

REVIEW ARTICLE

THE LAGENID BENTHIC FORAMINIFERAL GENUS WIGNALLYIA ALY AND ITS MEMBERS IN THE TETHYS

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ABSTRACT

Three species of the Eocene Lagenid benthic foraminiferal genus *Wignallyia* Aly are known from the Northern and Southern Tethys. The genus *Wignallyia* is characterized by its elongate test, involute earlier chambers and covered by beaded tubercles, and followed by uniserial globular chambers with longitudinal costae covered the surface, ended by a terminal circular aperture with thickened lip on a short neck. These species are: *Wignallyia hewaidyi*, *W. infracompressa* and *W. behmi*. The first two species are common in many sites in Egypt (Beni Suef area in Nile Valley, Fayoum area, southeast Cairo), and also are recorded in Poland and Hungary. The third one *W. behmi* is recorded in Italy, France, Swiss, Austria, Italy, Poland, Hungary and Slovenia (Northern Tethys), as well as in Egypt and the United Arab Emirates, UAE (Southern Tethys). The taxonomic consideration, stratigraphic implication of the erected taxa, and paleogeographic distribution of the identified species on both sides of the Tethys are also presented and discussed.

KEYWORDS

Lagenid, *Wignallyia*, Paleontology, Stratigraphy, Paleoenvironment, Paleogeography, Eocene, Egypt, UAE, Europe, Tethys

1. INTRODUCTION



Figure 1: The location map of the four localities which have Middle/Upper Eocene outcrop sections in Egypt: 1. Wadi Tayiba (Sinai), 2. Maadi (southeast Cairo), 3. Fayoum (southwest Cairo), 4. Beni Suef, Nile Valley.

The genotype of the Middle-Upper Eocene Lagenid genus *Wignallyia* Aly was originally erected from Beni Suef area, Nile Valley of Egypt (Figure 1.4) (Aly, 2016). The paleontological occurrence of the three species

belonging to this genus has been recorded from many localities in Northern Tethys (Italy, France, Swiss, Austria, Italy, Poland, Hungary and Slovenia, Figure 2) and also Southern Tethys (Egypt and UAE). Different species belonging to this close coiled to uncoiled Lagenid genus *Wignallyia* have been examined by the present authors. Two species of them *W. behmi* and *W. hewaidyi* are distinguished by their beaded tubercles in its initial portion with 16-18 longitudinal costae covered the uniserial portion, while the third species *W. infracompressa* has beaded tubercles between the longitudinal costae all over the test. All species ended by a terminal apertural neck. The assemblage of this genus indicates an open marine environment, which represents middle-outer neritic environment, and shows an affinity with Midway-Type Fauna (MTF).

2. STRATIGRAPHICAL REVIEW

Studies on planktic and benthic foraminifera around the Middle/Upper (M/U) Eocene boundary in Egypt (Sinai, Maadi, Fayoum and Beni Suef) were carried out by many authors. i. e. Figure 3 (Ansary, 1955; Haggag, 1989; Strougo, 1992; Anan, 1994; Aly et al., 2011; Aly 2016). Some planktic micropaleontologists considered the extinction of the Middle Eocene spinose forms as marking the contact between the Middle and Upper Eocene in Egypt. Haggag draw this contact between the *Truncorotaloides rohri* Zone (P14) and her *Turborotalia pseudoampliapertura* Zone, followed by the *Globigerinatheka semiinvoluta* Zone (P15) in the standard planktic foraminiferal zonation of (Haggag, 1989; Toumarkine and Luterbacher, 1985). Strougo followed by draw the base of the Upper Eocene at the first appearance of *G. semiinvoluta* (Strougo, 1992; Anan, 1994; Zone E14, after Berggren and Pearson, 2005). On the other hand, the benthic foraminiferal biozones of the M/U Eocene received different nomenclatures by different authors in Egypt, and this may due to the non-homogenous faunal assemblages in the different localities. Ansary proposed different benthic foraminiferal biozones according to different

