

A key to the identification of agglutinant and monothalamous foraminifera from Brazilian mangroves

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ABSTRACT

Identification keys are essential tools to guarantee higher precision during the taxonomic work. However, such keys are rare for foraminifera and often encompass a restrict group of species from a given geographic region. Thus, the taxonomic identification process usually occurs by visual comparison and by verifying the description of morphological attributes, which requires the previous knowledge of the species before identification. The use of an identification key seeks to help in this crucial step and contribute to the best taxonomic precision, which errors may propagate in the subsequent analyses that are supported by estimations on species richness and abundances. Moreover, it constitutes an extra tool to assist in the training of new researchers. This paper brings an identification key for agglutinant and monothalamous foraminifera from Brazilian mangroves, considering 50 genera and 91 species.

Descriptors: Foraminifera, Systematics, Mangrove, Identification key.

INTRODUCTION

Accurate taxonomic identification is a crucial step in research involving community ecology. Taxonomic errors can propagate along a chain of analysis, when ecological indices, transfer functions and statistical calculations differentiate taxonomic groups, and even over time if a particular work becomes a reference for other researchers to identify species (Wu, 1982; Bortolus, 2008; Payne et al., 2011; Vink et al., 2012). Such consequences can lead to inaccurate or erroneous interpretations of recent and past environmental scenarios and may lead to improper decisions about environmental management when they are

based on indicators such as species richness, abundance and diversity. In the case of using indexes such as Shannon (H'), both underestimation and overestimation of rare species significantly impact the value of diversity, as this index applies the logarithm on relative abundance and thus reduces the algebraic difference between dominant species and rare species (Magurran and McGill, 2011).

The use of recent foraminifera as bioindicators has been proposed for several purposes (Scott et al., 2001; Yanko et al., 2003; Murray, 2006; Alve et al., 2009; Sabeen et al., 2009; Frontalini et al., 2009; Bouchet et al., 2012; Alve et al., 2019). Although some species are recognized relatively easily, there are cases where only the detailed analysis of morphological attributes will ensure correct identification. Recently, the development of environmental DNA (eDNA) detection tools has pointed to new challenges in the field of taxonomy for foraminiferal species identification and estimating diversity (Pawlowski et al., 2014, 2016;

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Siemensma et al., 2017). However, in most cases, the identification of foraminifera species is based on the visual comparison between the test and images published in the literature, in addition to the observation of specific morphological characteristics described in detail in some classical references. However, these references do not provide species identification keys, and consulting their content usually requires pre-identification of the test in question.

Identification keys are handy tools in training researchers for taxonomy as well as for harmonizing species identification/taxonomic levels. Although certain areas of knowledge widely use these tools, such as Botany, there are few keys available about foraminifera (e.g., Todd and Low, 1981; Clark and Patterson, 1993; Revets, 2005). In this perspective, the present work proposes a key for the identification of Brazilian mangrove agglutinant and monothalamous foraminifera, aiming to contribute to the harmonization between research groups and results in the identification of species, as well as assisting in the training of new researchers.

MATERIAL AND METHODS

The construction of the identification key started from the creation of a database of occurrence of agglutinant and monothalamous foraminifera species from Brazilian mangroves. Therefore, it includes only articles published in national and international scientific journals, raised from searches in the main platforms of scientific publication available in Periódicos Capes (www.periodicos.capes.gov.br), totaling 19 productions (17 articles, one book chapter and one seminar paper in conference proceedings). The species list reported only for samples collected at mangroves in these papers was compiled, and then the key was constructed to the genus level. For each genus it is also listed the species respectively found in Brazilian mangroves. The construction of the key up to the genus aimed to make it less complex, and the identification of the species should be accompanied by consulting the literature where there are descriptions and images, in addition to the fact that some genera are represented by only one species.

Given that the purpose of this key is to help the researcher correctly identify a species based on the visualization of the test, the key refers to only the morphological attributes that are visible and distinguishable under the stereomicroscope. The organization of the morphological attributes of the species is based on compilation and systematic work of foraminifera that serve as

reference for several works (e.g. Ellis and Messina, 1940 et seq.; Closs, 1962; Boltovskoy et al., 1980; Loeblich and Tappan, 1988; Brönnimann et al., 1992; Hayward and Hollis, 1994; Hayward et al., 1999; Scott et al., 2001; Sen Gupta, 2003; Debenay, 2013). In addition to the identification key, species systematics was also organized with hierarchical levels harmonized with the World Foraminifera Database platform (Hayward et al., 2019).

THE IDENTIFICATION KEY

The key includes 50 genera, which in turn covers 91 species. The key is binary-type, i.e., only two answers are possible and are mutually exclusive. The identification pathways follow steps referenced with numbers. Each step can result in the identification of a genus (so, the identification pathway finishes) or in the indication of the next step to be consulted. In the case of the announced feature coincides with that observed by the researcher, the pathway indicate: "go to 'number'". The entry number in the step is followed by another in parentheses, which indicates which is the previous step to reach that point of the pathway (e.g., '36 (32)': indicates that the researcher has reached step #36 from step #32). Thus, if the identification finishes and does not match the test under observation, it is possible to return to the previous steps and look for alternatives. The images of most of species can be found in plates II, III and III (see Systematics section).

1. Uncoiled test (uniserial, biserial or triserial arrangement) – go to **2**.

Coiled test (trochospiral, planispiral or streptospiral. The coiled portion can be followed by a uniserial, biserial or triserial portion) – go to **26**.

2 (1). Unilocular test – go to **3**.

Multilocular test – go to **14**.

3 (2). Test without wall projections – go to **4**.

Test with wall projections – go to **9**.

4 (3). Test rectilinear tubular – genus *Bahianotubus*.

Test with another shape – go to **5**.

5 (4). Test fusiform – genus *Bahianofusus*.

Test with another shape – go to **6**.

6 (5). Globular test – genus *Blysmasphaera*.

Test with another shape – go to **7**.

