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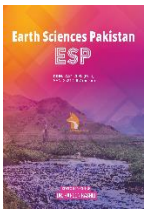

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RESEARCH ARTICLE

CONTRIBUTIONS TO THE ROMANIAN MIOCENE BENTHIC FORAMINIFERA

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ABSTRACT

The modern taxonomical consideration of the twenty seven Paleogene-Neogene smaller benthic foraminiferal species belonging to seven genera from the Northern Tethyan of Romania (East Europe), and other countries with nearly synchronous stratigraphic level represent good example of the Tethyan assemblage. Seven of the identified species are believed here to be new: *Laevidentalina popescui*, *Annulofrondicularia crihanae*, *Tollmannia haidari, T. omari, T. romanica*, *Percultazonaria romanica* and *Lenticubella romanica.* Environmental conditions of the identified species represent outer shelf-Bathyal environment (~200-2000m).

KEYWORDS

Benthic Foraminifera, Lagenid, Neogene, Tethys, Romania.

1. INTRODUCTION

The present study deals with the taxonomic consideration of Paleogene-Neogene 27 benthic foraminiferal species of the suborder Lagenid species from Romania (East Europe) and some other localities in the Tethys (Figure 1. A,B).

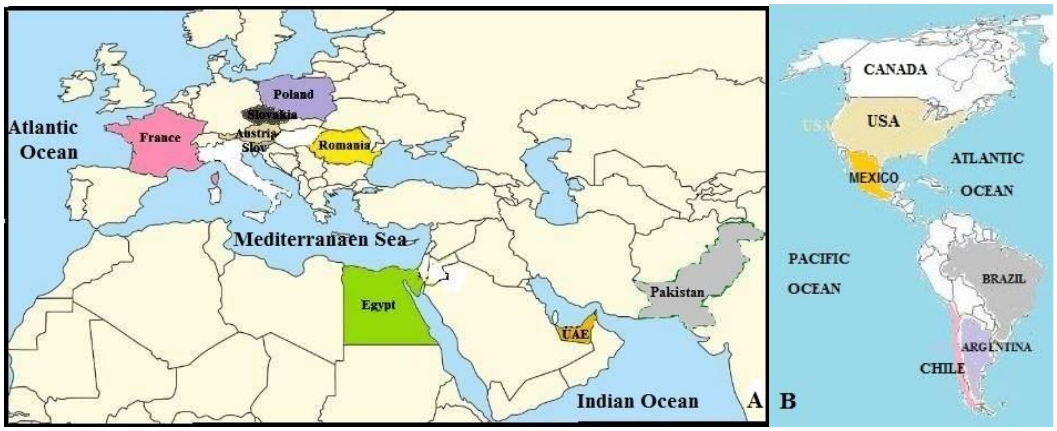

Figure 1: Lagenid recorded benthic foraminiferal species in some countries of the Tethys, A) Europe and Middle East, B) USA, Chile and Argentina.

2. MATERIAL AND METHODS

The modern taxonomical consideration of good preserved twenty seven Romanian Miocene benthic foraminiferal species are treated in this study.

3. SYSTEMATIC PALEONTOLOGY

The taxonomy of Loeblich and Tappan in 1988 is followed here for twenty seven Lagenid benthic foraminiferal species, which belong to seven genera, were recorded from the Miocene stratigraphic succession of Romania (East Europe) and other sites in the Tethys: USA, Chile, Argentina, West and Central Europe and Middle East. These identified species are illustrated in Plate (1).

Plate 1

Figure 1. *Laevidentalina ameeri* (Anan, 2022a). 2. *L. hudae* (Anan, 2015). 3. *L. jannoui* (Anan, 2023a). 4. *L. popescui* (Anan, n. sp). 5. *L. salimi* (Anan, 2009). 6. *Annulofrondicularia annularis* (d'Orbigny, 1846). 7. *A. bignoti* (Anan, 2002b); 8. *A. crihanae* (Anan, n. sp.). 9. *A. sztrakosae* (Anan, 2022b). 10. *Tollmannia argentinica* (Anan, 2023a) 11. *T. costata* (d'Orbigny, 1846). 12. *T. fingeri* (Anan, 2023b) 13. *T. haidari* (Anan, n. sp.) 14. *T. omari* (Anan, n. sp.) 15. *T. romanica* (Anan, n. sp.). 16. *Proxifrons interrupta* (Karrer, 1877); 17. *P. lapugyensis* (Neugeboren, 1856), 18. *Spincterules anaglyptus* (Loeblich and Tappan, 1988). 19. *S. ariminensis* (d'Orbigny, 1846); 20. *S. curvicosta* (Seguenza, 1880). 21. *Percultazonaria brantlyi* (Garrett, 1941); 22. *P. fragaria* (Gümbel, 1868). 23. *P. romanica* (Anan, n. sp.) 24. *Lenticubella irregularis* (Pożaryska, 1957); 25. *L. misrensis* (Anan, 2022c). 26. *L. polonica* (Anan, 2022c). 27. *L. romanica* (Anan n. sp.)