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localities: In Sinai (Wadi Tayiba), from younger to older: 3 (Ansary, 1955). Lituolidae Zone, 2. *Bulimina jacksonensis-Uvigerina mediterranea* Zone, 1. *Anomalina cocoaensis* Zone. In Maadi area (south Cairo): 2. *Bolivina-Nonion* Zone, 1. *Robulus-Bolivina-Nonion* Zone. In Fayoum area: 2. *Haplophragmoides emaciatus* Zone, 1. *Gyroidina cibaoensis* Zone. Anan identified two benthic biozone for M/U Eocene in Egypt, from younger to older: 2 (Anan, 1994). *Bulimina jacksonensis-Uvigerina jacksonensis* Assemblage Zone (Late Eocene), 1. *Palmula ansaryi* Zone (Middle Eocene). A group researchers considered the *Bulimina jacksonensis-Uvigerina jacksonensis* Assemblage Zone as equivalent to the *Truncorotaloides rohri-T. pseudoampliapertura* Zone (P15), but Late Eocene *Globigerinatheka semiinvoluta* and *Turborotalia cerroazulensis*, s. l. (P16/17) as noted (Anan, 1994; Aly et al., 2011).

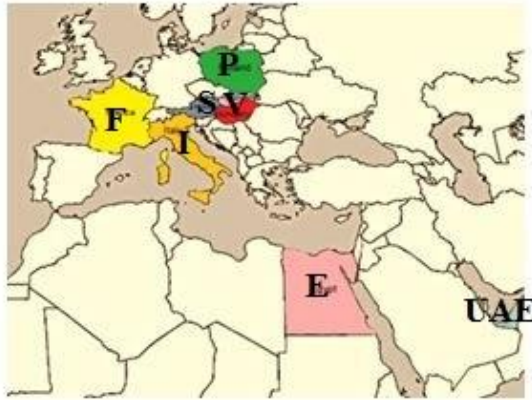


Figure 2: Map of some countries showing the distribution of the recorded species of the genus *Wignallyia*: Europe (P=Poland, V=Slovenia, F=France, I=Italy), as well as in the northeast Africa (E=Egypt) and southwest Asia (UAE).

3. FAUNAL DISCUSSION

The *Wignallyia* Aly has elongate slightly arcuate test, circular in section, early stage slightly coiled but not completely enrolled covered by raised nodes and beaded tubercles, later uniserial chambers gradually increased in size as added with prominent longitudinal costae, sutures depressed horizontally, wall calcareous hyaline radial, aperture radiate at the center of the terminal chamber, produced on a neck (Aly, 2016). This genus *Wignallyia* differs from the genus *Marginulinopsis* Silvestri in possessing two lamellar canaliculated wall structure, globular chamber in the uncoiled stage covered by nodes, depressed sutures and centered position of the terminal aperture, than not completely enrolled initial stage as in *Marginulinopsis* (Pl. 1, figs. 1, 2) with longitudinal costae all over the test chambers of the two stages, as treated (Silvestri, 1904; Loeblich and Tappan, 1988).

4. SYSTEMATIC PALEONTOLOGY

The taxonomy of Loeblich & Tappan (1988) is used for this study.

Order Foraminiferida Eichwald, 1830

Suborder Lagenina Delage and Hérouard, 1896

Superfamily Nodosariacea Ehrenberg, 1838

Family Vaginulinidae Reuss, 1860

Subfamily Marginulininae Wedekind, 1937

Genus *Wignallyia* Aly, 2016

Type species *Marginulinopsis infracompresa* Thalmann, 1937

***Wignallyia behmi* (Reuss, 1866)** - (Pl. 1, figs. 3-5)

1866 *Cristellaria* (*Marginulina*) *behmi* Reuss, p. 138, pl. 2, fig. 37.

1977 *Marginulinopsis behmi* (Reuss) - Pozaryska, p. 24, pl. 2, figs. 27; pl. 3, figs. 3, 6.

2000 *Marginulina behmi* (Reuss) - Sztrákos, p. 161.

2006 *Marginulinopsis behmi* (Reuss) - Cimerman et al., p. 24, pl. 5, fig. 1.