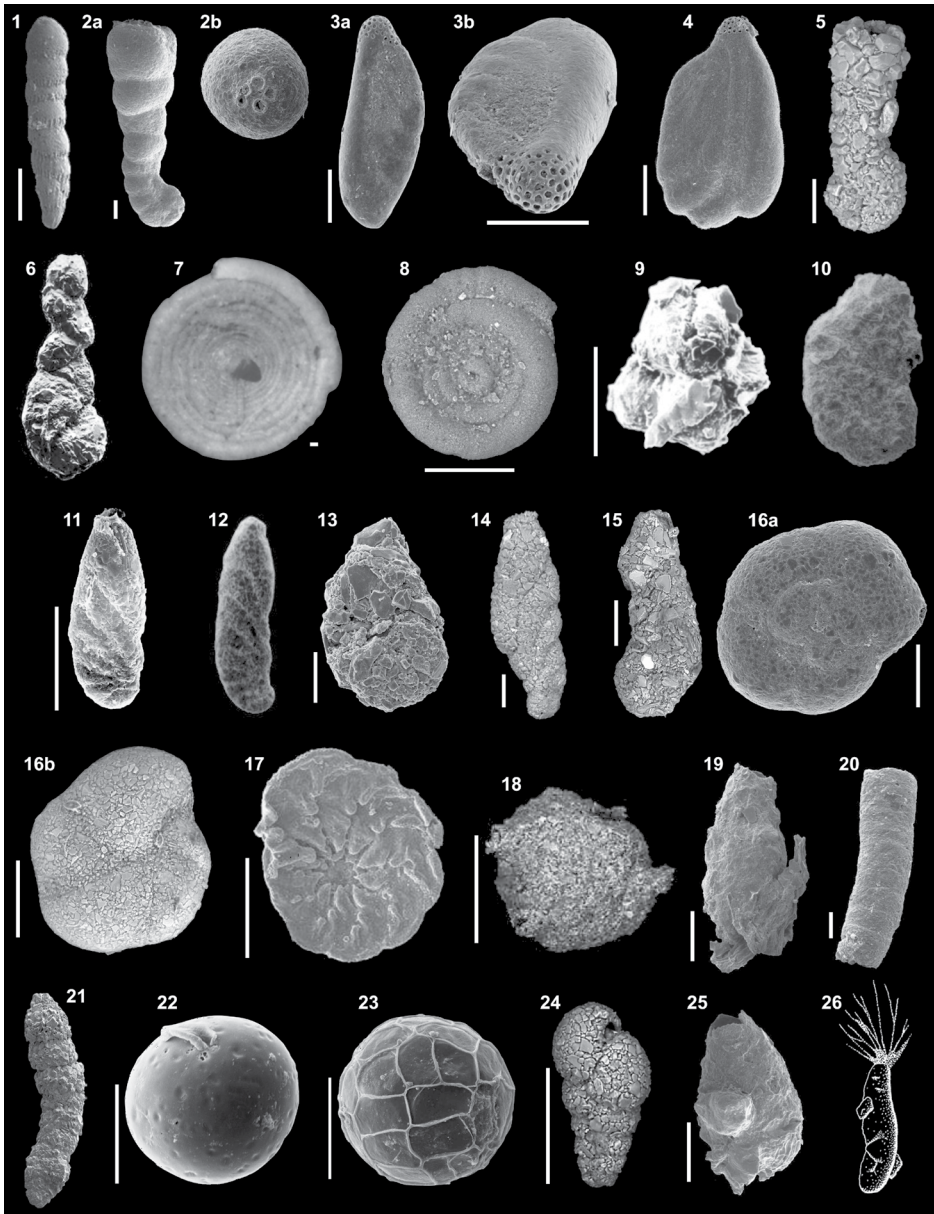


Plate I. **1.** *Acostata mariae*. Image adapted from Laut et al. (2017), Pl. I, Figure 1. **2a.** *Acupeina triperforata*. Image adapted from Laut et al. (2012), Figure 17, Il. 20. **2b.** *Acupeina triperforata*. Aperture view. Image adapted from Santa-Cruz (2004), Pl. VII, Figure 2. **3a,b.** *Ammoastuta inepta*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author's collection. **4.** *Ammoastuta salsa*. Image adapted from Santa-Cruz (2004), Pl. VI, Figure 5. **5.** *Ammobaculites exiguus*. Image adapted from Semensatto Jr. & Dias-Brito (2004), Figure 4, Il. 6. **6.** *Ammobaculoides* sp. (species illustrated: *Ammobaculoides troelsenii*) Image adapted from Brönnimann and Dias-Brito (1982), Pl. 1, Figure 5. **7.** *Ammodiscoides turbinatus*. Image adapted from LeRoy & Hodgkinson (1975), Pl. 2, Figure 14. **8.** *Ammodiscus* sp. Image adapted from Semensatto-Jr. & Dias-Brito (2004), Figure 4, Il. 2. **9.** *Ammopemphix* sp. (species illustrated: *Ammopemphix?*). Image adapted from Barbosa et al. (2005), Pl. 3, Figure 6. **10.** *Ammoscalaria* sp. Image adapted from Disaró (2006), Pl. 1, Figure 10. **11.** *Ammotium cassis*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author's collection. **12.** *Ammotium directum*. Image adapted from Disaró (2006), Pl. 1, Figure 12. **13.** *Ammotium morenoi*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author's collection. **14.** *Ammotium pseudocassis*. Image adapted from Semensatto Jr. & Dias-Brito (2004), Figure 4, Il. 11. **15.** *Ammotium salsum*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author's collection. **16a,b.** *Arenoparrella mexicana*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. **17.** *Asterotrochammina* sp. (species illustrated: *Asterotrochammina camposi*). Image adapted from Rudorff (2008), Pl. II, Figure 25. **18.** *Astrammmina rara*. Test collected at the mangrove from Ilha do Cardoso, Brazil, Recent. Image from the author's collection. **19.** *Bahianofusus ponteii*. Image adapted from Laut et al. (2012), Figure 17, Il. 2 (*Bahianofusus pontoni*). **20.** *Bahianotubus salvadorensis*. Image adapted from Laut et al. (2012), Figure 17, Il. 3. **21.** *Bigenerina* sp. (species illustrated: *Bigenerina nodosaria*). Image adapted from Milker and Schmiel (2012), Figure 10, Il. 11. **22.** *Blysmasphaera brasiliensis*. Image adapted from Semensatto et al. (2008), Pl. I, Figure B. **23.** *Blysmasphaera broennimanni*. Image adapted from Semensatto et al. (2008), Pl. I, Figure C. **24.** *Caronia exilis*. Test collected at the mangrove from Bertioja Channel, Brazil, Recent. Image from the author's collection. **25.** *Chitinosaccus guaratibaensis*. Image adapted from Laut et al. (2012), Figure 17, Il. 1. **26.** *Chitinosaccus zuluensis*. Image adapted from Smitter (1956), Figure 1, Il. D.

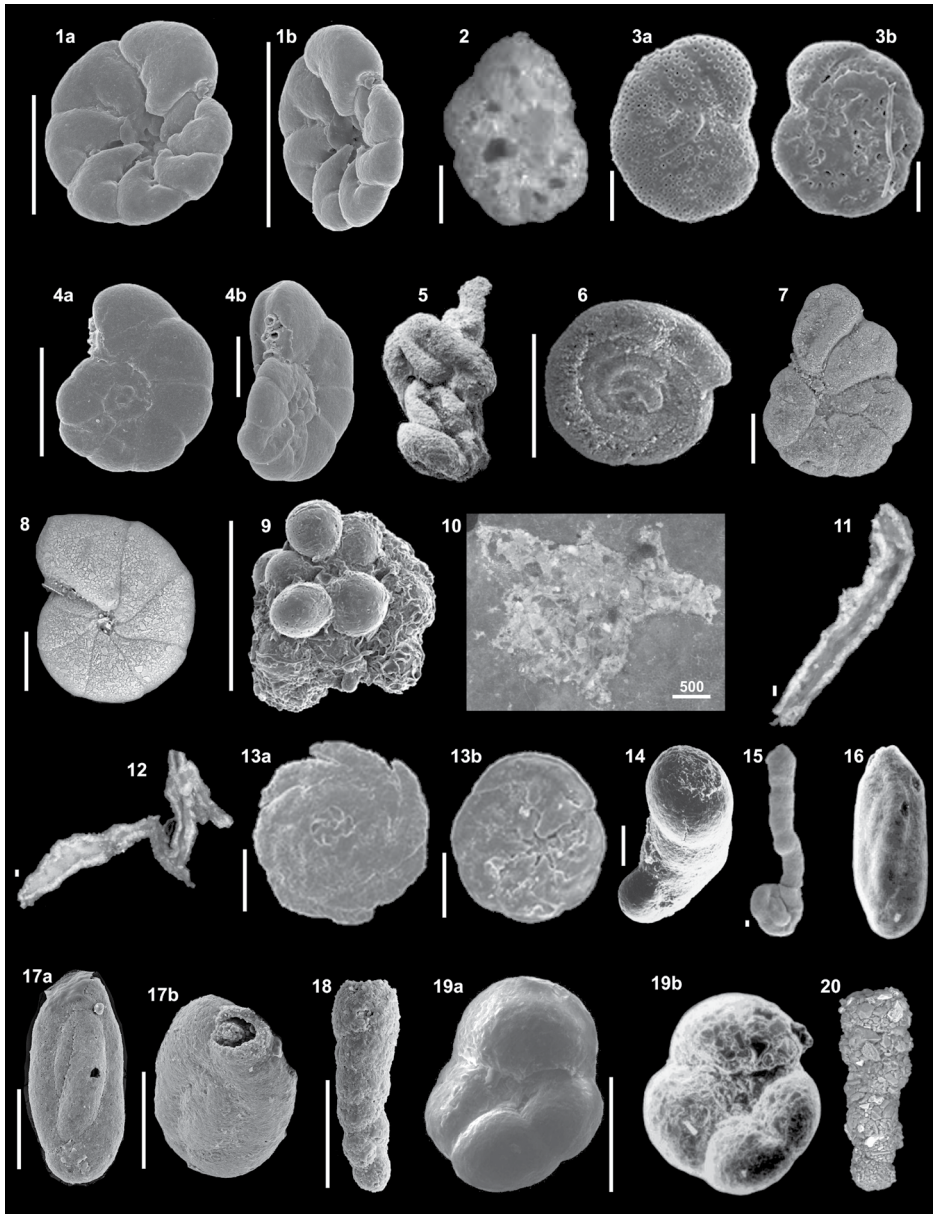


Plate II. **1a,b.** *Deuterammina* sp. Test collected at tidal marshes, Portugal, Recent. Image courtesy of Prof. Dr. Francisco Fatela and Dr. João Moreno. **2.** *Discammina* sp. Image adapted from Panchang & Nigan (2014), Pl.1, Figure 18. **3a,b.** *Discorinopsis aguayoi*. Image adapted from Camacho et al. (2015), Figure 3, Ils. 26, 27. **4a,b.** *Entzia macrescens*. Test collected at tidal marshes, Portugal, Recent. Image courtesy of Prof. Dr. Francisco Fatela and Dr. João Moreno (*Jadammina macrescens*). **5.** “*Glomospira*” *glomerata*. Image adapted from Galeotti et al. (2004), Pl. 2, Il. 7. **6.** *Glomospira gordialis*. Test collected at the intertidal zone from Curimataú River, Brazil, Recent. Image from the author’s collection. **7.** *Haplophragmoides manilaensis*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author’s collection. **8.** *Haplophragmoides wilberti*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author’s collection. **9.** *Hemisphaerammina bradyi*. Image adapted from Waškowska & Kaminski (2019), Figure 4, Il. G. **10-12.** *Iridia diaphana*. Image adapted from Kaminski et al. (2008), Pl., 7, Figures 7, 9, 10. **13a,b.** *Lepidodeuterammina ochracea*. Image adapted from Camacho et al. (2015), Figure 3, Ils. 5, 6. **14.** *Lituola* sp. Image adapted from Barbosa et al. (2005), Pl. I, Figure 23. **15.** *Lituotuba* sp. (species illustrated: *Lituotuba lituiformis*). Image adapted from Laut et al., (2014), Figure 9, FB1, Il. D. **16.** *Miliammina earlandi*. Image adapted from Disaró (2006), Pl. 2, Figure 16. **17a,b.** *Miliammina fusca*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author’s collection. **18.** *Monotalea salsa*. Image adapted from Semensatto-Jr. & Dias-Brito (2004), Figure 4, Il. 8. **19a,b.** *Paratrochammina clossi*. Image adapted from Laut et al. (2017), Pl. V, Figure B, and Disaró (2006), Pl. II, Figure p. **20.** *Polysaccammina hyperhalina*. Image adapted from Semensatto-Jr. & Dias-Brito (2004), Figure 4, Il. 13.



