

A key to the unilocular hyaline Foraminifera

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ABSTRACT – The paper is an attempt to apply best taxonomic practice to a well delimited group of Foraminifera: the lagenids. Analysis results in the recognition of 20 characters, which are defined and described through an explicitly defined, consistent terminology. The database resulting from the scoring of characters of all the lagenid genera allows the construction of a set of identification keys and the production of a set of uniform, consistent diagnoses. *J. Micropalaeontol.* 24(2): 145–158, October 2005.

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INTRODUCTION

Identification of Foraminifera remains an awkward and haphazard process. Most researchers confronted with rows and rows of specimens have to resort to what can only be described as picture matching, i.e. refer to drawings, photographs and plates scattered over a wide literature, in the hope of finding more or less reasonable matches. It is, therefore, hardly surprising that the quality of identification has deteriorated to the point where different, separate studies can no longer be compared or relied upon with confidence. This highly unsatisfactory state of affairs is rather at variance with that encountered in many branches of invertebrate and vertebrate zoology and most of botany.

Apportioning blame is an unproductive process as it does not provide any means for improvement. It is obvious that foraminiferal taxonomists bear substantial responsibility for the situation, but it is less clear why it has happened. One tends to cite the high diversity of the Foraminifera, peer pressure on the kind of research activity, the poor state of education and the absence of effective support for taxonomic research as mitigating circumstances or, more unhappily, as excuses. Expediency led to skirting around these difficulties and opting for the crutch of more or less profuse illustrations. This very conveniently bypasses the difficult process of developing terminology and keys. It lulls both provider and user into a false sense of security, but, in actual fact, offloads the responsibility of taxonomic and morphological decisions onto every single user.

For taxonomic work to be useful (as well as of value in its own right), to allow people to identify their specimens with reasonable ease and reliability, a number of conditions have to be fulfilled. Interestingly enough, such utilitarian criteria also characterize high quality taxonomic research.

First, a clear and precise terminology is essential. The characters and character states have to be well defined, clearly understandable and, as far as possible, mutually exclusive. There should be no room for doubt in the mind of anyone having to choose which particular character state applies to the specimen at hand. The vocabulary may well be highly technical; as long as it is accompanied by a well-developed explanatory glossary, it will be useful and effective. If this part of the taxonomic research has been done properly, drawings and photographs can once again fulfil their original role of illustration, rather than propping up ineffective descriptions and diagnoses.

Such a vocabulary has to be used rigorously and consistently. Only then can descriptions, diagnoses and keys be read, applied and used in a routine manner. It also means that there is no room for extraneous, additional terminology or florid language. The temptation to temper the aridity of the descriptions should be resisted, as any such attempt will effectively undo the very aim for which the terminology was developed in the first place. The constant order of the characters and the recurrence of the same terms may well make for deadly prose, but it greatly facilitates comparison and reference.

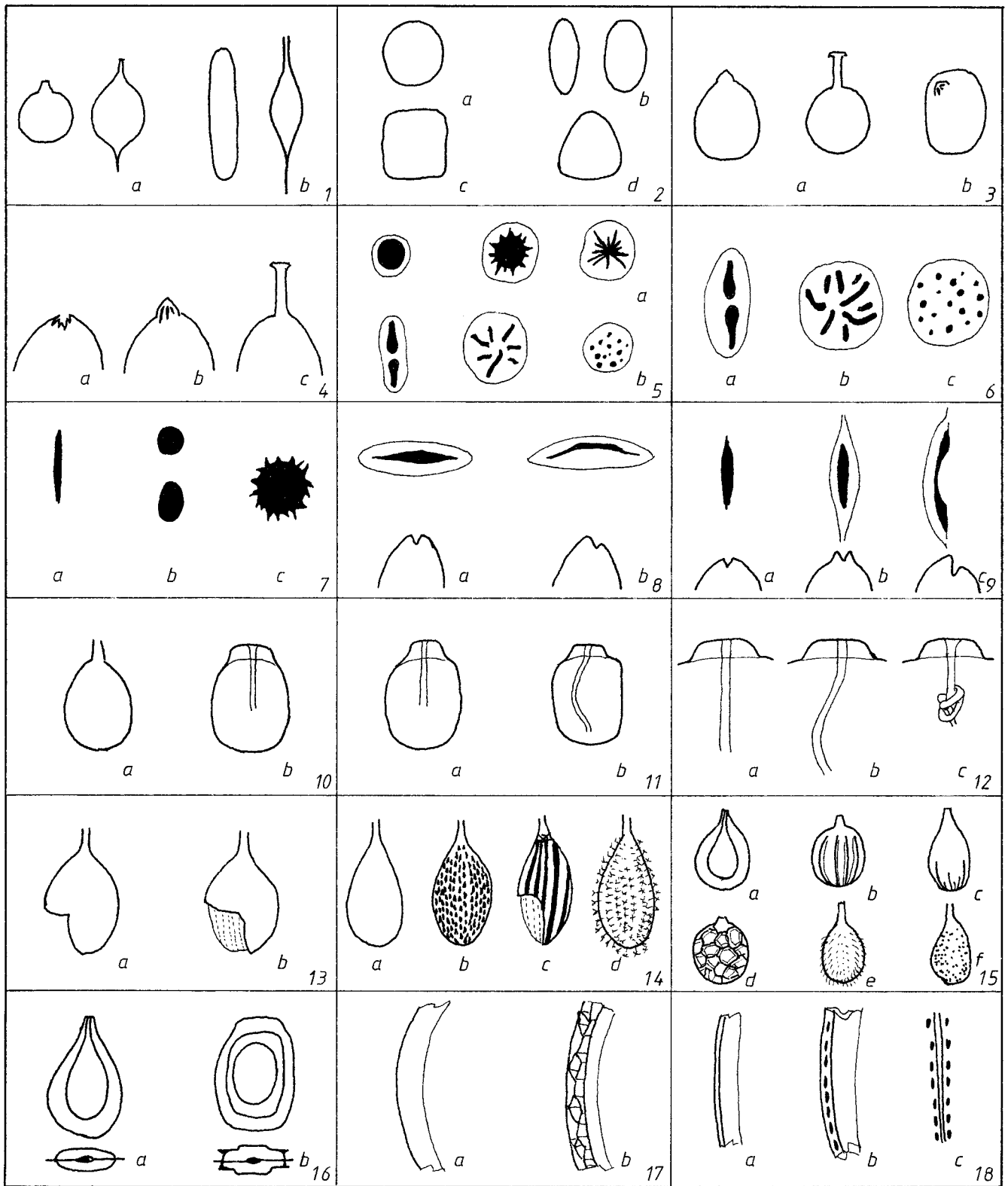
Thanks to the development of the DELTA coding system (Dallwitz, 1980; Dallwitz *et al.*, 1993), it has become much easier to implement and, especially, maintain the rigour and consistency of the application of terminology to descriptions.

