotova in Zolotova & Baryshnikov, 1980; *G. cora* Harlton, 1928; *G. kamensis* Reitlinger, 1950; *G. moderata* Reitlinger, 1949; *G. sissipatrovae* Baryshnikov in Zolotova & Baryshnikov, 1980; *G. unciata* Zolotova in Zolotova & Baryshnikov, 1980; *G. vulgaris* Morozova, 1949; *G. ovata* Cushman & Waters, 1928; *G. biseria* Cushman & Waters 1928; *G. pulchra* Reitlinger, 1950; *G. arguta* Konovalova, 1962; *G. discrata* Wang, 1974; *G. gaptankensis* Harlton 1928; *G. neglecta* Gaillot & Vachard (submitted); *G. parascaphoidea* Gaillot & Vachard (submitted); and *G. curiosa* Gaillot & Vachard in Gaillot et al. (submitted a).


Fourth group: *G. ex gr. spiralis*. Large species (D > 500μm) with unilayered dark wall and well-developed valvulae, with uncoiling and evolve last chambers. This group, relatively characteristic of the Late Pennsylvanian, is morphologically homogeneous, although the wall is microgranular in *G. nassichucki* and coarsely granular in *G. pergrata*. The members of this group are: *G. spiralis* Morozova, 1949; *G. nassichuki* Pinard & Mamet, 1998; *G. pergrata* Konovalova, 1962; *G. distensa* Wang in Zhao et al., 1981; *G. glo-merata* Ivanova, 1988; *G. orbiculata* Zolotova in Zolotova & Baryshnikov, 1980; *G. ovoidea* Zolotova in Zolotova & Baryshnikov, 1980; *G. pulchra* Reitlinger, 1950.

Fifth group: *G. ex gr. mosquensis*. Medium to large size species (D > 0.300 mm) with scarcely developed pseudofibrous internal layer: *G. mosquensis* Reitlinger, 1950; *G. syzranica* Reitlinger, 1950; *G. donbassica* Potievskaya, 1962; *G. cyprica* Reichel, 1946; *G. graeca* Reichel, 1946; *G. vonderschmitti* Reichel, 1946.


The question is to establish the real status of these groups due to the designation of the first one as the
distinct genus *Biseriella*. Theoretically, *Biseriella* differs from *Globivalvulina* by a microgranular wall versus a "diaphanothecal" wall. The generic modification was supposed to take place exactly at the Mid-Carboniferous Boundary. Rapidly, some problems have cropped up: (1) the genus *Biseriella* was criticized by Vachard (1977) and Altiner (1984), although the latter author accepted the genus in subsequent studies (e.g., Altiner & Savini, 1995); (2) assignments of species to both genera vary a lot according to the authors; (3) the revision of *G. bulloides*, the type species of *Globivalvulina*, by Brenckle (2005) did not confirm the existence of a true diaphanotheca in the wall, whereas *G. parva* was never revised. According to our observations, the so-called diaphanotheca is not a constant character among the *Globivalvulina*. Similarly, the double, pseudofibrous layer, affects only a part of the septa in the specimens and in each specimen only a part of the septa; e.g., in *G. graeca*, *G. vonderschmidtii*, *G. mosquensis* or *G. syzranica*. Brenckle (2005) doubted of the assignment of *G. mosquensis* and speaks about *Globivalvulina? mosquensis*, but the creation of a new genus for this species would be also questionable than that of *Biseriella*. Another problem: although they are very similar in coiling (last evolve chambers) and great size, and both signicantly different of *Globivalvulina bulloides*, the coeval *G. pergata* and *G. spiralis* (and its probable synonym *G. nassichuki*) differ completely between them by their wall microstructure (granular versus microgranular). Hence, we don’t know which type of objective criterion must be prioritized to create genera, subgenera, group of species, species or subspecies of Pennsylvanian *Globivalvulina*. Brenckle (2005, p. 13), with his options, must share the Reitlinger’s type material between several genera; for example, among the three type specimens of *Globivalvulina eogranulosa*, one should belong to *Biseriella*, the other one to *Globivalvulina*, and the last one was not revised. Similarly, the two specimens of the type material of *G. moderata* are assigned by Brenckle (2005) to *Biseriella* and *Globivalvulina*, respectively.