Plate III. 1. *Polysaccammina ipohalina*. Image adapted from Santa-Cruz (2004), Pl. I, Figure 2. 2a,b. *Portatrochammina* sp. Image adapted from Camacho et al. (2015), Figure 3, Ils. 9, 10. 3a,b. *Protoschista findens*. Image adapted from Jones (1994), Pl. 32, Figures 10A and B. 4a-c. *Psammosphaera frankei*. Image adapted from Rhumbler (1935), Pl. 5, Figures 4A, B and C. 5a,b. *Psammosphaera fusca* f. *adhaerens*. Image adapted from Rhumbler (1935), Pl. 9, Figures 5A and B. 6. *Pseudoclavulina curta*. Image adapted from Disaró (2006), Pl. II, Figure 6. 7a,b. *Pseudoclavulina gracilis*. Image adapted from Cushman & Todd (1948), Pl. 7, Figures 17A and B. 8. *Pseudothurammina limnetis*. Image adapted from Encarnação (2012), Figure 9.3. 9a,b. *Remaneica* sp. (species illustrated: *Remaneica helgolandica*). Image adapted from Encarnação (2012), Figures 9A and B, Ils. 2, 3. 10. *Reophax nana*. Image adapted from Rudorff (2008), Pl. 1, Figure 8. 11a-c. *Rotaliammina* sp. (species illustrated: *Rotaliammina squamiformis*). Adapted from Loeblich & Tappan (1994), Pl. 24, Figures 11A, B and C. 12a,b. *Siphotrochammina lobata*. Image adapted from Santa-Cruz (2004), Pl. VIII, Figure 1, Pl. VII, Figure 6. 13. *Spiroplectammina biformis*. Image adapted from Nathan et al. (2014), Figure 23, Il. 7. 14. *Textularia earlandi*. Test collected at the intertidal zone from Curimataú River, Brazil, Recent. Image from the author's collection. 15. *Textularia gramen*. Image adapted from Zeffass et al. (2006), Figure 6, Il. 5. 16a,b. *Tholosina centroforata*. Image adapted from Rhumbler (1935), Pl. 4, Figures 16A and B. 17a,b. *Tiphotrocha comprimata*. Image adapted from Santa-Cruz (2004), Pl. VIII, Figures 17A and B. 18. *Trilocularenna patensis*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author's collection. 19a. *Trochammina inflata*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author's collection. 19b. *Trochammina inflata*. Test collected at tidal marshes, Portugal, Recent. Image courtesy of Prof. Dr. Francisco Fatela and Dr. João Moreno. 20. *Trochammina squamata*. Image adapted from Laut et al. (2007), Pl. I, Figure 14. 21. *Trochamminita irregularis*. Image adapted from Encarnação (2012), Figure 9.6. 22. *Trochamminita salsa*. Test collected at tidal marshes, Portugal, Recent. Image courtesy of Prof. Dr. Francisco Fatela and Dr. João Moreno. 23. *Warrenita palustris*. Test collected at the intertidal zone from the São Francisco River delta, Brazil, Recent. Image from the author's collection.

7 (6). Test a saclike chamber with a rounded terminal aperture – genus ***Chitinosaccus***.

Test hemispherical, with or without apparent aperture – go to **8**.

8 (7). No apparent aperture – genus ***Hemisphaerammina***.

Two or more apertures just above the base of the test – genus ***Tholosina***.

9 (3). Test free – go to **10**.

Test attached – go to **12**.

10 (9). Test without projections, large (up to 6mm), consisting of one to several loosely joined spherical chambers – genus ***Psammosphaera***.

Test with projections – go to **11**.

11 (10). Smooth and homogeneous wall with numerous tubular extensions and with sand grains larger than the thickness of the wall – genus ***Astrammina***.

Wall finely agglutinated with silt grains and with up to five mammillae irregular projections – genus ***Pseudothurammina***.

12 (9). Wall proteinaceous – genus ***Iridia***.

Wall agglutinated – go to **13**.

13 (12). Wall thick, of agglutinated fine sand, sponge spicules, and other foraminiferal tests – genus ***Crithionina***.

Wall thin, flexible – genus ***Pseudothurammina***.

14 (2). Elongate chambers and cribrate aperture – genus ***Ammoastuta***.

Chambers with other forms – go to **15**.

15 (14). Biserial portion at least in one stage – go to **16**.

Test without biserial portion – go to **19**.

16 (15). Test with initial biserial portion followed by a uniserial portion – go to **17**.

Test with other features – go to **18**.

17 (16). Initial portion acute, aperture evaginated – genus ***Bigenerina***.

Initial portion rounded, aperture terminal rounded – genus ***Monotalea***.

18 (16). Test with a tiny initial triserial portion followed by a biserial portion – genus ***Textularia***.

Test only biserial – genus ***Caronia***.

19 (15). Test arched with aperture an elongate slit at the terminal end of the test – genus ***Warrenita***.

Test not arched – go to **20**.

20 (19). Chambers with irregular shape – genus ***Polysaccammina***.

Chambers with regular shape – go to **21**.

21 (20). Loosely joined spherical chambers – genus ***Psammosphaera***.

Chambers with another shape – go to **22**.

22 (21). Test with two or more branching uniserial stages – genus ***Protoschista***.

Test without branching series – go to **23**.

23 (22). Hemispherical chambers – genus ***Ammopemphix***.

Chambers with another format – go to **24**.

24 (23). Early-stage triserial and triangular, then uniserial with cylindrical chambers – genus ***Pseudoclavulina***.

Test only uniserial – go to **25**.

25 (24). Aperture rounded – genus ***Reophax***.

Aperture lenticular – genus ***Acostata***.

26 (1). Test planispiral (can be initially streptospiral or followed by a uniserial or biserial portion) – go to **27**.

Another coil – go to **39**.

27 (26). Test discoid – go to **28**.

Test not discoid – go to **30**.

28 (27). Initial portion streptospiral – genus ***Glomospira***.

Initial portion no-streptospiral – go to **29**.

29 (28). Test with a “w” outline in the lateral section – genus ***Ammodiscoides***.

Test without “w” outline – genus ***Ammodiscus***.

30 (27). Test with a uniserial or biserial portion – go to **31**.

- Test without a uniserial or biserial portion – go to **36**.
- 31 (30)**. Initial planispiral with biserial followed by uniserial portion – genus *Ammobaculoides*.
Another arrangement – go to **32**
- 32 (31)**. Only biserial portion – genus *Spiroplectammina*.
Only uniserial portion – go to **33**.
- 33 (32)**. Sutures rather indistinct – go to **34**.
Sutures distinct – go to **35**.
- 34 (33)**. Later part with tubular chambers – genus *Lituotuba*.
Later part with short and broad chambers – genus *Ammoscalaria*.
- 35 (33)**. Sutures oblique in the uniserial portion – genus *Ammotium*.
Sutures not oblique in the uniserial portion – go to **36**.
- 36 (35)**. Single aperture – genus *Ammobaculites*.
Aperture with several pores – genus *Lituola*.
- 37 (30)**. Aperture an interiomarginal arch evaginated at the base of the final chamber – genus – *Haplophragmoides*.
Other aperture – go to **38**.
- 38 (37)**. Chambers and sutures not distinct – genus *Discammina*.
Globular chambers distinct, irregularly arranged, depressed sutures – genus *Trochamminita*.
- 39 (26)**. Trochospiral test – go to **40**.
Another coil – go to **52**.
- 40 (39)**. Test plan-convex or concave-convex – go to **41**.
Test not plan-convex nor concave-convex – go to **45**.
- 41 (40)**. Chambers with large pores in the center and edges – genus *Discorinopsis*.
Chambers without pores – go to **42**.
- 42 (41)**. Chambers extending back at the periphery – genus *Lepidodeuterammina*.
- Chambers not extending back at the periphery – go to **43**.
- 43 (42)**. Aperture interiomarginal and extraumbilical with secondary openings – genus *Asterotrochammina*.
Other aperture – go to **44**.
- 44 (43)**. Aperture a low interiomarginal arch in the final septal face – genus *Portatrochammina*.
Aperture a small rounded interiomarginal extra-umbilical opening – genus *Remaneica*.
- 45 (40)**. Slit-like aperture areal to interiomarginal – genus *Arenoparella*.
Aperture with another shape – go to **46**.
- 46 (45)**. Supplementary areal apertures – genus *Entzia*.
Without supplementary apertures – go to **47**.
- 47 (46)**. Siphon-like aperture, chambers rounded – genus *Siphotrochammina*.
Aperture with another shape – go to **48**.
- 48 (47)**. Aperture umbilical – genus *Rotaliammina*.
Aperture umbilical-extraumbilical – go to **49**.
- 49 (48)**. Chambers distinctly “T”-shaped in the umbilical side – genus *Tiphotrocha*.
Chamber with other features – go to **50**.
- 50 (49)**. Secondary aperture at the umbilical tip – genus *Deuterammina*.
Without secondary aperture – go to **51**.
- 51 (50)**. Aperture with a lip – genus *Trochammina*.
Aperture without a lip – genus *Paratrochammina*.
- 52 (39)**. Milioline coil – go to **53**.
Another coil – go to **54**.
- 53 (52)**. Triloculine test – genus *Trilocularena*.
Quinqueloculine test – genus *Miliammina*.
- 54 (52)**. Initial portion streptospiral followed by a uniserial portion – genus *Acupeina*.
Initial portion streptospiral followed by a planispiral portion – genus *Glomospira*.