THE LAGENIDS

The lagenids are not only very beautiful Foraminifera, they are also highly diverse. A number of landmark publications, notably Sidebottom (1912, 1913), Matthes (1939), Buchner (1940) and McCulloch (1977), demonstrate very graphically the richness of this group. These papers also provide a clear indication that this diversity cannot be covered adequately by two or three genera: *Lagena*, *Oolina* and *Fissurina* are insufficient to accommodate the many names proposed over the years. An estimate from the *Catalogue of Foraminifera* (Ellis & Messina, 1940) suggests there are around 1000 species names in the lagenids.

Parr (1947) attempted to deal with this diversity at the generic level, but acknowledged that his modest proposals still left the genera he recognized – *Lagena*, *Oolina*, *Fissurina* and *Parafissurina* – too large and too diverse. Nevertheless, his proposal was adopted unchanged by most students of the Foraminifera, notably by Loeblich & Tappan (1964) and by Haynes (1981).

Jones (1984) argued that the lagenids had been maintained as a separate entity because they were all unilocular. He pointed out that this arrangement disregarded their extraordinary diversity and failed to acknowledge their polyphyletic nature. By raising the taxonomic value of characters such as the nature and position of the aperture, the presence or absence of an entosolenian tube, as well as the overall shape of the test, relationships to other foraminiferal groups could be inferred. The result was a radically different suprageneric classification of the unilocular



Foraminifera, which ended up dispersed over lagenids, pleurostomellids, eouvigerinids, glandulinids, plectofrondiculariids, lingulinids and nodosariids. In the process, he recognized 13 new genera, most of which have been maintained and continue to be useful in accommodating the many lagenid species.

In an excellent series of papers, Patterson revised and maintained most of the generic proposals made by Jones, expanding further the generic diversity of the lagenids (Patterson & Richardson, 1987, 1988). However, he returned the suprageneric classification to a more traditional framework, with the Lagenidae made up of the subfamilies Lageninae, Ellipsolageninae and Sipholageninae (Patterson & Richardson, 1987). Loeblich & Tappan (1987) incorporated these proposals, although they raised the Ellipsolagenidae to full family status, with Ellipsolageninae, Oolininae, Parafissurinae and Sipholageninae as subfamilies.

Loeblich & Tappan (1994) maintained the usage of the lagenid genera as incorporated in their 1987 classification, adding a number of generic names which had become available in the intervening years. In contrast, Jones (1994) now considers most of the compressed lagenids with an entosolenian tube to belong in a single genus, *Fissurina*, irrespective of the exact nature or even presence of apertural necks, keels or ornamentation patterns. He justifies, with similar arguments, the lumping of most uncompressed entosolenian forms into *Oolina*.

By now, more than 40 genera spread over five families have been proposed and it is becoming difficult to assign a specimen at hand to the appropriate genus. In order to ease generic identification, this paper proposes a glossary (with the DELTA system in mind), documenting the terms used to describe the test of lagenid Foraminifera. The DELTA system was then applied to score all the lagenid genera using the terminology developed. The database thus compiled was then processed to produce keys and diagnoses.

At first, unaware of the existence of the extensive and detailed key published by Clark & Patterson (1993), the keys proposed here were built and derived independently. Comparing the keys reveals a number of differences, many of which are likely to make the present keys easier and more efficient in use.

The most obvious difference is that here three separate keys are put forward, one for each family. This has the immediate and considerable advantage of shortening any of the traverses of the keys required to arrive at an identification. The Clark–Patterson key has an average length of 7.23 steps, with a maximum of 11 steps. The longest key generated here has an average length of 3.9 steps, with a maximum of 6 steps. The keys are much shorter because efficient algorithms are used which rely on the distribution of the characters and their states (Dallwitz, 1974),

rather than on the tedious and very labour-intensive construction by hand. The Clark–Patterson key tends to eliminate a single taxon at a time from the remainder of the taxa, which leads to a longer tree, rather than looking for the most efficient way of partitioning the taxa into groups.

Closer scrutiny of the content of the couplets shows that the present keys also have the advantage of consistent and shorter choices.

The inclusion of a documented glossary of the terms used to describe the characters and their states is also an important difference. By bringing together the terms used in the key (and the descriptions), the user sees immediately the contrasting character states as the choices available, with the differences explained there and then. This has the considerable advantage of clarifying the choices to be made, helping to ensure that the correct choice is made.

CHARACTERS AND THEIR STATES

Despite the apparent simplicity of the single-chambered test of lagenids, about 20 characters have been extracted to arrive at a proper description. The characters fall into four groups: the overall shape of the test; the nature of the apertural complex, including details of the entosolenian tube; the nature of the test wall; and ornamentation of the test. The numbers included in brackets, following character states, refer to the schematic drawings comprising Plate 1.

1. Type species

It is often useful, especially from the perspective of a taxonomic database, to include purely taxonomic and nomenclatorial data. The type species is an essential element in the delineation and description of a genus.