Remarks: This species has slightly curved elongated test, early stage large and represent about half of the whole test, closed coil not completely enrolled with keel and covered by raised nodes, later uniserial stage more or less globular, rounded in section, increased in size, covered by

10-12 longitudinal costae, not extend over the depressed horizontal sutures, the inter-costal spaces smooth, aperture rounded on neck, situated at the central part of the last chamber. The figured specimens of Pozaryska (1977, pl. 3, figs. 3, 6) belong here to the *W. behmi*, while the other figured specimens (1977, pl. 3, figs. 1, 2, 4) belong to the genus *Marginulina*, which characterized by its ornamented costate surface along the test. *W. behmi* is recorded from Swiss, Poland, France, Slovenia (Northern Tethys).

***Wignallyia hewaidyi* (Aly, 2011)** - (Pl. 1, figs. 6-13)

1977 *Marginulinopsis behmi* (Reuss) - Pozaryska, p. 24, pl. 3, figs. 7-9.

2007 *Marginulina behmi* (Reuss) - Ozsvárt, p. 53, pl. 5, fig. 17.

2011 *Marginulinopsis hewaidyi* Aly - Aly et al., p. 92, pl. 3, fig. 2.

2016 *Wignallyia hewaidyi* (Aly) - Aly, p. 164, pl. 3, figs. 1-3.

2016 *Wignallyia johnsoni* Aly, p. 164, pl. 3, figs. 4, 9-11.

2016 *Wignallyia* sp. Aly, p. 166, pl. 3, figs. 47, 8, 12.

2019 *Marginulinopsis hewaidyi* Aly - Anan, p. 260, pl. 1, fig. 16.

Remarks: This species has slightly curved elongated test, early portion compressed, closed coil, slightly curved, represent about $\frac{1}{4}$ of the whole test, last uniserial portion formed of 2-4 globular chambers covered by about 16 discontinuous straight longitudinal costae, not extend over the depressed horizontal sutures and the inter-costal spaces smooth, aperture rounded on neck situated at the central part of the last chamber. This species differs from *W. behmi* (Reuss) by its smaller initial portion of the test, larger numbers of the longitudinal costae. The figured specimens of Aly as *W. johnsoni* and *W. sp.* are included here in the specific concept of *W. hewaidyi*, because the only difference between them is the chamber number of the uniserial portion which ranged between 2-4 chambers. *W. hewaidyi* is recorded from Poland, Hungary (N. Tethys) and Egypt (S. Tethys).

***Wignallyia infracompresa* (Thalmann, 1937)** - (Pl. 1, figs. 14-17)

1937 *Marginulinopsis infracompresa* Thalmann, p. 348, pl. 23, fig. 2.

1955 *Marginulina infracompresa* (Thalmann) - Ansary, p. 38, pl. 2, fig. 29.

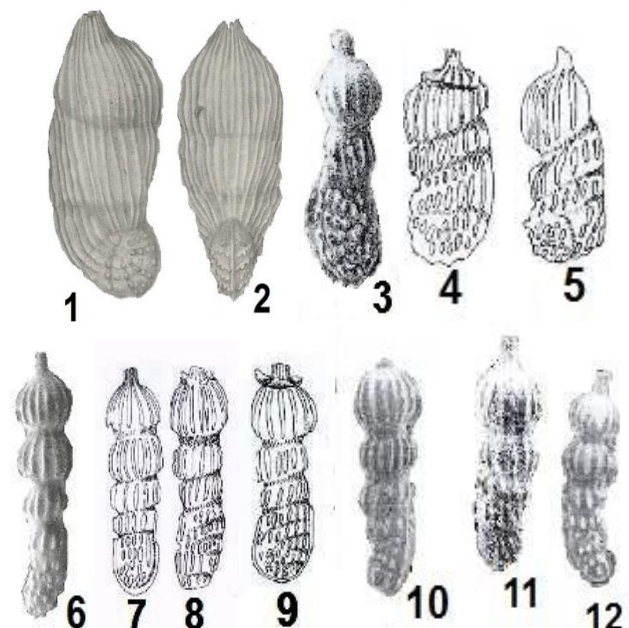
1975 *Marginulina behmi* (Reuss) - Braga & Grünig, p. 105, pl. 4, fig. 13.