Thirty years after the creation of *Biseriella*, the type material of *Globivalvulina* *G. bulloides*, was revised. Contrary to the rules of the ICZN (International Code of Zoological Nomenclature), Brenckle (2005) has not selected an illustration of Brady (1876, Pl. 4, Fig. 14 = Brenckle, 2005, Pl. 7, Fig. 21 = herein Fig. 6. 20) as lectotype, but another specimen. Paradoxically, when the name of the species is *bulloides*, something which is only obvious in an axial section, Brenckle chosen a transverse section as lectotype. Furthermore, this lectotyp-
tion. Other hypotheses can be the deepening of the carbonate platforms (according to our observations in southern Urals), and/or the appearance of many upwellings or cold-currents as admitted by Weidlich (2002) or Samankassou (2002) in Oman and the Carnic Alps. Another explanation is the subduction of Urals, which destroyed many centers of speciation of the Pennsylvanian species and interrupted the communications between Tethys and North America. These communications and migrations of Tethyan microfauna to North America were nevertheless re-established as soon as the Midian/Capitanian with the migration of the Neoschwagerina up to the North American Craton, in Texas. Some recently published biseriaminoinds from the Middle Permian of Texas (Nestell & Nestell, 2006) exhibit Tethyan affinities, and have entirely modified our palaeobiogeographical knowledge about this world area.

Another groups can occupy more successfully the same biotopes. This hypothesis can be confirmed by the presence of globivalvulinds in confined environments in Afghanistan (Vachard, 1980). Conversely, this adaptation could permit to the globivalvulinds to survive at the PTB crisis (see below).

Species mentioned in the late Early Permian are G. apiciformis Zolotova in Zolotova & Baryshnikov, 1980; G. bulloides minima Zolotova in Zolotova & Baryshnikov, 1980; G. kungurenis Ignin (see Chuvashov et al., 1990); G. orbiculata Zolotova in Zolotova & Baryshnikov, 1980; G. ovoidea Zolotova in Zolotova & Baryshnikov, 1980; G. unciata Zolotova in Zolotova & Baryshnikov, 1980; apparently all belong to the group G. bulloides.

Verispira was described in the Artinskian of Queensland (Australia), but here also this unquestionable variation might be only intraspecific.

THE LOPINGIAN DIVERSIFICATION AND THE PTB

After the Pennsylvanian-Cisuralian diversification, and the Artinskian-Murgabian impoverishment, the diversification of the globivalvulinid is maximal (e.g., Altiner, 1997, Gaillot, 2006). In the Midian-Lopingian times (late Middle to Late Permian), the family Globivalvulinae can be subdivided into 4 subfamilies (Fig. 8): Globivalvulinae Reitlinger, 1950; Paraglobivalvulinae Gaillot & Vachard in Gaillot et al. (submitted b); Dagmaritinae Bozorgnia, 1973 (= Louisettiitinae Loeblich & Tappan, 1984); Paradagmaritinae Gaillot & Vachard in Gaillot et al. (submitted b). The three latter are characteristic of the interval Midian-Lopingian, and the two latter can be generated by the unique species G. cyprica (as partly suggested by Altiner, 1997). The ecological tolerance of the globivalvulines was emphasized by Vachard in Vachard & Montenat (1981, p. 70). The Late Permian forms are tolerant to the hypersalinity, but the habitus is nearly always restricted to the inner platforms, where other groups are diversified.

The Midian-Wuchiapingian Globivalvulininae are composed of Globivalvulina Schubert, 1921; Charliella Altiner & Ozkan-Altiner, 2001; Siphoglobivalvulina Gaillot & Vachard in Gaillot et al. (submitted b); Retroseptellina Gaillot & Vachard in Gaillot et al. (submitted b) (Fig. 12). The Globivalvulina include diverse forms corresponding to new or older representatives of three of the seven groups listed above: (a) the group G. bulloides, (b) the group G. parva = “Biseriella” (auctorum), with G. kantharensis for example, and (c) sporadically bilayered taxa as such G. cyprica, G. graeca and G. vonderschmitti. Three species, still nomina nuda, will be introduced by Gaillot & Vachard (submitted): G. neglecta, G. parascapephoidea and G. curiosa. This latter appears in South China below the lithostatigraphical limit of the PTB (Gaillot et al., submitted a), and, after calibration by the FAD of the conodont Hindeodus parvus, might indicate that the Globivalvulina survive in the earliest Triassic times. Charliella differs by its wall and the more triangular shape of the chambers. It is likely that this group has evolved from the G. vonderschmitti pool (Nestell, pers. communication), developing the angular periphery and thicker wall due the high-energy tidal shoal environments during the late Wuchiapingian. This adaptation may have occurred at least twice during the Permian, firstly during the Midian with Charliella rossa and later during the late Wuchiapingian. This genus exists in the Midian of Turkey (northwest Anatolia), Italy (Monte Facito), Sumatra and Cambodia, early Midian of Oman, late Capitanian of central Mexico, and Late Permian of Thailand (Gaillot, 2006 with references). It is probably present in Japan (Taishaku, Yabeina zone), Oman and late Wuchiapingian of Zagros, Fars and Abu Dhabi; Gaillot, 2006).