2. Test in side-view

1. rounded (fig. 1a)
2. fusiform (fig. 1b)

The description of the overall shape of the test in a consistent and clear way is notoriously difficult and terminology is usually vague and difficult to apply. Here, the shape is divided over two states. Looking at the test from the side, rounded tests have a height: width ratio between 1: 1 and 3: 1; higher ratios are called fusiform.

3. Test in end-view

1. rounded (fig. 2a)
2. compressed (fig. 2b)
3. quadrangular (fig. 2c)
4. triangular (fig. 2d)

Explanation of Plate 1.

Schematic drawings of the character states. **1.** Test in side-view: (a) rounded; (b) fusiform. **2.** Test in end-view: (a) rounded; (b) compressed; (c) quadrangular; (d) triangular. **3.** Position of aperture: (a) terminal; (b) subterminal. **4.** Degree of production of aperture: (a) flush; (b) produced; (c) on a neck. **5.** Nature of aperture: (a) a single opening; (b) multiple openings. **6.** Nature of multiple openings: (a) double slit; (b) a few slits; (c) cribrate. **7.** Kinds of openings: (a) slit; (b) rounded opening; (c) radiate. **8.** Shape of slit: (a) bilaterally symmetric slit; (b) asymmetric slit. **9.** Lips around slit: (a) simple; (b) flanked by lips; (c) hooded. **10.** Entosolenian tube: (a) without tube; (b) with entosolenian tube. **11.** Entosolenian tube attachment: (a) tube free; (b) tube attached. **12.** Shape of entosolenian tube: (a) straight; (b) curved; (c) curled up. **13.** Layering of test wall: (a) a single layer; (b) a double layer. **14.** Type of outer wall: (a) continuous layer; (b) a coarse network; (c) parallel flat ribs; (d) dense cover of pillars. **15.** Type of ornamentation: (a) carinate; (b) costate; (c) striate; (d) reticulate; (e) hispid; (f) nodose. **16.** Number of carinae: (a) single carina; (b) multiple carinae. **17.** Complexity of carinae: (a) carina simple; (b) with tubes, struts or reticulations. **18.** Complexity of costae: (a) simple costae; (b–c) bridged or punctate.

The second descriptor of the test is the shape as seen from the apertural end. Interestingly, there are more differences in shape when looking at the test from this end.

4. Aperture – position

1. apical (fig. 3a)
2. subterminal (fig. 3b)

The aperture is nearly always at the top of the test; however, in *Obliquina* and *Ventrostoma*, it is placed well away from the apex.

5. Aperture – degree of production

1. flush with the test (fig. 4a)
2. produced (fig. 4b)
3. on a neck (fig. 4c)

A distinction is made between apertures which just protrude from the chamber (produced) and those which occur at the end of a clearly defined tubular neck.

6. Aperture – nature

1. a single opening (fig. 5a)
2. multiple openings (fig. 5b)

In some instances, radiating teeth around an aperture may grow across the opening and leave a set of radiate slit-like openings. Nevertheless, this kind of aperture should be distinguished carefully from one made up of true multiple slits: it belongs in the single opening type.

7. Aperture – multiple nature

1. a double slit (fig. 6a)
2. a few slits (fig. 6b)
3. cribrate (fig. 6c)

Multiple apertures are rare amongst the lagenids: in effect, each of the character states are characteristic for a single genus, respectively *Duplella*, *Rimulinoides* and *Cribrrolagena*.

8. Aperture – opening

1. a slit (fig. 7a)
2. a rounded opening (fig. 7b)
3. radiate (fig. 7c)

The distinction between slit and rounded opening, which includes elliptical openings, works well in practice as there are few, if any, borderline cases.

9. Aperture – shape of slit

1. slit bilaterally symmetric (fig. 8a)
2. slit asymmetric (fig. 8b)

Most apertures are at least bilaterally symmetric, but there are some of the slit-like apertures which have asymmetrically-built apertural lips.

10. Aperture – lips around slit

1. simple (fig. 9a)
2. flanked by lips (fig. 9b)
3. hooded (fig. 9c)

Slit-like apertures are usually flanked by lips. In some instances, one of the lips grows into a low arch, giving a hooded appearance to the aperture.

11. Entosolenian tube – presence

1. without entosolenian tube (fig. 10a)
2. with entosolenian tube (fig. 10b)

The presence or absence of an entosolenian tube is regarded by most as a valuable character. Patterson & Richardson (1987)

expressed doubt about the prominence given to it, claiming that it is not as constant in species as is generally assumed. Thanks to the study by Knight (1986), the nature of the entosolenian tube is now clear and can be recognized unambiguously.

12. Entosolenian tube – free-attached

1. free (fig. 11a)
2. attached (fig. 11b)

The tube may adhere to the lateral chamber wall over part or, indeed, over its entire length.

13. Entosolenian tube – shape

1. straight (fig. 12a)
2. curved (fig. 12b)
3. curled up (fig. 12c)

Attached entosolenian tubes often curve in various directions, with no particular relation to the test wall. In some instances, an almost knot-like coiling-up occurs.

14. Wall – nature of pores

1. normally perforate
2. with tubulopores

Nearly all lagenids have a standard perforate test wall. However, the genus *Globulospinella* has sets of well-developed tubulopores arranged in neat rows. Tubulopores are anatomical features which should be distinguished carefully from surficial ornamental features.

15. Wall texture

1. smooth
2. rugose

Most lagenids have a highly polished, glassy test wall. There are a number of taxa in which the test wall appears to be rugose, almost sucrosic. Bear in mind that opaque test walls are not necessarily rugose.

16. Wall layering

1. a single layer (fig. 13a)
2. a double layer (fig. 13b)

Most lagenids have a simple, single-layered wall. The studies by Moncharmont-Zei & Sgarrella (1978, 1980) have shown that some lagenids have modified their test wall, so that it is primarily two-layered. In contrast to the other Foraminifera, the two layers are clearly separated by strut-like pillars. As this surficial layer does not cover a possible neck, carinae or spines, it clearly is a modification of the lagenine test wall and not a separate, new kind of wall ultrastructure.