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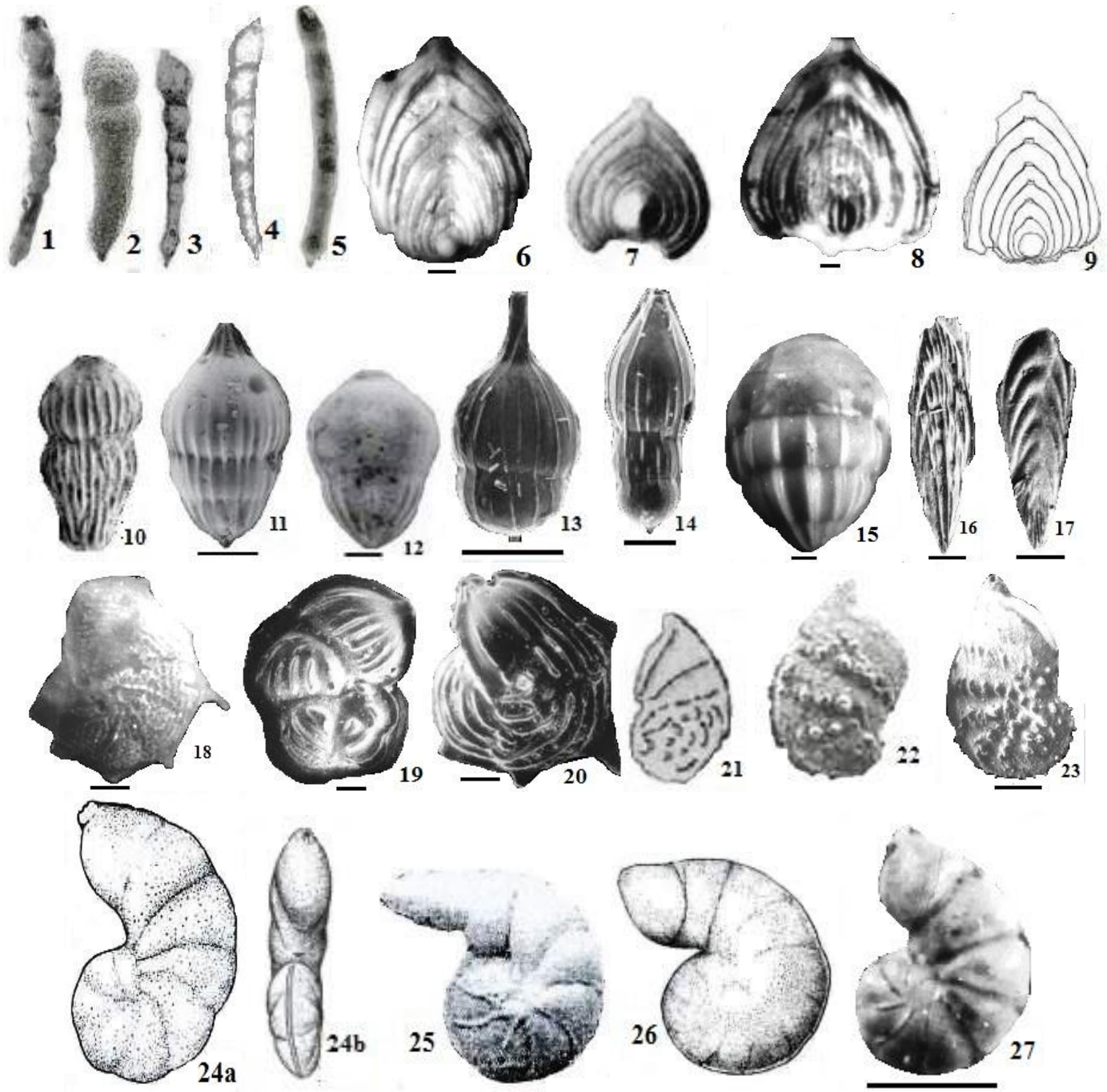