SYSTEMATICS

Phylum FORAMINIFERA

Class MONOTHALAMEA Haeckel, 1862 (Pawłowski, Holzmann and Tyska, 2013).

Order ASTRORHIZIDA Lankester, 1885.

Suborder ASTRORHIZINA Lankester, 1885.

Superfamily ASTRORHIZOIDEA Brady, 1881.

Family RHABDAMMINIDAE Brady, 1884.

Subfamily BATHYSIPHONINAE Avnimelech, 1952.

Genus *Bahianotubus* Brönnimann, Zaninetti and Moura, 1979.

Bahianotubus salvadorensis Brönnimann, Zaninetti and Moura, 1979, Pl. I, Figure 20.

Suborder SACCAMMININA Lankester, 1885.

Superfamily PSAMMOSPHAEROIDEA Haeckel, 1894.

Family LACUSTRINELLIDAE Mikhalevic, 1995.

Genus *Ammopemphix* Loeblich, 1952.

1931 *Urnulla* Wiesner.

1952 *Ammopemphix* Loeblich.

***Ammopemphix* sp.**, Pl. I, Figure 9.

Family PSAMMOSPHAERIDAE Haeckel, 1894.

Subfamily PSAMMOSPHAERINAE Haeckel, 1894.

Genus *Psammosphaera* Schulze, 1875.

1875 *Psammosphaera* Schulze.

1913 *Arphammosphaerum* Rhumbler.

1935 *Psammella* Rhumbler.

1939 *Arenosphaera* Shchendrina.

Psammosphaera frankei (Rhumbler, 1935), Pl. III, Figures 4A, B and C.

1935 *Psammella frankei* Rhumbler.

2018 *Psammosphaera frankei* Hayward, Le Coze and Gross.

Psammosphaera fusca f. adhaerens Rhumbler, 1935, Pl. III, Figures 5A and B.

1935 *Psammosphaera fusca f. adhaerens* Rhumbler.

1977 *Psammosphaera adherens* (Rhumbler) Zaninetti, Brönnimann, Beurlen and Moura.

Superfamily SACCAMMINOIDEA Brady, 1884.

Family CRITHIONINIDAE Hofker, 1972.

Subfamily CRITHIONININAE Hofker, 1972.

Genus *Crithionina* Goës, 1894.

1894 *Crithionina* Goës.

1913 *Arcrithionum* Rhumbler.

Crithionina mamila Goës, 1894.

***Crithionina* sp.**

Family SACCAMMINIDAE Brady, 1884.

Subfamily THOLOSININAE.

Genus *Iridia* Heron-Allen and Earland, 1914.

Iridia diaphana Heron-Allen and Earland, 1914, Pl. II, Figures 10-12.

1914 *Iridia diaphana* Heron-Allen and Earland.

1921 *Iridia diaphana* (Heron-Allen and Earland) Cushman.

1935 *Iridia diaphana* (Heron-Allen and Earland) Doyle.

***Iridia* sp.**

Genus *Tholosina* Rhumbler, 1935.

Tholosina centroforata Rhumbler, 1935, Pl. III, Figures 16A and B.

Subfamily THURAMMININAE Miklukho-Maklay, 1963.

Genus *Astrammia* Rhumbler, 1931.

1931 *Astrammia* Rhumbler.

1932 *Armorella* Heron-Allen and Earland.

Astrammia rara Rhumbler, 1931, Pl. I, Figure 18.

1871 *Astrammia rara* Rhumbler, 1931.

1932 *Armorella sphaerica* Heron-Allen and Earland.

1977 *Astrammia sphaerica* (Heron-Allen and Earland) Zaninetti, Brönnimann, Beurlen and Moura.

1980 *Astrammia sphaerica* (Heron-Allen and Earland) Lena.

1986 *Astrammia sphaerica* (Heron-Allen and Earland) Schröder.

2013 *Armorella sphaerica* (Heron-Allen and Earland) Debenay.

Genus *Bahianofusus* Brönnimann, Zaninetti and Moura, 1979.

Bahianofusus ponte Brönnimann, Zaninetti and Moura, 1979, Pl.

I, Figure 19.

Genus *Pseudothurammia* (Scott, Mediolini and Williamson, 1981).

Pseudothurammia limnetis (Scott and Mediolini, 1980), Pl. III, Figure 8.

1980 *Thurammia limnetis* Scott and Mediolini.

1981 *Pseudothurammia limnetis* (Scott and Mediolini) Scott, Mediolini and Williamson.

1994 *Pseudothurammia limnetis* (Scott and Mediolini) Hayward and Hollis.

1999 *Pseudothurammia limnetis* (Scott and Mediolini) Hayward, Grenfell, Reid and Hayward.

2013 *Pseudothurammia limnetis* (Scott and Mediolini) Debenay.

Family STEGNAMMINIDAE Moreman, 1930.

Subfamily HEMISPHAERAMMININAE Loeblich and Tappan, 1961.

Genus *Hemisphaerammina* Loeblich and Tappan, 1957.

Hemisphaerammina bradyi Loeblich and Tappan, 1957, Pl. II,

Figure 9.

Order ALLOGROMIIDA Loeblich and Tappan, 1961.

Family ALLOGROMIIDAE Rhumbler, 1904.

Genus *Blysmasphaera* Brönnimann, 1988.

Blysmasphaera brasiliensis Brönnimann, 1988, Pl. I, Figure 22.

Blysmasphaera broennimanni Semensatto, Oliveira and Dias-Brito, 2008, Pl. I, Figure 23.

Subfamily ALLOGROMIINAE Rhumbler, 1904.

Genus *Chitinosaccus* Smitter, 1956.

Chitinosaccus guaratibaensis Brönnimann, Zaninetti and Moura,

1979, Pl. I, Figure 25.

Chitinosaccus zuluensis Smitter, 1956, Pl. I, Figure 26.

***Chitinosaccus* sp.**

Class GLOBOTHALAMEA Pawlowski, Holzmann and Tyszka, 2013.

Subclass TEXTULARIANA Mikhalevich, 1980.

Order LITUOLIDA.

Suborder LITUOLINA Lankester, 1885.

Superfamily LITUOLOIDEA.

Family DISCAMMINIDAE Mikhalevich, 1980.

Genus *Ammoscalaria* Höglund, 1947.

***Ammoscalaria* sp.**, Pl. I, Figure 10.

Genus *Discammina* Lacroix, 1932.

***Discammina* sp.**, Pl. II, Figure 2.

Family HAPLOPHRAGMOIDIDAE Maync, 1952.

Genus *Haplophragmoides* Cushman, 1910.

1910 *Haplophragmoides* Cushman.

1960 *Recurvoidella* Uchio.

1973 *Linguaferina* Alekseychik-Mitskevich.

1973 *Pauciloculina* Alekseychik-Mitskevich.

1973 *Subtilina* Alekseychik-Mitskevich.

1981 *Pseudohaplophragmoides* Saidova.

1988 *Haplophragmoides* Loeblich and Tappan.

Haplophragmoides manilaensis Andersen, 1952, Pl. II, Figure 7.

Haplophragmoides wilberti Andersen, 1953, Pl. II, Figure 8.

1953 *Haplophragmoides wilberti* Andersen.

1994 *Haplophragmoides wilberti* (Andersen) Hayward and Hollis.

1999 *Haplophragmoides wilberti* (Andersen) Hayward, Grenfell, Reid and Hayward.

2013 *Haplophragmoides wilberti* (Andersen) Debenay.

***Haplophragmoides* sp.**

Genus *Trochamminita* Cushman and Brönnimann, 1948.

Trochamminita irregularis Cushman and Brönnimann, 1948, Pl.

III, Figure 21.

1948 *Trochamminita salsa* Cushman and Brönnimann.

1957 *Trochamminita salsa* (Cushman and Brönnimann) Saunders.

Trochamminita salsa (Cushman and Brönnimann, 1948), Pl. III, Figure 22.