17. Outer wall type

1. a continuous layer (fig. 14a)
2. a coarse network (fig. 14b)
3. parallel flat ribs (fig. 14c)
4. dense cover of pillars (fig. 14d)

At this point in time, four different types of double wall have been discovered. Not surprisingly, these different types are used to diagnose and separate four genera.

18. Wall – ornamentation

1. unornamented
2. ornamented

Many lagenids are ornamented, at times with fantastic delicacy. The kinds of ornamentation are varied, but it quickly

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transpired from this study that a simple differentiation between ornamented and unornamented tests is very useful in the construction of keys.

19. Type of ornamentation

1. carinate (fig. 15a)
2. costate (fig. 15b)
3. striate (fig. 15c)
4. reticulate (fig. 15d)
5. hispid (fig. 15e)
6. nodose (fig. 15f)

The richness of ornament can be more or less covered by the six states singled out here. Of course, different kinds of ornament may well be present in one and the same taxon.

20. Carina – number

1. single (fig. 16a)
2. multiple (fig. 16b)

A recurrent ornamentation in especially laterally compressed forms is the presence of one or more lateral carinae. Somewhat surprisingly, there does seem to be taxonomic value in this character at the generic rank.

21. Carina – complexity

1. simple (fig. 17a)
2. with tubes, struts or reticulations (fig. 17b)

Close observation of carinae revealed that, in some instances, the adoral part appears to dedouble and to be subdivided into rounded to angular tubes, to the point of becoming coarsely reticulate.

22. Costae – complexity

1. simple (fig. 18a)
2. bridged or punctate (fig. 18b)

Two different types of more complex costae have been found. It is too early to speculate about their relation and the possible recognition of two separate states. One type has the costae with a single series of punctae in their middle, while the other type has a double series of punctae adjacent to each costa.

23. Family

1. Lagenidae
2. Ellipsolagenidae
3. Sipholagenidae

It is convenient to include in which higher taxon each genus belongs, for descriptive purposes. When constructing keys or diagnoses, it is easy to omit such characters from consideration.

24. Subfamily of Ellipsolagenidae

1. Oolininae
2. Ellipsolageninae
3. Parafissurininae

KEYS

Dallwitz (1974) developed the KEY program as part of his DELTA system. In a two-step process, the data in DELTA format are converted into a set of tabular or bracketed keys. During these conversions, characters can be given different weightings – even excluded – and a number of parameters can be set to influence the construction of the keys.

It came as a surprise that the families formed disjunct sets without intervention on the weighting of the characters or the

parameters controlling the key construction. To make the keys easier to use, the three families were then processed separately.

Family Key

- 1(0) Wall a single layer2
Wall a double layerSipholagenidae
- 2(1) Aperture with entosolenian tubeEllipsolagenidae
Aperture without entosolenian tubeLagenidae

Lagenidae

- 1(0) Aperture flush with the test, test fusiform *Rimulinooides*
Aperture produced 2
Aperture on a neck.....5
- 2(1) Aperture a single opening3
Aperture multiple openings4
- 3(2) Aperture a rounded opening; wall
ornamented *Conolagena*
Aperture radiate; wall unornamented *Reussolagina*
- 4(2) Aperture a few slits..... *Anturina*
Aperture cribrate..... *Cribrrolagena*
- 5(1) Test in end-view quadrangular *Tetragonulina*
Test in end-view rounded6
- 6(5) Aperture apical7
Aperture subterminal *Obliquina*
- 7(6) Test in side-view rounded.....8
Test in side-view fusiform *Procerolagena*
- 8(7) Wall normally perforate *Lagena*
Wall with tubulopores *Globulospinella*

Ellipsolagenidae

- 1(0) Aperture flush with the test2
Aperture produced..... 6
Aperture on a neck15
- 2(1) Test in end-view rounded.....3
Test in end-view compressed4
Test in end-view triangular *Galwayella*
- 3(2) Entosolenian tube free; wall ornamented *Exsculptina*
Entosolenian tube attached; wall
unornamented *Arthurina*
- 4(2) Wall unornamented.....5
Wall ornamented *Wiesnerina*
- 5(4) Aperture subterminal; a single opening; entosolenian
tube attached..... *Ventrostoma*
Aperture apical; multiple openings; entosolenian tube
free *Duplella*
- 6(1) Test in end-view rounded.....7
Test in end-view compressed.....11
Test in end-view quadrangular *Laculatina*
- 7(6) Aperture a slit8
Aperture a rounded opening10
Aperture radiate *Oolina*

- 8(7) Aperture a bilaterally symmetric slit; wall unornamented.....*Pseudoolina*
Aperture an asymmetric slit; wall ornamented.....9
- 9(8) Apertural slit flanked by lips; entosolenian tube straight.....*Cursina*
Apertural slit hooded; entosolenian tube curved.....*Parafissurina*
- 10(7) Wall unornamented.....*Heteromorphina*
Wall ornamented.....*Favulina*
- 11(6) Aperture a slit.....12
Aperture a rounded opening.....*Cerebrina*
- 12(11) Aperture a bilaterally symmetric slit.....*Fissurina*
Aperture an asymmetric slit.....13
- 13(12) Apertural slit flanked by lips; carina single.....14
Apertural slit hooded; carina multiple....*Pseudofissurina*
- 14(13) Entosolenian tube straight.....*Walterparria*
Entosolenian tube curved.....*Irenita*
- 15(1) Test carinate.....16
Test costate.....21
Test hispid.....*Pristinosceptrella*
- 16(15) Aperture a slit.....17
Aperture a rounded opening.....19
- 17(16) Aperture a bilaterally symmetric slit; entosolenian tube free.....18
Aperture an asymmetric slit; entosolenian tube attached.....*Pseudosolenina*
- 18(17) Carina single.....*Lagenosolenia*
Carina multiple.....*Palliolatella*
- 19(16) Carina simple.....20
Carina with tubes, struts or reticulations.....*Lagnea*
- 20(19) Carina single.....*Vasicostella*
Carina multiple.....*Buchnerina*
- 21(15) Costae simple.....*Homalohedra*
Costae bridged or punctate.....*Cushmanina*