Siphoglobivalvulina, with two submitted species, has a granular wall and an aperture differing from that of Globivalvulina. Its distribution is late Midian-Lopingian from Zagros-Fars area (Iran) and Turkey (Hazro), Transcaucasia?, Montenegro, Italy, Hungary,
South China, central Japan, northern Thailand (Gaillot, 2006). Retroseptellina, with three already described species: R. globosa, R. decrouezae and R. nitida, is characterized by (a) the horizontally elongate coiling giving abnormally broad tests than in a true Globivalvulina, and (b) especially, by the backward curvature of the septa. It is Midian to Changhsingian in age, in southern Turkey, Thailand and Malaysia, Batain Plain (Oman). Transcaucasia, New Zealand, central Japan, Greece, South China, northern Italy, Iran, Saudi Arabia, and Hungary (see Gaillot, 2006, with references).

The Paraglobivalvininai are Globivalvulinae with entirely or almost entirely enveloping last chambers; i.e., they tend to a spherical shape. They exist some endoskeletal supplementary formations at the roof of the chambers, and a wall microgranular unilayered, occasionally with an Omphaloitis-like differentiation. The subfamily composition is: Septoglobivalvulina Lin, 1978; Paraglobivalvulina Reitlinger, 1965; Urushthenella Pronina-Nestell in Pronina-Nestell & Nestell, 2001; and Paraglobivalvulinoidea Zaninetti & Jenny-Deshusses, 1985. They exist during the Midian-Changhsingian in Tethys. Septoglobivalvulina is morphologically transitional between Globivalvulina and Paraglobivalvulina. It begins as a Globivalvulina and its last chamber envelops all the preceding ones. Paraglobivalvulina is accurately known from the work of Jenny-Deshusses (1983). Unlike Unal et al. (2003), we consider P. gracilis as very similar to the type-species P. mira. Paraglobivalvulinoidea is well separated from Paraglobivalvulina by the largest size and the details of the endoskeleton, while Urushthenella is only a Paraglobivalvulina with an Omphalotis-type wall.

The Dagmariinae Bozorgnia, 1973 nomen translata (ex family) are uncoiled biseriate (or exceptionally re-becoming biserially coiled) Globivalvulinae, with chambers often with horn-like lateral expansions, and a basal, simple aperture with valvula. They are composed of Sengoerina Altiner, 1999; Crescentia Ciarpica, Cirilli, Martini & Zaninetti, 1986; Dagmarita Reitlinger, 1965; Siphodagmarita Gaillot & Vachard in Gaillot et al. (submitted b); Bidagmarita Gaillot & Vachard in Gaillot et al. (submitted a); and Louisettita Altiner & Bronnimann, 1980. The genus Sengoerina is a Dagbivalvulina passing to a Dagmarita by the modification of the shape of the chambers. The type species is Midian in age, but unpublished material is present in the Murgabian of Afghanistan. Dagmarita was remarkably well described by Reitlinger (1965). Crescentia is a Dagmarita which recovers a coiled growth. Bidagmarita is larger than Dagmarita with a different wall. Louisettita is a Dagmarita with some additional elements of endoskeleton, still not entirely well interpretable. Siphodagmarita with Siphodagmarita vasleti Gaillot & Vachard in Gaillot et al. (submitted b) as type species, has a wall and an aperture of Siphoglobivalvulina but is rectilinear as a dagmaritini. The convergence with Palaeotextulariidae or Textulariidae is extreme in this case, and a possible Mesozoic form of this taxon has been denominated Textularia tetragonica by Arnaud-Vanneau (1980).

The Paradagmaritinae are a subfamily of Globivalvulinae characterized by a uncoiling more or less developed after an initial coiling generally slightly trochospiral. They are composed of Paradagmarita Lys in Lys & Marcoux, 1978, Paradagmaritopsis Gaillot & Vachard in Gaillot et al. (submitted a), Paradagmaritella Gaillot & Vachard (submitted), Paradagmacrusta Gaillot & Vachard (submitted); and Paremiratella Gaillot & Vachard (submitted).

Paradagmarita is well known, and remarkably abundant in Taurus and Zagros but still mentioned in several Neo-Tethyan areas. Its type of development (trochospiral biseriate becoming biseriate uncoiled) exists also in Paradagmaritella (with a granular wall) and Paradagmacrusta (with a thick crusta on the floor of the chambers, and because this supplementary crusta is a character apparently unique among the Biseriamminoidea). The last appeared genus of the lineage (Fig. 12), Paremiratella, is a homeomorph of Paradagmarita with an internal globivalvuline (Fig. 11), a short uncoiled part and a frequently microsparitized wall. It is homeomorph of some here above suggested Biseriammina.