2009 *Marginulinopsis infracompresa* Thalmann - Anan, p. 6, pl. 1, fig. 6.

2011 *Marginulinopsis infracompresa* Thalmann - Aly et al., p. 92, pl. 3, fig. 1.

2016 *Wignallyia infracompresa* (Thalmann) - Aly, p. 164, pl. 3, figs. 5, 6.

Remarks: This species has slightly curved elongated test as other species of the genus. It differs from other *Wignallyia* spp. in its nodes in the inter-costal space in the uniserial chambers and the apertural neck. *W. infracompresa* was recorded from Italy (N. Tethys), Egypt and UAE (S. Tethys).



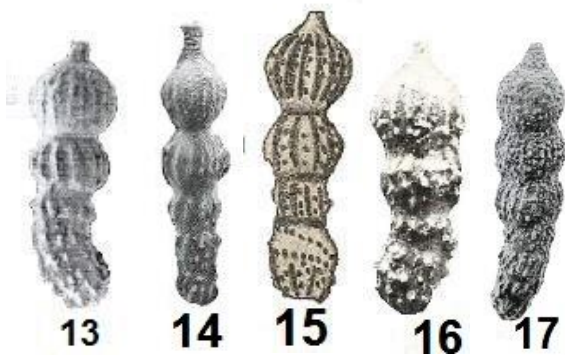


Plate 1: Figs. 1, 2: *Marginulinopsis bradyi* (Goes), side and front views x 50. 3-5: *Wignallyia behmi* (Reuss), 3. (after Cimerman et al., 2006) x 30, 4, 5. (after Pozaryska, 1977) x 60. 6-13: *Wignallyia hewardi* (Aly), 6, 7. specimen with four globular uniserial chambers x 20 (after Aly, 2016) x 20, 8, 9. specimens with three uniserial chambers) after Pozaryska (1977) x 20. 10. specimen with four uniserial chambers, after Aly (2016) x 20. 11. specimen with three uniserial chambers, after Ozsvárt (2007) x 25, 12,13. specimens with two uniserial chambers, after Aly (2016) x 25. 14-17: *Wignallyia infracompressa* (Thalmann), 14. after Aly (2016) x 25, 15. after Ansary (1955) x 45, 16. after Braga & Grünig (1975) x 40, 17. after Anan (2009) x 25.

5. PALEOGEOGRAPHY

The representatives of the genus *Wignallyia* have wide geographic distribution in the Tethys, from west to east: Europe, north Africa and southwest Asia (Fig. 3) (Aly, 2016). One species *W. infracompressa* (Thalmann) was recorded from Europe, Egypt and UAE. *W. behmi* (Reuss) is confined to Europe (Austria, Poland, France and Slovenia), while the third species *W. hewardi* (Aly) was recorded, so far, from Egypt, Poland, Hungary. A group researcher noted the continuous marine Paleogene connection between the area of the present-day Mediterranean and the Indian Ocean had been isolated in Burdigalian (early Oligocene) time when a land bridge connected southwest Asia to Arabia, which means that the faunas of the Mediterranean and Indo-West Pacific began to diverge (Adams et al., 1983). A group researcher recorded the extended realms of the Tethys, Indo-Pacific with Atlantic Oceans in the Maastrichtian-late Eocene (Zachos et al., 1993). Anan concluded that the Tethyan Realm during the Middle-Late Eocene extends to the southeast and connected with the Indo-Pacific Realm via seaway (Anan, 1995). Some researchers show that the Tethyan Realm had been connected with the Indo-Pacific Ocean to the east and with the Atlantic Ocean to the west via the Mediterranean Sea cross the Middle East region during the Late Cretaceous and early Cenozoic times (Rosenbaum et al., 2002). Anan noted that the Egyptian Paleogene assemblage suggest gradual paleogeographical changes from transitional open marine facies in the northern and central Egypt to shallow shelf setting in the southern Egypt (Anan, 2017).