Sipholagenidae

- 1(0) Outer wall a continuous layer.....2
Outer wall a coarse network.....*Sipholagena*
Outer wall parallel flat ribs.....*Pytine*
Outer wall dense cover of pillars.....*Nanosylvanella*
- 2(1) Without entosolenian tube; wall hispid..*Pygmaeoseistron*
With entosolenian tube; wall costate.....*Bifarilaminella*

DIAGNOSES

Having keyed out a particular genus, it is very useful to have a complete diagnosis of the taxon to verify and to confirm the

identification made. The following diagnoses have been generated with the DELTA package, from the character database. It includes the diagnoses of all the genera included. If a particular genus cannot be distinguished from a more senior taxon, or only insufficiently so, this is discussed in appended remarks.

The descriptions themselves provide a good illustration of the capabilities of the system. Note in particular the consistency in terminology and layout of the diagnoses. The designation of the type species of each genus is abbreviated as OD for original designation, OD(M) original designation through monotypy, and SD for subsequent designation.

Anturina Jones, 1984

Type species. *Anturina haynesi*, Jones, 1984. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; multiple openings; a few slits. Without entosolenian tube. Wall texture smooth; a single layer; unornamented.

Family. Lagenidae.

Remarks. *Anturina* is here maintained as a separate genus, but reclassified in the Lagenidae. When Jones proposed the genus, he described the presence of an entosolenian tube and a radiate aperture. He used the latter to differentiate his new genus from *Oolina*, which he regarded as closely allied. The incomplete description and illustrations led Loeblich & Tappan (1987) to retain the genus tentatively alongside *Oolina*.

The study by Knight (1986) included SEM observations of *Anturina haynesi*, demonstrating both the nature of the aperture and the absence of an entosolenian tube. What is still unclear is to what extent the aperture in *Anturina* differs from that in *Reussoolina*: it may well be the case that *Anturina* will have to be synonymized into *Reussoolina*.

Arthurina Jones, 1984

Type species. *Lagena depressa* Chaster, 1892. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; flush with the test; a single opening; a rounded opening. With entosolenian tube; tube attached; straight. Wall texture smooth; a single layer; unornamented.

Family. Ellipsolagenidae, Parafissurininae.

Remarks. Jones (in litt.) suggests synonymizing this genus back into *Oolina*, but the bean-like shape of the test and the attached entosolenian tube allow a sharp distinction to be drawn. As these characteristics are found in a number of species, the genus is maintained here.

Bifarilaminella Patterson & Richardson, 1988

Type species. *Lagena advena* Cushman, 1923. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening.

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With entosolenian tube; tube free; straight. Wall texture rugose; a double layer; outer wall a continuous layer; ornamented; costate; costae simple.

Family. Sipholagenidae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Pytine*. However, the nature of the outer wall is very different in the two groups: a continuous layer juxtaposed to the inner wall in *Bifarilaminella* against a covering of disjoint strips or net-like cover separated by struts or pillars from the inner wall in *Pytine*.

Buchnerina Jones, 1984

Type species. *Buchnerina iberica* Jones, 1984. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate; carina multiple; simple.

Family. Ellipsolagenidae, Oolininae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Fissurina*. The very different nature of the aperture encountered in the two genera is more important than the differences related to the carinae. Certainly, these differences are sufficient to maintain the taxa separate.

Cerebrina Patterson, 1986

Type species. *Cerebrina perplexa* Patterson, 1986. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; produced; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate and costate; carina single; simple; costae simple.

Family. Ellipsolagenidae, Ellipsolageninae.

Remarks. Jones (1994) proposed synonymizing this genus into *Fissurina*. The produced but rounded aperture differs from the slit-like aperture in *Fissurina* and the carinate patterns also seem to be consistently different. Therefore, the two taxa are tentatively retained here.

Conolagena Malumián, Nànez & Caramés, 1991

Type species. *Conolagena argentina* Malumián, Nànez & Caramés, 1991. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; ornamented; reticulate.

Family. Lagenidae.

Remarks. The initial proposal of this genus stressed the reticulate ornamentation pattern, but the produced nature of the

aperture instead of a neck is a better reason to separate this taxon from *Lagena*.

Cribrrolagena Jones, 1984

Type species. *Lagena ampulladistoma* var. *cribrostomoides* Cushman, 1913. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; multiple openings; cribrate. Without entosolenian tube. Wall texture smooth; a single layer; unornamented.

Family. Lagenidae.

Cursina Patterson & Richardson, 1988

Type species. *Cursina adornata* Patterson & Richardson, 1988. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; a slit; slit asymmetric; flanked by lips. With entosolenian tube; tube attached; straight. Wall texture smooth; a single layer; ornamented; carinate and reticulate; carina single; simple.

Family. Ellipsolagenidae, Parafissurininae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Oolina*. However, the asymmetric elongate slit is very different from the rounded radiate aperture encountered in *Oolina*, hence the two are retained as separate taxa.

Cushmanina Jones, 1984

Type species. *Lagena vulgaris* var. *desmophora* Rymer Jones, 1872. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; costate; costae bridged or punctate.

Family. Ellipsolagenidae, Oolininae.

Duplella Patterson & Richardson, 1987

Type species. *Duplella apexadina* Patterson & Richardson, 1987. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; flush with the test; multiple openings; a double slit. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; unornamented.

Family. Ellipsolagenidae, Ellipsolageninae.

Exsculptina Patterson & Richardson, 1988

Type species. *Lagena sidebottomi* Earland, 1934 (= *Lagena intermedia* Sidebottom, 1912). OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; flush with the test; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; costate; costae simple.

Family. Ellipsolagenidae, Oolininae.