1948 *Labrospira salsa* Cushman and Brönnimann.

1948 *Trochamminita irregularis* Cushman and Brönnimann.

1957 *Trochamminita salsa* (Cushman and Brönnimann) Saunders.

1994 *Trochamminita salsa* (Cushman and Brönnimann) Hayward and Hollis.

1999 *Trochamminita salsa* (Cushman and Brönnimann) Hayward, Grenfell, Reid and Hayward.

Family LITUOLIDAE Blainville, 1827.

Subfamily AMMOASTUTINAE Loeblich and Tappan, 1984.

Genus *Ammoastuta* Cushman and Brönnimann, 1948.

Ammoastuta inepta (Cushman and McCulloch, 1939), Pl. I,
Figures 3A and B.

1939 *Ammobaculites ineptus* Cushman and McCulloch.

1948 *Ammoastuta inepta* (Cushman and McCulloch) Cushman and
Brönnimann.

1962 *Ammoastuta inepta* (Cushman and McCulloch) Closs.

Ammoastuta salsa Cushman and Brönnimann, 1948, Pl. I, Figure 4.

1948 *Ammoastuta salsa* Cushman and Brönnimann.

1952 *Ammoastuta salsa* (Cushman and Brönnimann) Bursch.

1986 *Ammoastuta salsa* (Cushman and Brönnimann) Brönnimann.

Subfamily AMMOMARGINULININAE Podobina, 1978.

Genus *Ammobaculites* Cushman, 1910.

Ammobaculites dilatatus Cushman and Brönnimann, 1948.

1948 *Ammobaculites dilatatus* Cushman and Brönnimann.

2002 *Ammotium dilatatus* (Cushman and Brönnimann) Debenay, Guiral
and Parra.

Ammobaculites exiguus Cushman and Brönnimann, 1948, Pl. I,
Figure 5.

1948 *Ammobaculites exiguus* Cushman and Brönnimann.

1992 *Ammobaculites exiguus* (Cushman and Brönnimann) Brönnimann,
Whittaker and Zaninetti.

1994 *Ammobaculites exiguus* (Cushman and Brönnimann) Hayward and
Hollis.

1999 *Ammobaculites exiguus* (Cushman and Brönnimann) Hayward,
Grenfell, Reid and Hayward.

2013 *Ammobaculites exiguus* (Cushman and Brönnimann) Debenay.

Genus *Ammotium* Loeblich and Tappan, 1953.

1953 *Ammotium* Loeblich and Tappan.

1960 *Ammovaginulina* Nakkady and Eissa.

1988 *Ammotium* Loeblich and Tappan.

Ammotium angulatum Brönnimann, Whittaker and Zaninetti, 1992.

Ammotium cassis (Parker, 1870), Pl. I, Figure 11.

1870 *Lituola cassis* Parker.

1870 *Ammobaculites cassis* (Parker) Parker.

1870 *Haplophragmium cassis* (Parker) Parker.

1953 *Ammotium cassis* (Parker) Loeblich and Tappan.

1980 *Ammotium cassis* (Parker) Boltovskoy, Giussani, Watanabe and
Wright.

Ammotium directum (Cushman and Brönniman, 1948), Pl. I,
Figure 12.

1948 *Ammobaculites directus* Cushman and Brönniman.

1948 *Ammobaculites diversus* Cushman and Brönniman.

1953 *Ammotium directum* Loeblich and Tappan.

Ammotium morenoi (Acosta, 1940), Pl. I, Figure 13.

1940 *Ammobaculites morenoi* Acosta.

- 1948 *Ammobaculites salsus* Cushman and Brönniman.
 1948 *Ammobaculites salsus* var. *distinctus* Cushman and Brönniman.
 1952 *Ammoscalaria fluvialis* Parker.
 1957 *Ammotium palustre* Warren.
 1992 *Ammotium morenoi* Brönnimann, Whittaker and Zaninetti.

Ammotium planissimum (Cushman, 1927).

- 1927 *Haplophragmoides planissima* Cushman.
 1973 *Ammotium planissimum* Lankford and Phleger.

Ammotium pseudocassis (Cushman and Brönnimann, 1948), Pl. I, Figure 14.

- 1948 *Ammobaculites pseudocassis* Cushman and Brönniman.
 1953 *Ammotium pseudocassis* (Cushman and Brönniman) Loeblich and Tappan.
 1992 *Ammotium pseudocassis* (Cushman and Brönniman) Brönnimann, Whittaker and Zaninetti.

Ammotium salsum (Cushman and Brönnimann, 1948) Pl. I, Figure 15.

- 1948 *Ammobaculites salsus* Cushman and Brönniman.
 1953 *Ammotium salsum* (Cushman and Brönnimann) Loeblich and Tappan.
 1967 *Ammotium palustre* Warren.
 2013 *Ammotium salsum* (Cushman and Brönnimann) Boltovskoy, Giussani, Watanabe and Wright.
 2013 *Ammotium salsum* (Cushman and Brönnimann) Debenay.

Subfamily LITUOLINAE Blainville, 1827.

Genus *Lituola* Lamarck, 1804.

- 1804 *Lituola* Lamarck.
 1862 *Lituola* Reuss.
 1918 *Lituola* (Lamarck) Cushman.

***Lituola* sp.**, Pl. II, Figure 14.

Superfamily LITUOTUBOIDEA.

Family LITUOTUBIDAE Loeblich and Tapan, 1984.

Genus *Lituotuba* Rhumbler, 1895.

- 1895 *Lituotuba* Rhumbler.
 1913 *Arlituotubum* Rhumbler.
 1981 *Lituiforminoides* Saidova.
 1988 *Lituotuba* (Rhumbler) Loeblich and Tappan.

***Lituotuba* sp.**, Pl. II, Figure 15.

Superfamily RECURVOIDOIDEA Alekseychik-Mitskevich, 1973.

Family ACUPEINIDAE Brönnimann and Zaninetti, 1984.

Genus *Acupeina* Brönniman and Zaninetti, 1984.

Acupeina triperforata (Millett, 1899), Pl. I, Figures 2A and B.

- 1899 *Haplophragmium agglutinans* var. *tripperforata* Millett.
 1948 *Haplophragmium salsum* (Millett) Cushman and Brönnimann.
 1984 *Acupeina triperforata* (Millett) Brönnimann and Zaninetti.
 2002 *Acupeina triperforata* (Millett) Debenay, Guiral and Parra.
 2013 *Acupeina triperforata* (Millett) Debenay.

Suborder RZEHAKININA Saidova, 1981.

Superfamily RZEHAKINOIDEA Cushman, 1933.

Family TRILOCULARENIDAE Mikhalevich and Kaminski, 2008.

Genus *Trilocularena* Loeblich and Tappan, 1955.

Trilocularena patensis Closs, 1963, Pl. III, Figure 18.

1963 *Trilocularena patensis* Closs.

2013 *Trilocularena patensis* (Closs) Debenay.

Suborder SPIROPECTAMMININA Mikhalevich, 1992.

Superfamily SPIROPECTAMMINOIDEA Cushman, 1927.

Family SPIROPECTAMMINIDAE Cushman, 1927.

Subfamily SPIROPECTAMMININAE Cushman, 1927.

Genus *Ammobaculoides* Plummer, 1932.

Ammobaculoides sp., Pl. I, Figure 6.

Genus *Spiropectamina* Cushman, 1927.

Spiropectamina biformis (Parker and Jones, 1865), Pl. III, Figure 13.

1835 *Textularia aglutinans* var. *biformis* Parker and Jones.

1884 *Spiropecta biformis* (Parker and Jones) Brady.

1932 *Spiropectamina biformis* (Parker and Jones) Heron-Allen and Earland.

1962 *Spiropectamina biformis* (Parker and Jones) Closs.

2013 *Spiropectamina biformis* (Parker and Jones) Debenay.

Family TEXTULARIOPSIDAE Loeblich and Tappan, 1982.

Genus *Monotalea* Brönnimann, Whittaker and Zaninetti, 1992.

Monotalea salsa Brönnimann, Whittaker and Zaninetti, 1992, Pl. II, Figure 18.

1992 *Monotalea salsa* Brönnimann, Whittaker and Zaninetti.

2013 *Monotalea salsa* (Brönnimann, Whittaker and Zaninetti) Debenay.

Suborder TROCHAMMININA Saidova, 1981.

Superfamily TROCHAMMINOIDEA Schwager, 1877.

Family REMANEICIDAE Loeblich and Tappan, 1964.

Subfamily ASTEROTROCHAMMININAE Brönnimann, Zaninetti and Whittaker, 1983.

Genus *Asterotrochammina* Bermúdez and Seiglie, 1963.

Asterotrochammina sp., Pl. I, Figure 17.

Subfamily REMANEICINAE Loeblich and Tappan, 1964.

Genus *Remaneica* Rhumbler, 1938.

Remaneica sp., Pl. III, Figures 9A and B.

Family TROCHAMMINIDAE Schwager, 1877.

Subfamily ARENOPARELLINAE Saidova, 1981.