**BIOSTRATIGRAPHY**

Globivalvulina? bristolensis is characteristic of the late Tournaisian (e.g., Devuyst, 2006). The sequence from late Ashbian to late Serpukhovian can probably be accurately biozoned and especially the Visean/Serpukhovian boundary (e.g., Kulagina and Gibshman, 2002). The Bashkirian is poorly divided by this group due to the good scales provided by the fusulinids. The Moscovian is well known, as well as the Kasimovian. No many changes in species composition are recorded to the Gzhelian-Sakmarian. The Artinskian-Murgabian is poorly zoned. The Midian-Lopingian is principally characterized by a strong
diversification of the Globivalvulinidae. The last species of *Globivalvulina, G. curiosa* Gaillot & Vachard in Gaillot et al. (submitted a) attains the summit of the Permian and might survive in the earliest Triassic? of South China at the base of the thrombolites lithostratigraphically assigned to the base of Triassic (investigation of conodonts in progress). In this species, the shape of the chambers is very irregular, hemispherical to semi-ovoid, as in the tests affected today by mechanic perturbations, hypersalinity or marine pollutions (e.g., Stouff et al., 1999; Armynot du Châtelet et al., 2004); abnormal chambers are located at the end of the coiling, at the beginning of the terminal whorl, or in the entire terminal whorl. According to colleagues of Lausanne, Switzerland (pers. comm.), more or less similar “crazy globivalvulines” exist in the Lopingian of Alborz (northern Iran). They might belong to *G. curiosa*. All the coeval “normal” globivalvulines of the literature are different, as well as the “Biseriella”. Because of their location in the PTB (Permian-
Triassic Boundary) levels, these forms are evidently upon the controls of the different geochemical shifts observed during this period.

Among the other Globivalvulininae, according to Gaillot (2006), Charliella altineri is characteristic of the late Wuchiapingian in Zagros and adjacent areas, and disappears just below the appearance of the Changhsingian marker Paradagmacrusta callosa, in southern Iran (Gaillot, 2006). Paraglobivalvulina is generally considered as a Late Permian indicator (Pronina, 1995), whereas in southern Iran (Zagros) the FAD of Paraglobivalvulina mira was suggested as late Capitanian in age (Baghbani, 1997), as well as the Hazro section (Taurus, southern Turkey), where P. mira is associated with the keriothecal fusulinid Chusenella aff. sinensis (Gaillot, 2006; Gaillot et al., submitted b) considered as Middle Permian in age (e.g., Leven, 1998). Paraglobivalvulinoïdes septulifer indicates the latest Changhsingian in Alborz (Bozorgnia, 1973), Italy (Pasini, 1985), Greece (Vachard et al., 1993), Himalaya (Lys et al., 1980), South China (Lin et al., 1990; Gaillot et al., submitted a), Thailand (Sakagami & Hatta, 1982, Yanagida et al., 1988), Transcaucasia (Pronina-Nestell & Nestell, 2001), Japan (Kobayashi, 1997, 1999), and Malaysia (Fontaine et al., 1994). Louisettita elegantissima, initially considered as late Changhsingian in Turkey (Altiner & Brönnimann, 1980), has a likely earlier FAD in the middle Wuchiapingian in Zagros and was found in late Changhsingian strata in South China (Gaillot et al., submitted a). An event with abundant Louisettita elegantissima and Dagmarita spp. corresponds to a major regional bloom in biseriamminoid species. Louisettita extraordinaria Gaillot & Vachard in Gaillot et al. (submitted b) has a range limited to another important event as it allows a direct correlation with sections towards the southeastern Turkey (e.g., Hazro) and possibly with the Changhsingian levels of Afghanistan (as a possible synonym of the Paradagmarita dubreuilli nomen nudum of Vachard, 1980). Finally in our investigations, three markers appear to be fundamental to attribute an interval to the late Changhsingian: (a) the calcareous algae Actractyliopsis lastensis, (b) the dagmartinin Louisettita extraordinaria, and (c) the last representative of the Paradagmarita lineage, Paradagmarita planispiralis Gaillot & Vachard in Gaillot et al. (submitted b).

The genus Paradagmarita and its subfamily characterize exclusively the Lopingian.