Remarks. At first, Jones (1994) proposed synonymizing this genus in *Oolina*, but now (in litt.) suggests synonymizing it into *Fissurina*. The rounded shape of the chamber and the rounded nature of the aperture argue against inclusion in *Fissurina*, while the non-produced, non-radiate nature argues against inclusion in *Oolina*.

Favolagena Malumián, Nànez & Caramés 1991 (= *Lagena*)

Type species. *Lagena atilai* Bertels, 1964. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; ornamented; reticulate.

Family. Lagenidae.

Remarks. The genus is here synonymized into *Lagena*: the only difference between the two genera is the nature of the surficial ornamentation. In view of the variety of ornamentation encountered in *Lagena* species, it seems unwise to attach particular significance to the reticulate ornamentation pattern.

Favulina Patterson & Richardson, 1988

Type species. *Entosolenia squamosa* var. *gamma hexagona* Williamson, 1848. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; reticulate.

Family. Ellipsolagenidae, Oolininae.

Remarks. Jones (1994) proposed synonymizing this genus into *Oolina*. The rounded aperture rather than a radiate one suffices to separate the two genera.

Fissurina Reuss, 1850

Type species. *Fissurina laevigata* Reuss, 1850. OD(M).

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; produced; a single opening; a slit; slit bilaterally symmetric; flanked by lips. With entosolenian tube; tube free to attached; straight to curved. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Ellipsolageninae.

Galwayella Patterson & Pettis, 1986

Type species. *Lagena trigonoelliptica* Balkwill & Millett, 1884. OD.

Diagnosis. Test in side-view rounded; in end-view triangular. Aperture apical; flush with the test; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Oolininae.

Globofissurella Patterson, 1986 (= *Pseudoolina*)

Type species. *Globofissurella scotti* Patterson, 1986. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; a slit; slit bilaterally symmetric; flanked by lips. With entosolenian tube; tube attached; straight to curved. Wall texture smooth; a single layer; ornamented; costate; costae simple.

Family. Ellipsolagenidae, Ellipsolageninae.

Remarks. Jones (1994) proposed synonymizing this genus in *Pseudoolina*, and now (in litt.) suggests a synonymy with *Fissurina*. As the only difference between *Globofissurella* and *Pseudoolina* is the presence of ornamentation in the former, Jones' initial proposal of synonymy between *Globofissurella* and *Pseudoolina* is supported here.

Globulospinella Patterson, 1988

Type species. *Globulospinella porcupina* Patterson, 1988. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; ornamented; tubulopores.

Family. Lagenidae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Fissurina*. However, the uncompressed nature of the test and especially the presence of tubulopores are clearly sufficient to recognize the genus.

Heteromorpha Jones, 1984

Type species. *Oolina heteromorpha* Parr, 1950. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; unornamented.

Family. Ellipsolagenidae, Oolininae.

Unilocular foraminifera key

Homalohedra Patterson & Richardson, 1988

Type species. *Lagena guntheri* Earland, 1934. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; costate; costae simple.

Family. Ellipsolagenidae, Oolininae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Oolina*. The aperture in *Homalohedra* is developed into a neck, rather than just produced above the test. The presence of ornamentation is an additional characteristic with which to separate the two taxa.

Hyalinonetrion Patterson & Richardson, 1988 (= *Procerolagena*)

Type species. *Hyalinonetrion sahalense* Patterson & Richardson, 1988. OD.

Diagnosis. Test in side-view fusiform; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; unornamented.

Family. Lagenidae.

Remarks. Jones (1994) proposed synonymizing *Hyalinonetrion* into *Procerolagena*, but is now of the opinion that *Procerolagena* should be synonymized into *Lagena*, while *Hyalinonetrion* should be maintained as a genus in its own right. The genus is here tentatively included in the senior *Procerolagena*: the only difference between the two taxa is the presence of more or less well developed longitudinal striae. In view of the variation of this type of ornamentation in the closely allied *Lagena*, it seems unwise to recognize a separate genus on these grounds.

Irenita Jones, 1984

Type species. *Lagena cornigera* Buchner, 1940. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; produced; a single opening; a slit; slit asymmetric; flanked by lips. With entosolenian tube; tube attached; curved. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Parafissuriniinae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Fissurina*. The asymmetric nature of the apertural slit and the protrusion and extension of the apertural lips are very different from the simple, symmetric aperture in *Fissurina*, and the genera are therefore maintained.

Laculatina Patterson & Richardson, 1988

Type species. *Lagena quadrilatera* var. *striatula* Earland, 1934. OD.

Diagnosis. Test in side-view fusiform; in end-view quadrangular. Aperture apical; produced; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; striate.

Family. Ellipsolagenidae, Oolininae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Fissurina*. However, the elongate quadrate shape of the test, as well as the round aperture, are very different from what is encountered in *Fissurina*. The genus is therefore maintained.

Lagena Walker & Jacob in Kanmacher, 1798

Type species. *Serpula (Lagena) sulcata* Walker & Jacob in Kanmacher, 1798. SD, Parker & Jones, 1859.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; usually ornamented; costate, or striate; costae simple.

Family. Lagenidae.

Lagenosolenia McCulloch, 1977

Type species. *Lagenosolenia soulei* McCulloch, 1977. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a slit; slit bilaterally symmetric; flanked by lips. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Ellipsolageninae.

Remarks. Jones (1994) proposed synonymizing this genus into *Fissurina*. The apertural complex in this genus is, however, quite unusual, as it combines the presence of a distinct neck with a surprisingly narrow elliptical slit. As such, it certainly deserves generic recognition.

Lagena Popescu, 1983

Type species. *Fissurina radiata* Seguenza, 1862. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate; carina single to multiple; with tubes, struts or reticulations.

Family. Ellipsolagenidae, Oolininae.