Genus *Arenoparrella* Andersen, 1951.

Arenoparrella mexicana (Kornfeld, 1931), Pl. I, Figures 16A and B.

1931 *Trochammina inflata* var. *mexicana* Kornfeld.

1951 *Arenoparrella mexicana* (Kornfeld) Andersen.

1992 *Arenoparrella mexicana* (Kornfeld) Brönnimann, Whittaker and Zaninetti.

2007 *Arenoparrella mexicana* (Kornfeld) Berkeley, Perry, Smithers, Horton and Taylor.

2013 *Arenoparrella mexicana* (Kornfeld) Debenay.

Subfamily JADAMMININAE Saidova, 1981.

Genus *Entzia* Daday, 1883.1883 *Entzia* Daday.1938 *Jadammina* Bartenstein and Brand.2018 *Entzia* Hayward, Le Coze and Gross.***Entzia macrescens*** (Brady, 1870), Pl. II, Figures 4A and B.1870 *Trochammina inflata* var. *macrescens* Brady.1938 *Jadammina macrescens* (Brady) Bartenstein and Brand.1980 *Trochammina macrescens* (Brady) Scott and Medioli.1994 *Jadammina macrescens* (Brady) Hayward and Hollis.1999 *Jadammina macrescens* (Brady) Hayward, Grenfell, Reid and Hayward.2005 *Trochammina macrescens* (Brady) Barbosa, Scott, Seoane and Turcq.2013 *Jadammina macrescens* (Brady) Debenay.2018 *Entzia macrescens* (Brady) Hayward, Le Coze and Gross.***Entzia polystoma*** (Bartenstein and Brand, 1938).1938 *Jadammina polystoma* Bartenstein and Brand.2018 *Entzia polystoma* Hayward, Le Coze and Gross.***Entzia* sp.**

Subfamily POLYSTOMAMMININAE Brönnimann and Beurlen, 1977.

Genus *Deuterammina* Brönnimann, 1976.1976 *Deuterammina* Brönnimann.1983 *Deuterammina (Centrodeuterammina)* (Brönnimann) Brönnimann and Whittaker.1988 *Deuterammina* (Brönnimann) Loeblich and Tappan.***Deuterammina* sp.**, Pl. II, Figures 1A and B.Genus *Lepidodeuterammina* Brönnimann and Whittaker, 1983.1983 *Deuterammina (Lepidodeuterammina)* Brönnimann and Whittaker.1988 *Lepidodeuterammina* (Brönnimann and Whittaker) Loeblich and Tappan.***Lepidodeuterammina ochracea*** (Williamson, 1858), Pl. II, Figures 13A and B.1858 *Rotalina ochracea* Williamson.1983 *Deuterammina (Lepideuterammina) ochracea* Brönnimann and Whittaker.1980 *Trochammina ochracea* (Williamson) Boltovskoy, Giussani, Watanabe and Wright.2018 *Lepideuterammina ochracea* Hayward, Le Coze and Gross.

Subfamily ROTALIAMMININAE Saidova, 1981.

Genus *Rotaliammina* Cushman, 1924.1924 *Rotaliammina* Cushman.1964 *Polysiphotrocha* Seiglie.1988 *Rotaliammina* (Cushman) Loeblich and Tappan.***Rotaliammina* sp.**, Pl. III, Figures 11A, B and C.Genus *Siphotrochammina* Saunders, 1957.***Siphotrochammina lobata*** Saunders, 1957, Pl. III, Figures 12A and B.1957 *Siphotrochammina lobata* Saunders.1977 *Siphotrochammina elegans* Zaninetti, Brönnimann, Beurlen and Moura.2013 *Siphotrochammina lobata* (Saunders) Debenay.***Siphotrochammina* sp.**

Genus *Tiphotrocha* Saunders, 1957.

Tiphotrocha comprimata (Cushman and Brönnimann, 1948), Pl. III, Figures 17A and B.

1948 *Trochammina comprimata* Cushman and Brönnimann.

1957 *Tiphotrocha comprimata* (Cushman and Brönnimann) Saunders.

1980 *Tiphotrocha comprimata* (Cushman and Brönnimann) Scott and Mediol.

1992 *Tiphotrocha comprimata* (Cushman and Brönnimann) Brönnimann, Whittaker and Zaninetti.

2006 *Tiphotrocha comprimata* (Cushman and Brönnimann) Horton and Edwards.

Subfamily TROCHAMMININAE Schwager, 1877.

Genus *Paratrochammina* Brönnimann, 1979.

Paratrochammina clossi Brönnimann, 1979, Pl. II, Figures 19A and B.

***Paratrochammina* sp.**

Genus *Portatrochammina* Echols, 1971.

1971 *Portatrochammina* Echols.

1983 *Portatrochammina* (*Paratrochammina*) (Echols) Brönnimann, Zaninetti and Whitaker.

1971 *Portatrochammina* (Echols) Loeblich and Tappan.

***Portatrochammina* sp.**, Pl. III, Figures 2A and B.

Genus *Trochammina* (Parker and Jones, 1859).

1859 *Rotalia* (*Trochammina*) Parker and Jones.

1860 *Trochammina* (Parker and Jones) Jones and Parker.

1988 *Trochammina* (Parker and Jones) Loeblich and Tappan.

Trochammina inflata (Montagu, 1808), Pl. III, Figures 19A and B.

1808 *Nautilus inflatus* Montagu.

1859 *Trochammina inflata* (Montagu) Parker and Jones.

1994 *Trochammina inflata* (Montagu) Hayward and Hollis.

1999 *Trochammina inflata* (Montagu) Hayward, Grenfell, Reid and Hayward.

2006 *Trochammina inflata* (Montagu) Horton and Edwards.

2013 *Trochammina inflata* (Montagu) Debenay.

Trochammina squamata Jones and Parker, 1860, Pl. III, Figure 20.

1860 *Trochammina squamata* Jones and Parker.

1964 *Trochammina squamata* (Jones and Parker) Hedley, Hurdle and Burdett.

1980 *Trochammina squamata* (Jones and Parker) Boltovskoy, Giussani, Watanabe and Wright.

***Trochammina* sp.**

Suborder VERNEUILININA Mikhalevich and Kaminski, 2000.

Superfamily VERNEUILINOIDEA Cushman, 1911.

Family REOPHACELLIDAE Mikhalevich and Kaminski, 2000.

Subfamily CARONIINAE Brönnimann, Whittaker and Zaninetti, 1992.

Genus *Caronia* Brönnimann, Whittaker and Zaninetti, 1992.

Caronia exilis (Brönnimann and Cushman, 1948), Pl. I, Figure 24.

1948 *Gaudryina exilis* Brönnimann and Cushman.

1992 *Caronia exilis* (Brönnimann and Cushmann) Brönnimann, Whittaker and Zaninetti.

2002 *Caronia exilis* (Brönnimann and Cushmann) Debenay, Guiral and Parra.

2013 *Caronia exilis* (Brönnimann and Cushmann) Debenay.

Order TEXTULARIIDA.

Suborder TEXTULARIINA Delage and Hérouard, 1896.

Superfamily EGGERELLOIDEA Cushman, 1937.

Family PSEUDOGAUDRYINIDAE Loeblich and Tappan, 1985.

Subfamily PSEUDOGAUDRYININAE Loeblich and Tappan, 1985.

Genus *Pseudoclavulina* Cushman, 1936.

Pseudoclavulina curta Cushman and Brönnimann, 1948, Pl. III, Figure 6.

Pseudoclavulina gracilis Zheng, 1988, Pl. III, Figures 7A and B.

***Pseudoclavulina* sp.**

Family VALVULAMMINIDAE Loeblich and Tappan, 1986.

Genus *Discorinopsis* Cole, 1941.

Discorinopsis aguayoi (Bermúdez, 1935), Pl. II, Figures 3A and B.

1935 *Discorbis aguayoi* Bermúdez.

1941 *Discorinopsis aguayoi* Cole.

Superfamily TEXTULARIOIDEA Ehrenberg, 1838.

Family TEXTULARIIDAE Ehrenberg, 1838.

Subfamily TEXTULARIINAE Ehrenberg, 1838.

Genus *Bigenerina* d'Ornigny, 1826.

***Bigenerina* sp.**, Pl. I, Figure 21.

Genus *Textularia* Defrance, 1824.

Textularia earlandi Parker, 1952, Pl. III, Figure 14.

1952 *Textularia earlandi* Parker.

1994 *Textularia earlandi* (Parker) Hayward and Hollis.

1999 *Textularia earlandi* (Parker) Hayward, Grenfell, Reid and Hayward.

2010 *Textularia earlandi* (Parker) Alve and Goldstein.

Textularia gramen d'Orbigny 1846, Pl. III, Figure 15.

Class MONOTHALAMEA.

Order ASTRORHIZIDA.

Suborder SACCAMMININA.

Superfamily PSAMMOSPHAEROIDEA.

Family POLYSACCAMMINIDAE.

Subfamily POLYSACCAMMININAE.

Genus *Polysaccamina* Scott, 1976.