The stratigraphic distribution of Paradagmarita has been discussed: Dorashamian (Vachard et al., 2002) or late Dzhulfian-Dorashamian (Altiner, 1981). The Paradagmarita zone in Taurus (Turkey) is considered as Changhsingian/Dorashamian when associated with Louisettita (e.g., Altiner et al., 2000). Russian authors proposed an early Dzhulfian/Wuchiapingian Paradagmarita FAD (Kotlyar et al., 1989; Pronina, 1995). Herein, according to Gaillot (2006), the early Wuchiapingian-late

**Figure 12—Phylogeny of Paradagmaritinae (Gaillot and Vachard, submitted).** The Persian Gulf possibly acted as a radiative pole with a pool of initially endemic species that intermittently spread towards relatively closed palaeobiogeographic domains. The units (Gaillot, 2006) are regional subdivisions, not used in this synthetic paper.
Changhsingian distribution of Paradagmarita is admitted (Fig. 10). Contrary to the previous studies, this genus is not unique in this zone, and all a lineage with diverse genera can be reconstructed in this interval (Fig. 10). Paradagmarita simplex occurs in the lower part of the Wuchiapingian, above the Rectostipulina zone; Paradagmarita zaninettae could constitute the late Wuchiapingian representative of the Paradagmarita lineage that evolved from the early Wuchiapingian P. simplex to the Changhsingian P. monodi. This latter could be considered as the early/middle Changhsingian “turnover marker”, similarly to Paradagmaritella brevispira for the Wuchiapingian/Changhsingian transition. Paradagmarita planispiralis Gaillot & Vachard (submitted) is the most advanced form, with an almost planispiral coiling, and seems to be the last representative of the Paradagmarita lineage. P. monodi and P. planispiralis are especially abundant just before the Permian-Triassic boundary in the Zagros-Fars area and in Turkey. In these areas, the Permian-Triassic transition is characterized by abundant Paradagmarita monodi below the appearance of the classical thrombolites. The first appearance of Triassic fauna (such as the annelid Spirorbis phlyctae-na) confirms the transgressive character of the sedimentary cycle through the Permian-Triassic boundary interval and correlatable character of both events. A specimen of Paradagmarita monodi (it does not seem reworked) was found in the Permian-Triassic turnover (the end-Permian extinction), coinciding with the base of the thrombolitic beds. These different taxa permit to divided the early Wuchiapingian-late Changhsingian interval into four units IIB, IIIa, IVc, IVb (Fig. 10). A regional relay occurs between the Wuchiapingian pool of biseriamminoids (i.e., Paradagmarita, Paradagmaritella, Dagmarita, Louisettita) and the more advanced forms of the family in the basal part of the Changhsingian. This event might explain and solve the problem of the discussion about the FAD of the Paradagmarita genus.

Among the brother-genera, Paradagmaritella brevispira at Kuh-e Surmeh (Zagros, Iran) constitutes a good marker for the Wuchiapingian/Changhsingian transition, as indicated above A similar event has been observed within the Khuff succession of the Saudi Arabian subsurface (Gaillot, 2006). The genus Paradagmaritopsis with Paradagmaritopsis kobayashii has been documented in the Changhsingian of Japan and South China (Gaillot, 2006), and those latter taxa are distributed more or less abundantly up to the latest Changhsingian suggesting their belonging to a homogenous palaeogeographic unit with Iran. This homogeneity is nevertheless relative and the markers could also appear during the Wuchiapingian, with delayed appearances due to migration processes. A late Wuchiapingian age is here favored as the biseriamminoid bloom of the overlying unit is considered to be linked to a major transgressive event in the early Changhsingian. The first occurrences of Paradagmaritopsis kobayashii and Charliella altineri are also validated within this unit, as well as the LAD of Nanlingella simplex. Both genera Paradagmacrusta and Paremiratella revealed powerful concerning the correlations within the Changhsingian levels. Paradagmacrusta callosa, Louisettia ultima and the nodosarioid Aulacophloia martiniæ are the main early Changhsingian foraminiferal markers in Zagros (Gaillot, 2006).

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Biseriammina is apparently limited to the Urals. Similarly, G.? bristolensis is nearly confined to England and adjacent countries. Kokjubinidae sensu stricto exist from Kazakhstan to the USA and Canada but are very sporadically mentioned. The lineage Dzhamansorina-Globivalvulina was apparently found in different localities of western Europe, Ukraine, Kazakhstan and South China. Since the late Serpukhovian, many taxa seem to be cosmopolite. Koktjubina exotica is particularly puzzling because of its distribution in Kazakhstan and USA, without any specimens mentioned in well known areas such as Urals, North China or Japan. Late Carboniferous to Sakmariar taxa are especially known in Spitsbergen, Arctic Canada and Urals, but the same forms seem exist from the Carnic Alps (Austria) to New Mexico (USA) and Thailand (D.V. unpublished data).