Remarks. Jones (1994) proposed synonymizing this genus into *Fissurina*. However, the presence of a neck on which the rounded aperture is placed differs from the produced slit-like aperture encountered in *Fissurina*. Furthermore, at times the complex structuring of the lateral carinae transcends the notion

of mere ornamentation. The genus certainly deserves to be maintained in its own right. The genus *Solenina* has been included in *Lagnea* by Loeblich & Tappan (1987), a proposal that has been supported consistently ever since.

Nanosylvanella Patterson, 1990

Type species. *Nanosylvanella palmulina* Patterson, 1990. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture rugose; a double layer; outer wall dense cover of pillars; unornamented.

Family. Sipholagenidae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Sipholagena*. However, the absence of an entosolenian tube and the very different nature of the outer wall are sufficient to maintain the two groups as separate taxa.

Obliquina Seguenza, 1862

Type species. *Obliquina acuticosta* Seguenza, 1862. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture subterminal; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; ornamented; striate.

Family. Lagenidae.

Oolina d'Orbigny, 1839

Type species. *Oolina laevigata* d'Orbigny, 1839. SD, Galloway & Wissler, 1927.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; radiate. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; unornamented.

Family. Ellipsolagenidae, Oolininae.

Palliolatella Patterson & Richardson, 1987

Type species. *Palliolatella avita* Patterson & Richardson, 1987. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a slit; slit bilaterally symmetric; flanked by lips. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate; carina multiple; simple.

Family. Ellipsolagenidae, Ellipsolageninae.

Remarks. Jones (1994) proposed synonymizing this genus into *Fissurina*. However, the presence of a neck, in conjunction with

the systematic presence of multiple carinae, set it well apart from *Fissurina*.

Parafissurina Parr, 1947

Type species. *Lagnea ventricosa* Silvestri, 1904. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; a slit; slit asymmetric; hooded. With entosolenian tube; tube attached; curved. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Parafissurininae.

Pristinosceptrella Patterson & Richardson, 1987

Type species. *Pristinosceptrella hispida* Patterson & Richardson, 1987. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture rugose; a single layer; ornamented; hispid.

Family. Ellipsolagenidae, Oolininae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Lagnea*. The presence of an entosolenian tube firmly puts this taxon in the Ellipsolagenidae, rather than the Lagenidae.

Procerolagena Puri, 1954

Type species. *Lagnea gracilis* Williamson, 1848. OD.

Diagnosis. Test in side-view fusiform; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; ornamented; striate to costate; costae simple.

Family. Lagenidae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Lagnea*, whereas before (Jones, 1994), he synonymized *Hyalinotrion* into *Procerolagena*, a genus he now appears to recognize. As discussed under *Hyalinotrion*, I recognize *Procerolagena* as a genus in its own right, alongside *Lagnea*. The highly elongate, fusiform shape of the test, usually with a very drawn-out aboral end as well, differs enough from the rounded, flask-shaped *Lagnea* to receive taxonomic recognition.

Pseudofissurina Jones, 1984

Type species. *Pseudofissurina mccullochae* Jones, 1984. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; produced; a single opening; a slit; slit asymmetric; hooded. With entosolenian tube; tube attached; straight. Wall texture smooth; a single layer; ornamented; carinate; carina multiple; simple.

Family. Ellipsolagenidae, Parafissurininae.

Unilocular foraminifera key

Pseudoolina Jones, 1984

Type species. *Pseudoolina fissurinea* Jones, 1984. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; a slit; slit bilaterally symmetric; flanked by lips. With entosolenian tube; tube attached; straight. Wall texture smooth; a single layer; unornamented.

Family. Ellipsolagenidae, Ellipsolageninae.

Pseudosolenina Jones, 1984

Type species. *Pseudosolenina borealis* Jones, 1984. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a slit; slit asymmetric; flanked by lips. With entosolenian tube; tube attached; straight. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Parafissuriniinae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Fissurina*. The peculiar organization of the apertural complex, in particular the asymmetric nature of the lips, leading to an almost hooded appearance, as well as the accentuation of the entosolenian tube on the surface of the chamber wall, set it apart from *Fissurina*.

Pygmaeosestron Patterson & Richardson, 1988

Type species. *Lagena hispidula* Cushman, 1913. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture rugose; a double layer; outer wall a continuous layer; ornamented; hispid (finely).

Family. Sipholagenidae.

Remarks. Jones (1994) proposed synonymizing this genus into *Lagena*, and now (Jones, in litt.) into *Sipholagena*. Neither of these proposals can be maintained: the presence of an entosolenian tube in *Sipholagena* and of an outer wall making an incomplete cover for the inner test wall, separated by struts, clearly differentiates it from *Pygmaeosestron*. In turn, the double test wall sets it apart from *Lagena*.

Hottinger *et al.* (1993) showed the double nature of the test wall in this genus. In contrast, nearly all the species attributed to this genus by Loeblich & Tappan (1994) belong elsewhere, most in *Lagena*. Identification of this genus is difficult, as the double nature of the test wall requires careful scrutiny.

Pytine Moncharmont Zei & Sgarrella, 1978

Type species. *Pytine parthenopeia* Moncharmont Zei & Sgarrella, 1978. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a double layer; outer wall parallel flat ribs; ornamented; costate; costae simple.

Family. Sipholagenidae.

Reussoolina Colom, 1956

Type species. *Oolina apiculata* Reuss, 1851. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; produced; a single opening; radiate. Without entosolenian tube. Wall texture smooth; a single layer; unornamented.

Family. Lagenidae.

Rimulinoides Saidova, 1975

Type species. *Rimulinoides elongatus* Saidova, 1975. OD.

Diagnosis. Test in side-view fusiform; in end-view rounded. Aperture apical; flush with the test; multiple openings; a few slits. Without entosolenian tube. Wall texture smooth; a single layer; unornamented.

Family. Lagenidae.

Sipholagena Moncharmont Zei & Sgarrella, 1980

Type species. *Lagena benevestita* Buchner, 1940. OD.

Diagnosis. Test in side-view rounded; in end-view rounded. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a double layer; outer wall a coarse network; unornamented.