Order Foraminiferida Eichwald, 1830

Suborder Lagenina Delage and Hérouard, 1896

Genus *Laevidentalina* (Loeblich and Tappan, 1986)

L. ameeri Anan, 2022a, p. 40, plate 1, figure. 10. Early Eocene. Egypt.

L. hudae Anan, 2015, p. 65, plate 1, figure 1. Paleocene. United Arab Emirates (UAE).

L. jannoui Anan, 2023a, p. 36, plate 1, figure 1. Early Eocene. Argentina.

L. popescui Anan, n. sp. (=*Laevidentalina* sp. 2 - Popescu and Crihan, 2000, p. 398, plate 4, figure 23).

Holotype: Plate 1, figure 4.

Etymology: after Gheorghe Popescu, Geological Institute of Romania.

Stratigraphic level: Middle Miocene.

Diagnosis: This new species has elongate and arcuate smooth test, apiculate globular proloculus, uniserial chambers nearly cylindrical smaller than proloculus, chambers gradually increased as added, sutures slightly depressed, aperture terminal radiate.

Remarks: *L. popescui* may be evolved from the M-L Eocene *L. salimi* Anan, 2009.

L. salimi Anan, 2009, p. 3, plate 1, figure 2. Eocene. UAE.

Genus *Annulofrondicularia* (Defrance, 1826)

A. annularis (d'Orbigny, 1846). Eocene-Middle Miocene. France, Romania.

A. bignoti (Anan, 2002), p. 632, figure. 2). Paleocene. Egypt.

*A. crihan**ae*** Anan, n. sp. (=*Annulofrondicularia annularis* – Popescu and Crihan, 2000, p. 388, plate. 1, figure 13).

Holotype: Plate 1, figure 8.

Etymology: after Ileana-Monica Crihan, University Petroleum and Gas, Romania.

Stratigraphic level: Middle Miocene.

Diagnosis: Test large flattened palmate, initial chamber globular followed by 4 broad low equitant arched chambers, sutures arched, surface ornamented with longitudinal costae, aperture terminal.

Remarks: This new species has fewer chambers than the other species, and

ornamented by longitudinal costae. *A. crihanae* may be evolved from the L Eocene *A. sztrakosae* Anan, 2022c.

A. sztrakosae Anan, 2022c., p. 4, plate 1, figure 8. Eocene. France.

Genus *Tollmannia* Sellier de Civrieux and Dessauvagie, 1965

T. argentinica Anan, 2023a, p.37, plate 1, figure 6. Eocene. Argentina.

T. costata (d'Orbigny, 1846). Eocene. France, Austria.

T. fingeri Anan, 2023b, p. 42, plate 1, figure 4. Miocene. Chile.

T. haidari Anan, n. sp. (=*Lagenodosaria* sp. - Mohan et al., 2011, p. 57, plate 7, figure 6).

Holotype: Plate 1, figure 13.

Etymology: after the grandson Haidar Samer.

Stratigraphic level: Miocene of Blake Ridge, NW Atlantic Ocean.

Diagnosis: Test has two chambers increase rapidly in breadth as added with apiculate base, final chamber comprising two-third the length of the test, sutures depressed, surface with longitudinal ribs, aperture terminal with pronounced long neck.

Remarks: *Tollmannia haidari* n. sp. is characterized by semiglobular test, two uniserial chambers, longitudinal ribs on the surface cross the suture, aperture with the long elevated neck.

T. omari Anan, n. sp. (=*Lagenodosaria* sp. - Mohan et al., 2011, p. 57, plate 7, figure 7).

Holotype: Plate 1, figure 14.

Etymology: after the grandson Omar Samer.

Stratigraphic level: Miocene of Blake Ridge, NW Atlantic Ocean.

Diagnosis: Test has elongate three chambers increase rapidly in breadth as added with apiculate base, final chamber comprising half the length of the test, sutures depressed, surface ornamented with longitudinal ribs, aperture terminal.

Remarks: It differs from *T. haidari* by its more elongate test, three chambers than two, without long elevated neck.

T. romanica Anan, n. sp. (=*Lingulina costata* - Popescu and Crihan, 2000, p. 389, plate 1, figure 11).

Holotype: Plate 1, figure 15.

Etymology: after the State of Romania, East Europe.

Stratigraphic level: Middle Miocene.