The center of speciation/diversification of the Late Permian biseriamminoid markers is probably located within the Arabian platform interior (Zagros and Fars basins) and isolated during Wuchiapingian time (Gaillot, 2006). By means of the basal Changhsingian event and subsequent bloom, those markers likely spread over a larger palaeogeographic domain (Fig. 13). Midian to Lopingian taxa are generally endemic of Zagros, Taurus and South China; i.e., relatively con-

The presence of the genera *Paradagmaritopsis*, *Paradagmarita* and *Louisettita* in the Laren section (Guangxi, South China; Gaillot et al., submitted a) suggests that the Zagros area was periodically connected with the Laren foraminiferal fauna between two palaeogeographic domains that were relatively close to each other, without major oceanic barrier separating those domains (Fig. 13).

Because of the stenotopic and stenobath characters of its species, *Paradagmarita* indicates the continuity and the free communication in the Neo-Tethys seaway during the Changhsingian, and this latter genus seems to be characteristic of the Neo-Tethys because it is only mentioned in Italy (under some erroneous designations: *Paradagmarita evoluta* and *Paraglobivalvulina monodi*; Cirilli et al., 1998, p. 99; Jenny & Stampfli, 2000); Tunisia (Bir Mastoura borehole) as *Paradagmarita* sp. (Lys, 1988); Hungary, as *Globivalvulina cyprica* (Berczi-Makk et al., 1995, Pl. 5, Fig. 4); Greece: Hydra: Jenny & Stampfli (2000); central, eastern and southern Turkey: *Paradagmarita* n. gen. sp. 1, 2, 3 (Argyriadis & Lys, 1977), *Paradagmarita monodi*, *P. sp. 2*, *P. sp. 3* (Lys & Marcoux, 1978); *P. monodi*, *P. evoluta*, *P. lata* (Lys, 1988); *P. monodi*, *P. flabelliformis*, *P. sp.* (Zaninetti et al., 1981; Altiner, 1981, 1984; Koyluoglu & Altiner, 1989; Altiner et al., 2000; Jenny & Stampfli, 2000; Unal et al., 2003); Hazro as *P. sp.* (Lys, 1988) or as *Palaeotextularia* sp. (Canuti et al., 1970), and probabli Valvulinidae (Canuti et al., 1970); Armenia, Dorasham 2: *Paradagmarita* sp. (Pronina, 1988, 1989; Kotlyar et al., 1989); Oman *Paradagmarita* sp. (Lys in Montenat et al., 1977, but...
this reference is questionable, because Paradagmarita is here associated to Shanita, a late Midian marker, according to Vachard et al., 2002; Trucial Oman (Lys, 1988); Saudi Arabia: Paradagmarita flabelliformis, P. sp. (Manivit et al., 1986; Vaslet et al., 2005; Vachard et al., 2005); southern Iran (Argyriadias & Lys, 1977; Argyriadis, 1978; Lys, 1988; Baghbani, 1997; Altiner et al., 2000), and northern Iran (Okimura et al., 1985, Partoazar, 1995); central Mountains of Afghanistan: Paradagmarita dubreuilii nomen nudum (Vachard, 1980); Salt Range (Okimura, 1988, Fig. 3. 4: P sp.; Fig. 2: P. monodi; Jenny & Stampfli, 2000); Paradagmarita? is mentioned in Zanskar Himalaya by Jenny-Deshusses & Baud (1989, p. 885, 886), as well as “Crescentia” (sic) (ibidem, p. 887); Thailand (Fontaine et al., 1988: Khao Khan Ban Dai, near Prachuabkhirikhan; and Vachard, unpublished data: road N 323, just before the kilometer 22, at the NW of Kachanaburi); South China (Jenny & Stampfli, 2000; Gaillot et al., submitted a). The form of Japan (Iwai-Kanyo area; Chichibu Terrane): Paradagmarita sp. (Kobayashi, 1997, PI. 4, Fig. 19: 2004, Fig. 6.47-6.50) is in fact a Paradagmaritopsis. The absence of Paradagmarita monodi in South-China can be explained by strong infeodation to platform-interior environments (probably shallower and more restricted) that prevailed during the Late Permian onto the rimmed Arabian platform. Paradagmaritopsis is present in Zagros and Japan, as well two taxa described as Partisania sp. and Globivalvalina sp. by Kobayashi (2004), and renamed Partisania sp. and Floritheca variata n. gen. n. sp. (Gaillot, 2006; Gaillot & Vachard, submitted).