Polysaccamina hyperhalina Mediolli, Scott and Petrucci, 1983, Pl. II, Figure 20.

Polysaccamina ipohalina Scott, 1976, Pl. III, Figure 1.

1976 *Polysaccamina ipohalina* Scott.

1980 *Polysaccamina ipohalina* (Scott) Scott and Mediolli.

Class NODOSARIATA Mikhalevich, 1992 emend. Rigaud, Vachard, Schlagintweit, Martini and 2015.

Subclass HORMOSINANA Mikhalevich, 1992.

Superfamily CRIBRATINOIDEA Loeblich and Tappan, 1984.

Family THOMASINELLIDAE Loeblich and Tappan, 1984 †.

Genus *Protoschista* Eimer and Fickert, 1899.

Protoschista findens (Parker, 1870), Pl. III, Figures 3A and B.1870 *Lituola findens* Parker.1953 *Protoschista findens* (Parker) Loeblich and Tappan.

Suborder HORMOSININA.

Superfamily HORMOSINOIDEA.

Family HORMOSINIDAE.

Subfamily CUNEATINAE.

Genus *Acostata* (Acosta, 1940).1940 *Reophax* Acosta.1992 *Acostata* Brönnimann, Whitaker and Valleri, 1992.***Acostata mariae*** (Acosta, 1940), Pl. I, Figure 1.1940 *Reophax mariae* Acosta.1980 "*Hormosina*" *mariae* (Acosta) Brönnimann.1992 *Acostata mariae* (Acosta) Brönnimann, Whitaker and Valleri.Genus *Warrenita* Loeblich and Tappan, 1984.***Warrenita palustris*** (Warren, 1957), Pl. III, Figure 23.1957 *Sulcophax palustris* Warren.1984 *Warrenita palustris* Loeblich and Tappan.

Family REOPHACIDAE Cushman, 1927.

Genus *Reophax* Monfort, 1808.***Reophax nana*** Rhumbler, 1913, Pl. III, Figure 10.1913 *Reophax nana* Rhumbler.2005 *Reophax nana* (Rhumbler) Barbosa, Scott, Seoane and Turcq.2013 *Reophax nana* (Rhumbler) Debenay.***Reophax* sp.**

Class TUBOTHALAMEA Pawlowski, Holzman and Tyszka, 2013.

Order MILIOLIDA Delage and Hérouard, 1896.

Family MILIAMMINIDAE Saidova, 1981.

Genus *Miliammina* Heron-Allen and Earland, 1930.***Miliammina earlandi*** Loeblich and Tappan, 1955, Pl. II, Figure 16.***Miliammina fusca*** (Brady, 1870), Pl. II, Figures 17A and B.1870 *Quinqueloculina fusca* Brady.1930 *Miliammina fusca* (Brady) Heron-Allen and Earland.1936 *Miliammina fusca* (Brady) Rhumbler.1953 *Miliammina fusca* (Brady) Miller.1992 *Miliammina fusca* (Brady) Brönnimann, Whittaker and Zaninetti.1994 *Miliammina fusca* (Brady) Hayward and Hollis.1999 *Miliammina fusca* (Brady) Debenay, Grenfell, Reid and Hayward.2013 *Miliammina fusca* (Brady) Debenay.***Miliammina* sp.**

Order SPIRILLINIDA Hohenegger and Piller, 1975.

Suborder AMMODISCINA Mikhalevich, 1980.

Superfamily AMMODISCOIDEA Reuss, 1862.

Family AMMODISCIDAE Reuss, 1862.

Subfamily AMMODISCINAE Reuss, 1862.

Genus *Ammodiscus* Reuss, 1862.***Ammodiscus* sp.**, Pl. I, Figure 8.Genus *Ammodiscoides* Cushman, 1909.

Ammodiscoides turbinatus Cushman, 1909, Pl. I, Figure 7.

Subfamily USBEKISTANIINAE Vyalov, 1968.

Genus *Glomospira* Rzehak, 1885.***“Glomospira” glomerata*** (Grzybowski, 1898), Pl. II, Figure 5.1898 *Ammodiscus glomeratus* Grzybowski.2005 *“Glomospira” glomerata* Kaminski and Gradstein.***Glomospira gordialis*** (Jones and Parker, 1860), Pl. II, Figure 6.1860 *Trochammina squamata* var. *gordialis* Jones and Parker.1885 *Glomospira gordialis* (Jones and Parker) Rzehak.1994 *“Glomospira gordialis”* (Jones and Parker) Hayward and Hollis.2013 *Glomospira gordialis* (Jones and Parker) Debenay.***Glomospira* sp.**

CONCLUSION

Considering the territorial dimensions of the Brazilian mangroves, the high concentration of results in the states of Sao Paulo and Rio de Janeiro (Table 1), the very limited number of mangroves analyzed on the Northeastern and Northern Brazilian coast, as well as the results from several works that have never been published, the number of species is potentially higher than now recorded. Moreover, new tools for environmental genetic analysis have contributed to revealing a significant abundance of cryptic species present in the environment, which may be taken into account.

In this case, monothalamous species are a particular group rarely reported in the literature. Although in estuarine environments such species are indeed rare in abundance, their occurrence may be underestimated because not all researchers recognize the tests of these species as foraminifera. It can be inferred from the fact that certain species are reported only by a researcher or research group who, having found them at some time, tends to report them again in other works. Besides, it should be considered that some sample preparation procedures potentially eliminate species that attach to substrates, such as sieving (excluding large fragments or particles where individuals may be attached) and flotation (decantation of denser particles with attached tests).

In addition to these factors, 28 genera were reported at some point without species identification (Table 1): *Ammobaculites* sp., *Ammobaculoides* sp., *Ammodiscus* sp., *Ammopemphix* sp., *Ammoscalaria* sp., *Ammotium* sp., *Asterotrochammina* sp., *Bigenerina*

sp., *Chitinosaccus* sp., *Crithionina* sp., *Deuterammina* sp., *Discammina* sp., *Entzia* sp., *Glomospira* sp., *Haplophragmoides* sp., *Iridia* sp., *Lituola* sp., *Lituotuba* sp., *Miliammina* sp., *Paratrochammina* sp., *Portatrochammina* sp., *Pseudoclavulina* sp., *Remaneica* sp., *Reophax* sp., *Rotaliammina* sp., *Siphotrochammina* sp., *Textularia* sp. and *Trochammina* sp. In some cases, the conditions of the tests probably have not facilitated species identification, although it was possible to recognize the genus. However, in the cases of the genera *Ammobaculoides*, *Ammodiscus*, *Ammopemphix*, *Ammoscalaria*, *Asterotrochammina*, *Bigenerina*, *Deuterammina*, *Discammina*, *Lituotuba*, *Portatrochammina*, *Remaneica* and *Rotaliammina*, no species have ever been identified in the Brazilian mangroves.

In addition to the possibility that these genera include species not yet described in the literature, it may emphasize the potential impact that species omission can have on ecological indices (e.g., diversity and evenness), as well as for comparison between assemblages (similarity indices), which are strongly influenced by taxonomic accuracy. Additionally, the synonyms may draw attention, since some same genera and species are reported differently in the literature. It is the case, for example, of the genus *Entzia*, the accepted synonym for the genus *Jadammina*, which in its turn has moved to the status of “not accepted” on the platform maintained by Hayward et al. (2019).

Among the 91 species reported in Brazil, 56 of them were illustrated by SEM images (Table 1). The absence of several species is because they are

Table 1. List of agglutinant and monothalamous foraminifera species reported from Brazilian mangroves with the geographical regions and references, respectively Symbol "X" indicates the presence of the species.