Diagnosis: Test large, four chambers increase rapidly in breadth as added, final chamber comprising one-third the length of the test, sutures depressed, surface with longitudinal ribs, aperture terminal.

Remarks: This species is characterized by an large globular-semi globular test, longitudinal ribs on the surface except the smooth final chamber.

Genus *Proxifrons* (Vella, 1963)

P. interrupta (Karrer, 1877), p. 380, plate 16b, figure 27. Miocene. Romania.

P. lapugyensis (Neugeboren, 1856), p. 93, plate 5, figures. 1, 2. Miocene. Romania.

Genus *Spincterules* de (Montfort, 1808)

S. anaglyptus Loeblich and Tappan, 1988. Miocene-Holocene. Morocco, Romania.

S. ariminensis (d'Orbigny, 1846). Miocene. France, Austria, Romania.

Remarks: It differs from *S. curvicostata* (Seguenza) by the lower number of chambers on the last whorl (7, 8 to *S. curvicostata* instead of 6, 7) and the absence of the marginal spines.

S. curvicosta (Seguenza, 1880) [*In* Popescu and Crihan, 2000]. Miocene. Romania.

Genus *Percultazonaria* (Loeblich and Tappan, 1968)

P. brantlyi (Garrett, 1941), p. 154, plate 26, figures. 1-4. Paleocene-Middle Eocene. USA, Argentina, Egypt, Pakistan.

P. fragaria Gümbel, 1868, p. 57, plate 1, figure 58. Eocene. USA, France, Slovenia, Slovakia.

P. romanica Anan, n. sp. (= *Percultazonaria* sp. - Popescu and Crihan, 2000, p. 398, plate 4, figure 9).

Holotype: Palate 1, figure 23.

Etymology: after the State of Romania.

Stratigraphic level: Middle Miocene.

Diagnosis: This species has moderately elongated test, close coiled early stage, later uncoiling and rectilinear, somewhat flattened, chambers broad and low, surface ornamented by beedlike tubercles that are arranged in inclined lines in closed planispiral involute part, aperture radial at the peripheral angle, commonly slightly produced.

Remarks: This species differs from other species by its rectilinear uncoiling part of the test.

Genus *Lenticubella* (Anan, 2022)

L. irregularis (Pożaryska, 1957), p. 124, plate 16, figures 1, 3. Paleocene, Poland.

L. misrensis Anan, 2022c, p. 19, plate 1, figure 4. Paleocene. Egypt.

L. polonica Anan, 2022c, p. 19, plate 1, figure 3. Paleocene, Poland.

L. romanica Anan, n. sp. (=*Lenticulina kittlii*-Popescu and Crihan, 2000, p. 392, plate 2, figure 9, *non* figure 10).

Holotype: Plate 1, figure 27.

Etymology: after the State of Romania.

Stratigraphic level: Miocene.

Diagnosis: Test smooth involute, with tendencies to uncoil or uncoiled in the adult stage, chambers numerous about 10-12, gently increasing in size as added, sutures depressed thickened, peripheral margin slightly angular, aperture radiate on the top of the last formed chamber.

Remarks: It differs from the other species by its depressed thickened sutures.

4. PALEOGEOGRAPHY

The following remarks can be presented:

This study proved that the paleogeographic distribution of the Lagenid genera (*Laevidentalina*, *Annulofrondicularia, Tollmannia*, *Proxifrons*, *Spincterules*, *Percultazonaria*, *Lenticubella*) and its species are expanded into more than ten different countries in the Northern and Southern Tethys (USA, Chile, Argentina, France, Austria, Poland, Slovakia, Slovenia, Egypt, UAE and Pakistan). (See Figure 1).

The Paleogene paleogeographic maps of many authors (Zachos et al., 1993; Morsi et al., 2008; Finger, 2013; Salahi, 2021) show that the Tethyan realm had been connected with the Indo-Pacific Ocean from east to Atlantic Ocean to the west (Figure 2).

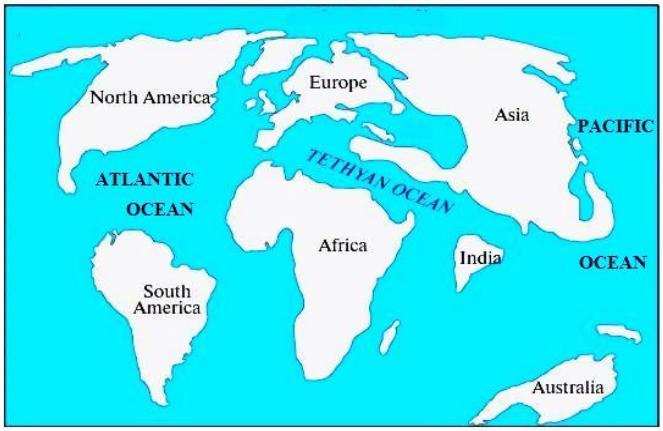

Figure 2: Paleogene paleogeography of the Tethys Ocean (Salahi, 2021).