Louissettita is apparently confined to eastern Taurus, Zagros (Altiner, 1981; Gaillot, 2006), and Oman (but not illustrated: Pillevuit, 1993, p. 91), and is also present in South-China (Gaillot et al., submitted a). Charliella, Sengoerina, Siphoglobivalvalina and Siphodagmarita appear more endemic because they are apparently absent of South China. Paraglobivalvalinoides is mentioned in more localities from Italy to Japan: Italy (Tesero Member: Noé, 1987); Greece, Attica (Vachard et al., 1993), Evvia (Jenny-Deshusses & Baud, 1989); northwestern Caucasian (Kotlyar et al., 1999; Pronina-Nestell & Nestell, 2001); Armenia (Jenny & Stampfli, 2000); Alborz (Bozorgnia, 1973; Jenny & Stampfli, 2000); Abadeh (Baghiani, 1993; Jenny & Stampfli, 2000); Zagros (Baghiani, 1997; but not found during this study); Oman (Jenny & Stampfli, 2000); Ladakh Himalaya under the name of Paraglobivalvalina mira Reitlinger (Lys et al., 1980); S.E. Pamir (Kotlyar et al., 1999); Zanskar Himalaya (Jenny-Deshusses & Baud, 1989); Thailand (Toriyama, 1984): Paraglobivalvalina piyasini Sakagami & Hatta, 1982; South China with Paraglobivalvalina spumida (Lin et al., 1990); Japan (Kobayashi, 1997: under the name Paraglobivalvalina piyasini).

Hence, several taxa that seemed limited to the western Neo-Tethys, migrated finally to Japan. These taxa prove the existence of a continuous platform permitting the dispersion of these smaller foraminifers infeodated to very shallow environments and devoid of pelagic stage if compared with the modern similar forms. Alternatively, some terranes can present rapid and long travels, because the taxa in question are apparently absent in relatively well known areas such as Oman, Afghanistan or Pakistan, as well as South China or Thailand. The classical solutions in these cases are (a) gap of the geological record; (b) unfavourable lithologies and/or dissolution; (c) absence of a maximum flooding surface (MFS) or a precise parasequence, (d) unfavourable environments and/or substrates, (e) the favourable areas were destroyed and digested during obduction and/or subduction phenomena, (f) data of subsoil exploration are lacking. The solution to these problems is evidently fundamental for the palaeobiographical reconstructions.

Finally, the Globivalvalinidae can re-inforce the classical palaeobiographic markers, for example Shanita (e.g., Sengör et al., 1988; Ueno, 2003), Palaeofusulina and Colianiella (e.g., Kobayashi, 1999), and Paradagmarita (Sengör et al., 1988; Gaillot & Vachard, 2004). They indicate that the BaoShan Block (Yunnan) and Lhassa Block (Xizang) are related with to the Perigondwan border and/or a plate more or less directly related with to Gondwana. The North Chinese Tarim Basin and Kun-Lun Mountains are related to the Perihercynian Block because of the Visean foraminifers and calcareous algae palaeobiography, and the presence of Eopolydiexodina (e.g., Vachard & Bouyx, 2002). Intermediary plates of South China and Indoinsia are Cimmerian (according to the nomenclature of Sengör, 1979). Well constrained in latitude, these plates are not constrained in longitude and can be located in a more western location as generally reconstructed, and consequently almost in connection with Iran (see also the palaeomagnetic data of Besse et al., 1998). That explains also the many similarities between Viet-Nam and Greece, in the fusuline population of Sphaeroschwagerina, Zellia, Neoschwagerina, and Verbeekina.

If the blocks of North China and Mongolia are similarly displaced to the west, we can obtain a
CONCLUSIONS

1. The biseriamminoids are considered here as monophyletic, although rapidly divided in two lineages because (a) no transitional forms were ever observed between Biseriammina and Globivalvulina; (b) the wall of Biseriammina is similar to that of Granuliferella or Haplophragmella and entirely distinct from that of the globivalvulinds despite of the great variety of microstructures in this group. The first lineage would comprise forms mainly with coarsely granular wall: the Biseriamminidae with the Biseriammininae and Kottjubininae. The second lineage would be composed of forms exhibiting a microgranular wall: the Globivalvulinaidae.

2. Some problems concerning the origin of group can modify this interpretation: (a) the coiling of Biseriammina is most probably a double endothyroid coiling than a biseriate coiling; (b) primitive globivalvulinds are very similar (and often confused in the literature) with the tetrataxid Pseudotaxis which is probably truly their ancestor.

3. The suborder Palaeotextulariina Hohengger & Piller, 1975 is not admitted here, because of the presence of a terminal biseriate stage following many unlinked initial coiled parts (e.g., endothyrid, chernyshinellid, haplophragmellid).

4. The biseriamminids sensu stricto correspond to a group which is only Tournaisian and Visean in age and which have no descendence in the Pennsylvania or Permian. The biseriamminids sensu stricto are probably limited to Biseriammina and some very poorly known genera as such Globochernella or Lipinella.