Family. Sipholagenidae.

Solenina Jones, 1984 (= *Lagena*)

Type species. *Lagenosolenia tenuistriatiformis* McCulloch, 1977. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate (may be costate or striate as well); carina single or multiple; with tubes, struts or reticulations.

Family. Ellipsolagenidae; Oolininae.

Remarks. Jones (1994) proposed synonymizing this genus into *Fissurina*, but Loeblich & Tappan (1987) pointed out that *Solenina* cannot be distinguished from *Lagena*.

Tetragonulina Seguenza, 1862

Type species. *Tetragonulina prima* Seguenza, 1862. OD.

Diagnosis. Test in side-view rounded; in end-view quadrangular. Aperture apical; on a neck; a single opening; a rounded opening. Without entosolenian tube. Wall texture smooth; a single layer; unornamented.

Family. Lagenidae.

Tortaguttus Barrick, Beverage, Patterson & Schubert, 1989
(= *Lagnea*)

Type species. *Entosolenia sigmoidella* var. *timmsensis* Cushman & Gray, 1946. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate; multiple carinae, carinae with struts or reticulations.

Family. Ellipsolagenidae, Oolininae.

Remarks. The type species of this genus is indistinguishable from *Lagnea*. The only difference that can be seen is the twisted appearance of the test, a feature that cannot be given taxonomic value, certainly not at generic level. Note that Patterson & Richardson (1987) attributed *E. timmsensis* to *Solenina*, a genus later synonymized into *Lagnea*.

Vasicostella Patterson & Richardson, 1987

Type species. *Lagnea vulgaris* var. *helophoromarginata* Rymer Jones, 1872. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; on a neck; a single opening; a rounded opening. With entosolenian tube; tube free; straight. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Oolininae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Fissurina*. The nature of the apertural complex, the presence of a neck with the aperture a rounded opening, rather than being just produced and a narrow elongate slit, are sufficiently important to distinguish the two taxa.

Ventrostoma Schnitker, 1970

Type species. *Lagnea fovigera* Buchner, 1940. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture subterminal; flush with the test; a single opening; a rounded opening. With entosolenian tube; tube attached; curved. Wall texture smooth; a single layer; unornamented.

Family. Ellipsolagenidae, Parafissurininae.

Walterparria Jones, 1984

Type species. *Lagnea millettii* Chaster, 1892. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; produced; a single opening; a slit; slit asymmetric; flanked by lips. With entosolenian tube; tube attached; straight. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Parafissurininae.

Wiesnerina Jones, 1984

Type species. *Lagnea unguis* Heron-Allen & Earland, 1913. OD.

Diagnosis. Test in side-view rounded; in end-view compressed. Aperture apical; flush with the test; a single opening; a rounded opening. With entosolenian tube; tube attached; curved. Wall texture smooth; a single layer; ornamented; carinate; carina single; simple.

Family. Ellipsolagenidae, Parafissurininae.

Remarks. Jones (in litt.) suggests synonymizing this genus into *Fissurina*. The fact that the aperture is flush with the test surface and is a simple rounded opening differs enough from the produced, slit-like aperture in *Fissurina* to distinguish the two taxa. The peculiar, almost bean-shaped nature of the test is also very effective in separating this genus from the rounded, button-like *Fissurina*.

DISCUSSION

The trend to recognize more genera to accommodate the diversity of the lagenids was initiated by Jones (1984) in his seminal paper and taken further by the efforts of Patterson and his colleagues (Patterson & Richardson, 1987, 1988). Their proposals were well received and quickly incorporated in taxonomic compendia as well as in large faunal studies.

In his publication on the *Challenger* Foraminifera, Jones (1994) went against this trend, signalling implicitly a major change in his views of the lagenids. He confirms this change of mind (in litt.), stating that the differentiation of entosolenian tube-bearing compressed forms with slit-like to sub-rounded apertures with or without necks or keels is almost arbitrary and that such forms should be included in *Fissurina*. This proposal reduces some 13 generic names to a synonym of *Fissurina*. Applying the same reasoning to rounded entosolenian forms, and disregarding in particular any differences in ornamentation patterns, reduces another four genera to synonyms of *Oolina*.

Having had the privilege of seeing the 18 000 lagenid specimens from the Thornhill collection (now in the collections of the Natural History Museum, London), studied by Sidebottom (1912, 1913) in his publications on the Lagenae of the South-West Pacific, the author can see substantial merit in the recognition of many of the genera proposed. Experience leads to a disagreement with the view that the nature of an apertural neck, the definition of a slit-like aperture and the like are arbitrary. It is true that every now and then, the odd specimen

will refuse to fall neatly into one or the other category: that does not mean that a continuum exists between these categories. The presence of outliers does not invalidate the recognition of clusters; and taxa are usefully seen as cluster concepts.

The nature of ornamentation and the way in which it might be used to deal with lagenid diversity remains problematic. Experience with most foraminifera shows that costae, striae and spinosity are characteristics which may be used to differentiate, at most, species, but not taxa of higher rank. Accordingly, *Hyalinonetrion* species are nothing but striate *Procerolagena* species and there is no need to maintain a separate genus for them.

In contrast, the nature of the carina is much more difficult to assess. As is the case for most features of the foraminiferal test, the function of a carina is not understood. The modifications of carinae in *Lagnea*, with their honeycomb-like subdivisions of the intercarinate space, or the exhaust-like tubular folds of lateral carinae, seem too intricate and too complex to be regarded as ornamentation. The same doubts arise regarding the nature, and status, of the regular pits along the costae in *Cushmanina*.

These considerations have led to adoption here of the more cautious path of maintaining most of the genera proposed. As is clear from the keys, and underlined by the remarks complementing the diagnoses, ornamentation by itself is not used as the main reason to maintain a genus. How well the diversity of the lagenids is served by the existing taxonomic framework shall become clear through usage. This paper is meant to help this process of assessment along by providing an accessible and practical guide to these beautiful foraminifera.

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