About 40% (11/27) of the total recorded Lagenid species in this study were described from Romania, 14% (4/27) from France and Egypt, 11% (3/27) from USA, and 0.03% from the other countries in the Tethys.

More than one species have wide geographic distribution around the world. Some of them have four localities: i.e. *Percultazonaria brantlyi* and

Percultazonaria fragaria, while *Spincterules ariminensis* has three localities, but *Proxifrons interrupta* has two localities. The other species have an endemic to the original description.

The existence of a marked differences between the number of recorded benthic foraminiferal species in the closest or farest localities in respect with Romania may due to one or more parameters: the differences in the paleoenvironmental conditions.

5. PALEOENVIRONMENT

Most recorded species in this study were erected from many countries in the Tethys, which are indicated an open connection of the Tethys and represent fully marine outer shelf to upper bathyal foraminifera assemblages in an open deep marine basin during the Paleogene-Neogene time (Aubry et al., 2007) (Figure 3).

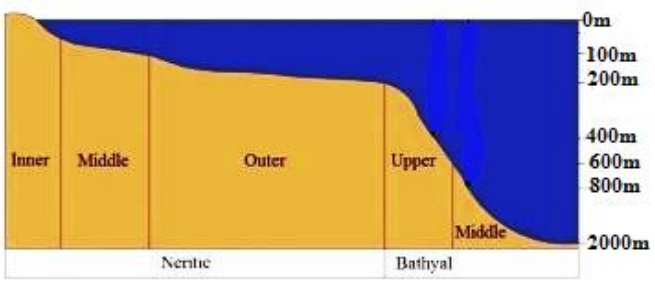

Figure 3: Different zones of the water-depths, from neritic to bathyal environment.

This conclusion supports the open flow direction of the Tethyan Circumglobal Current (TCC) in all directions (Abed, 2013) (Figure 4).

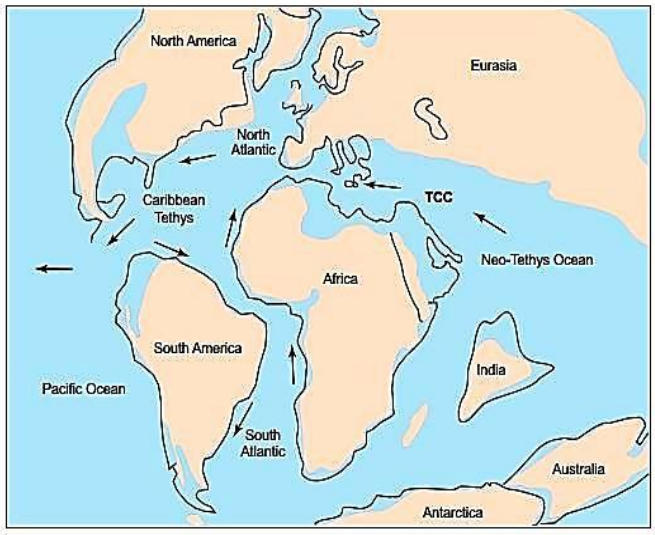

Figure 4: The Neo-Tethys Ocean during the Late Cretaceous-Paleogene times showing the open flow direction of the Tethyan Circumglobal Current (TCC) in all directions (after Abed, 2013).

6. CONCLUSIONS

The present study deals with the recording of the twenty seven Paleogene-Neogene smaller benthic foraminiferal species belonging to seven genera from the Northern Tethyan of Romania (East Europe), and other countries with nearly synchronous stratigraphic level represent good example of the Tethyan assemblage. Seven of the identified species are believed here to be new: *Laevidentalina popescui*, *Annulofrondicularia crihanae*, *Tollmannia haidari*, *T. omari, T. romanica*, *Percultazonaria romanica* and *Lenticubella romanica.* Environmental conditions of the identified species represent outer shelf-upper Bathyal environment (~200-1000m). Evolutionary changes of the some identified species are presented, and these changes help to define the major faunal change through that time.

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