Species	Locality												References with images	
	Saf-Guaçu River (PR) ^a	Guaratuba Bay (PR) ^a	Cananéia and Cardoso Island (SP) ^{b,c,d}	Juréia-Itatins (SP) ^e	Santos Estuary (SP) ^f	Bertioga Channel/Itapanhaú River (SP) ^{g,h,i,j}	Guaratiba/Sepeitiba (RJ) ^{k,l,m,n}	Saquarema Lagoon (RJ) ^a	Jacarépiá Lake (RJ) ^a	Acupe (BA) ^o	Itaparica Island (BA) ^p	São Francisco River Delta (SE) ^{q,r}		Araguari Estuary (AP) ^s
<i>Acostata mariae</i>	.	.	X	.	.	.	.	.	.	.	.	.	.	.
<i>Acupeina triperforata</i>	.	.	X	.	.	.	X	.	.	.	.	.	.	c, n
<i>Ammoastuta inepta</i>	X	X	.	.	.	X	X	.	.	X	.	X	.	a, q, n
<i>Ammoastuta salsa</i>	.	.	X	.	X	X	X	.	.	X	.	.	.	c, i, k, n
<i>Ammobaculites exiguus</i>	.	X	X	.	.	X	X	.	.	X	.	X	.	a, c, q, n
<i>Ammobaculites</i> sp.	.	.	X	.	X	X	X	.	.	X	.	.	.	c
<i>Ammobaculoides</i> sp.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
<i>Ammodiscoides turbinatus</i>	.	X	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ammodiscus</i> sp.	.	X	.	.	.	X	X	.	.	X	.	X	.	a, q, n
<i>Ammopemphix</i> sp.	X	.	X	.	.	.	.	a, n
<i>Ammoscalaria</i> sp.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
<i>Ammotium angulatum</i>	X	.	.	.	.	.	.	.	.
<i>Ammotium cassis</i>	.	.	X	.	X	X	X	.	.	.	.	X	.	c, q, n
<i>Ammotium directum</i>	.	X	X	.	.	X	X	.	.	X	X	.	.	a, d, n, p
<i>Ammotium morenoi</i>	.	.	X	.	.	X	.	.	.	.	.	.	.	.
<i>Ammotium pseudocassis</i>	.	.	X	.	.	X	X	.	.	X	.	X	.	q
<i>Ammotium salsum</i>	X	X	X	.	.	X	X	.	.	X	X	X	.	a, c, e, i, k, n, p, q
<i>Ammotium</i> sp.	X	.	.	.	.	X	.	.	.	.
<i>Arenoparrella mexicana</i>	X	X	X	X	X	X	X	.	.	X	.	X	X	a, c, d, e, i, k, n, q
<i>Asterotrochammina</i> sp.	.	.	.	X	.	.	.	.	.	.	.	.	.	.
<i>Astrammina rara</i>	X	.	.	.	.	.	.	k, n
<i>Bahianofusus ponteii</i>	X	.	.	.	.	.	.	l, n
<i>Bahianotubus salvadorensis</i>	X	.	.	.	.	.	.	l, n
<i>Bigenerina</i> sp.	.	X	X	.	.	.	.	.	.	.	.	.	.	a, c
<i>Blysmasphaera brasiliensis</i>	.	.	X	.	.	.	.	.	.	.	.	.	.	q, n, r
<i>Blysmasphaera broenni-manni</i>	X	.	r
<i>Caronia exilis</i>	.	X	X	X	.	X	X	.	.	X	.	.	.	a, c, e, n, k
<i>Chitinosaccus guaratibaensis</i>	X	.	.	.	.	.	.	l, n
<i>Chitinosaccus</i> sp.	.	X	X	.	.	.	.	.	.	.	.	.	.	c
<i>Chitinosaccus zuluensis</i>	X	.	.	.	.	.	.	k
<i>Crithionina mamilla</i>	X	.	.	.	.	.	.	.
<i>Crithionina</i> sp.	X	.	.	.	.

CONTINUED TABLE 1.

<i>Deuterammina</i> sp.	.	.	X	.	.	.	.	.	.	.	.	.	c
<i>Discammina</i> sp.	.	.	.	.	.	.	.	X	.	.	.	.	.
<i>Discorinopsis aguayoi</i>	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Entzia macrescens</i>	X	X	X	.	X	.	X	X	X	.	.	.	a, n
<i>Entzia polystoma</i>	.	X	X	.	.	.	.	.	.	.	.	X	c
<i>Entzia</i> sp.	.	.	.	.	X	.	.	.	.	.	.	.	.
" <i>Glomospira</i> " <i>glomerata</i>	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Glomospira gordialis</i>	.	X	X	.	X	X	.	.	.	.	.	.	c
<i>Glomospira</i> sp.	.	.	X	.	.	.	.	.	.	.	.	.	c
<i>Haplophragmoides manilaensis</i>	X	X	X	.	X	X	.	.	.	.	X	.	a, q, n
<i>Haplophragmoides</i> sp.	.	.	.	X	.	.	.	.	X	.	.	.	p
<i>Haplophragmoides wilberti</i>	X	X	X	.	X	X	X	X	X	X	X	X	a, c, e, i, k, q, n
<i>Hemisphaerammina bradyi</i>	.	X	.	.	.	.	.	.	.	.	.	.	.
<i>Iridia diaphana</i>	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Iridia</i> sp.	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Lepidodeuterammina ochracea</i>	.	X	X	.	.	X	.	.	.	.	.	.	a, n
<i>Lituola</i> sp.	.	.	.	.	.	X	.	.	.	.	.	.	n
<i>Lituotuba</i> sp.	.	.	.	.	.	.	.	.	X	.	.	.	.
<i>Miliammina earlandi</i>	.	.	X	.	.	X	.	.	.	.	.	.	c
<i>Miliammina fusca</i>	X	X	X	.	X	X	.	.	X	.	X	X	a, c, e, n, q
<i>Miliammina pariaensis</i>	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Miliammina</i> sp.	.	.	X	.	X	.	.	.	X	.	.	.	.
<i>Monotalea salsa</i>	.	.	.	.	X	.	.	.	.	.	X	.	q
<i>Pararotalia cananeiaensis</i>	.	.	.	.	X	.	.	.	.	.	.	.	.
<i>Paratrochammina clossi</i>	.	.	X	.	X	X	.	.	.	.	.	.	n
<i>Paratrochammina</i> sp.	.	.	X	X	.	X	.	.	X	.	.	.	c
<i>Polysaccammina hyperhalina</i>	X	X	.	.	.	X	.	.	.	.	X	.	a, q
<i>Polysaccammina ipohalina</i>	X	X	X	.	.	X	.	X	X	.	.	.	a, c, k
<i>Portatrochammina</i> sp.	.	.	.	.	.	.	.	.	X	.	.	.	a
<i>Protoschista findes</i>	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Psammosphaera frankei</i>	.	.	.	.	.	X	.	.	.	.	.	.	k
<i>Psammosphaera fusca</i> f. <i>adhaerens</i>	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Pseudoclavulina curta</i>	.	.	.	.	X	.	.	.	X	.	.	.	.
<i>Pseudoclavulina gracilis</i>	.	.	.	.	.	.	.	.	X	.	.	.	.
<i>Pseudoclavulina</i> sp.	.	.	X	.	.	.	.	.	.	.	.	.	.
<i>Pseudothurammina limnetis</i>	X	X	X	.	.	.	.	.	.	.	.	.	a, c
<i>Remaneica</i> sp.	.	X	.	.	.	.	.	.	.	.	.	.	a
<i>Reophax nana</i>	.	X	X	.	.	X	.	.	.	.	.	.	a, c
<i>Reophax palustris</i>	.	.	.	.	.	X	.	.	.	.	.	.	.
<i>Reophax</i> sp.	X	.	.	.	X	X	.	.	X	.	.	.	.
<i>Rotaliammina</i> sp.	.	.	.	.	X	.	.	.	.	.	.	.	.
<i>Siphotrochammina elegans</i>	.	.	.	.	.	X	.	.	X	.	.	.	k

CONTINUED TABLE 1.

Siphotrochammina lobata	.	.	X	X	X	X	X	.	.	X	.	.	X	c, i, n
Siphotrochammina sp.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
Spiroplectammina biformis	.	X	.	.	.	.	.	.	.	.	.	.	.	.
Textularia earlandi	X	X	X	.	.	X	X	.	.	.	X	X	.	d, n, q
Textularia gramen	.	.	.	.	.	.	.	.	.	.	X	.	.	p
Textularia paranaguensis	.	.	.	.	.	.	X	.	.	.	.	.	.	n
Textularia sp.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Tholosina centroforata	.	.	.	.	.	.	.	.	X	.	.	.	.	.
Tiphotrocha comprimata	X	X	X	.	.	X	X	.	.	X	X	.	.	a, c, n, k
Trilocularena patensis	.	.	.	.	.	.	X	.	.	.	.	.	.	.
Trochammina inflata	X	X	X	.	X	X	X	.	.	X	X	.	.	a, c, d, i, k, n, p
Trochammina sp.	.	X	X	.	.	X	.	X	X	X	.	.	.	c
Trochammina squamata	X	X	X	.	.	.	X	.	.	.	.	.	X	a, n
Trochamminita irregularis	.	.	X	.	.	.	X	.	.	.	.	X	.	c, k, q, n
Trochamminita salsa	.	.	.	.	.	X	X	.	.	X	.	.	X	.
Warrenita palustris	.	.	X	.	.	X	X	.	.	.	.	X	.	c, q, n

^aBarbosa et al. (2005); ^bEichler & Bonetti (1995); ^cBonetti & Eichler (1997); ^dSemensatto-Jr. et al. (2009); ^eDuleba & Debenay (2003); ^fBonetti et al. (2002); ^gEichler et al. (2007); ^hPassos et al. (2017); ⁱEichler (2019); ^jKukimodo & Semensatto (2019); ^kZaninetti et al. (1977); ^lBrönnimann et al. (1979); ^mBrönnimann et al. (1981); ⁿLaut & Rodrigues (2011); ^oZaninetti et al. (1979); ^pZerfass et al. (2006); ^qSemensatto Jr. & Dias-Brito (2004); ^rSemensatto et al. (2008); ^sLaut et al. (2010).

generally rare, and their tests may not have adequate conditions for image capture, and in the publications, it is preferred to illustrate the main species found. Thus, it is suggested to publish images of species not yet illustrated in Brazil, in order to constitute visual references and contribute to their identification.

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