5. Although relatively similar to the Biseriamminidae and Kottjubinidae by the type of wall and the biseriate chambers, Globispiroplectammina and Spireitlina are definitively excluded of their phylogeny.

6. No new genera are proposed in order to share the Globivalvulina genus, but we recommend putting in synonymy Biseriella and Globivalvulina up to a complete revision of the genus Globivalvulina because the specimens appear very variable among the populations. Nevertheless, Globivalvulina appears composed of six main groups of species according to the wall structure, test size, development of the valvulae, shapes of chambers, and apertural face. The six main groups are: G. ex gr. parva, G. ex gr. bulloidae, G. ex gr. granulosa, G. ex gr. spiralis, G. ex gr. mosquensis, and a unnamed group.

7. The Permian globivalvulinids can be subdivided into four subfamilies: Globivalvulinae, Paraglobivalvulinae, Dagmaritinae and Paradagmaritinae. Nevertheless, the two genera Siphoglobivalvulina and Siphodagmarita seem to be phylogenetically related to each other (due to the type of wall) whereas their morphologies must be separated, and related with Globivalvulina and Dagmarita respectively. Consequently, the independence and/or reality of the subfamilies Globivalvulinae and Dagmaritinae might be questioned due to these possible polyphyletisms (based on wall structure and morphology, respectively).

8. During the Late Permian (Lopingian), and as early as the late Middle Permian, the evolutive trends in the four subfamilies of globivalvulinds are as follows. Among the Globivalvulinae, (a) Globivalvulina subsisted but gave rise to three morphological differentiations: Retroseptellina, Charlillexa and Siphoglobivalvulina; (b) Retroseptellina shows a backward curvature of septa linked to a very slow increasing in height of the last chambers; (c) Charlillexa differs from Globivalvulina by the complex type of wall and the triangular shape of the chambers; and (d) Siphoglobivalvulina exhibits fundamentally a different, but also a more granular wall. The Paraglobivalvulinae confirm the tendency, appeared with (a) Septoglobivalvulina where the last chamber is very high and broad, and lead to (b) Paraglobivalvulina with a completely sphaerical, medium-sized test and chamberlets on the roof of the chambers, and to (c) Paraglobivalvulinoideas, where the test becomes very large and the apertural endoskeleton very complicated. The Dagmaritinae cannot derive from Crescentia, which is in fact, as indicated by each FAD, a secondarily coiled Dagmarita. Some forms without horny expansions can be mentioned, especially one form well characterized by its aperture: Siphodagmarita. Finally, an endoskeleton appears in this group with Louisetta. The Paradagmaritinae are very much diversified that indicated in the previous studies which were only concerned with Paradagmarita. P. flabelliformis was not encountered in our material indicating that the endemism is very important in this group. Similarly, some illustrations of Transcaucasia and NW Caucasus can correspond to
other unpublished taxa. However, the Paradagmarita of Pakistan as well as Thailand might be an advanced form of Charliella and not a true Paradagmarita. The unique citation in Oman is doubtful, and P. dubreilli in Afghanistan is most probably a Louisettita. Consequently, true Paradagmarita are limited to Saudi Arabia, Transcaucasia, NW Caucasus, and of course southern Turkey and Zagros. Nevertheless, very closely related forms are present in our material of South China (Gaillot et al., submitted a). The most interesting genus is Paradagmaritopsis whose distribution is Zagros, South China and Japan.

9. The phylogeny of Paradagmarita begins in the early Wuchiapingian with P. simplex which is unquestionably related with Globivalvulina (no with Dagmarita, contrary to the reconstruction of Altiner, 1997). The spire and the number of pairs of chambers increase in the following species: P. zaninettiae, which evolves progressively into P. cf. monodi, P. monodi (truly characteristic of Changhsingian) and P. planispiralis. Paradagmacrusta callosa is another characteristic species of the late Changhsingian. Exceptionally among the globivalvulinids, it exhibits crustae on the roof of the chambers. Two other index species are rarer: Paradagmaritella surmehensis and P. brevispira.

10. The Mississippian Biseriamminoidea appear as endemic, or with a surprising distribution (e.g., Koktjubina exotica). Some areas of Kazakhstan, Morocco and Ireland appear as the most important sectors for a detailed study of the Mississippian phylogeny.

11. The palaeogeographic distribution of selected Late Permian Globivalvulinidae: Paradagmarita, Paradagmaritopsis, Louisettita, Paraglobivalvulinoides, due to the necessity of the continuity of the carbonate platforms for the migration of foraminifers living in very shallow seas, permit to conclude that South China was closely located to Zagros and Turkey during the Late Permian, and maybe since the Early Carboniferous.

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