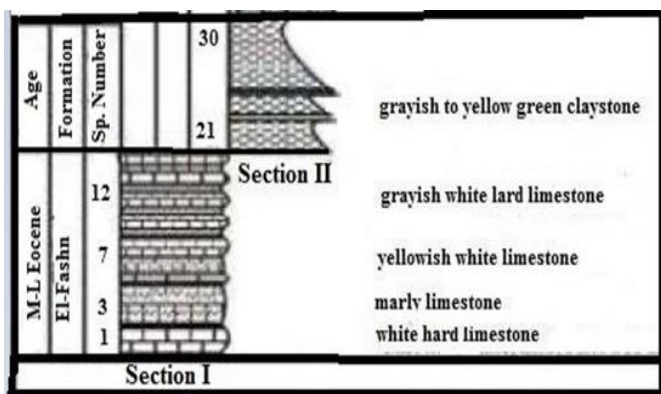


Figure 3: Stratigraphic composite section of the Middle-Late Eocene of Bayad El Arab (section I) and Gabal Homret Shaibon (section II), Beni Suef area, Nile Valley, Egypt (after Aly, 2016).

6. PALEOECOLOGY AND PALEOBATHYMETRY

Keller noted that general cooling trend between middle Eocene to early late Oligocene is indicated by the successive replacement of warm middle Eocene surface water species (planktic) by cooler Late Eocene

intermediate water species (Keller, 1983). This is indicated by the coexistence of surface, intermediate and deep dwelling species group, suggest that increased thermal gradients developed between the equator and poles nearly coincident with the development of late psychrosphere. Cherif & EL Deeb noted that arid climate at the close of the middle Eocene became markedly wetter and seems to have been accompanied by a cooling of the water temperature (Cherif and EL Deeb, 1984). Moreover, the climatic changes inferred from the Hafit area seems to have been widespread, at least in part of the Middle East. Anan noted that in the late Eocene time in the UAE and surrounding areas had been located in the tropical and warm-temperate region based on many faunal environmental elements (Anan, 1995). This interpretation is in accordance with the worldwide conclusions (Berggren, 1978; Moore et al., 1978). Ozsvárt noted that the diversity and composition of benthic foraminiferal assemblages is strongly controlled by water temperature and salinity of water mass, especially, in shallow and deeper region on shelves, where changes in temperature and salinity might pass off rapidly (Ozsvárt, 2007). In this study, The existence of the genus *Wignallyia* and its species in the northern Egypt than the southern Egypt, as well as the other localities in the Northern and Southern Tethys due to a middle-outer neritic environment, and shows an affinity with Midway-Type Fauna (MTF).

7. CONCLUSION

This study includes three species are found to now follow genus *Wignallyia*: *W. behmi*, *W. hewardi* and *W. infracompressa* which recorded from El Fashn formation, Beni Suef area, Nile Valley, Egypt. The wall structure of the genus *Wignallyia* is distinguished by its sub prismatic crystal of calcite, bilamellar, canaliculated calcareous shell walls. The inner wall surface is smooth, but rough around the septa. The inter-costal space on outer surface in the chambers and apertural neck are smooth in two species: *W. behmi* and *W. hewardi*, but has nodes in the third: *W. infracompressa*. The species *W. behmi* was recorded in different localities in Europe: Austria, France, Poland and Slovenia. The species *W. hewardi* was originally recorded from Beni Suef area of Egypt, while other figured forms of it were recorded in Poland and Hungary, but under different names. The species *W. infracompressa* was recorded originally in Europe, and also in two different localities in Egypt: Beni Suef (southeast) and Fayoum (west Cairo), and UAE. Considered the benthic foraminiferal biozone *Bulimina jacksonensis-Uvigerina jacksonensis* Assemblage Zone, to be equivalent to the *Turborotalia pseudoampliapertura-Truncorotaloides rohri* Zone (Middle Eocene), but Late Eocene by Anan. The rare numbers of these species in different localities in the Northern Tethys in Europe (France, Austria, Italy, Poland, Hungary and Slovenia) and Southern Tethys (Egypt and UAE) may be due the lack of detailed studies, different latitudes, miss identification, land barriers, physically isolated areas, and/or certain paleoenvironmental conditions during the Middle-Late Eocene in the Tethys.

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