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RESEARCH ARTICLE

PALEONTOLOGY, PALEOGEOGRAPHY, PALEOENVIRONMENT OF THE CAMPANIAN-NEOGENE TETHYAN FORAMINIFERAL GENERA AND SPECIES OF ANAN A- SUBORDERS TEXTULARIINA AND MILIOLINA

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ABSTRACT

During the last four decades ago, fifty-seven (54 agglutinated and 3 porcelaneous) benthic foraminiferal species and related to 23 genera have been erected by the present author, which start at 1984, which are recoded from many countries around the Arabia (Egypt, Palestine, Jordan, Iraq, UAE, Iran and Pakistan), and also Saudi Arabia, Yemen, UAE and Qatar. Some of these species were also recorded from many countries in the Northern Tethys (Atlantic Ocean, USA, Spain, France and Poland), and western Pacific Ocean. These species help, not only to define the major faunal changes throughout the Campanian-Neogene time, but also to emphasis the stratigraphic importance of them in different localities in the Tethys. Most of the identified species were erected: 12 species (from Egypt), 11 (UAE), 8 (Iraq), 4 (Iran), 3 (Pakistan and France), 2 (Palestine, Pakistan, Spain and Poland), while one species only from the other countries. The Tethys assemblage indicates an open marine environment, which represents middle-outer neritic environment and shows an affinity with Midway-Type Fauna (MTF).

KEYWORDS

Paleontology, Benthic Foraminifera, Agglutinated, Porcelaneous, Tethys

1. INTRODUCTION

An attempt has been made to bring together the holotypes and paratypes of fifty-seven Campanian-Neogene agglutinated and porcelaneous benthic foraminiferal species were erected in many countries in the Southern and Northern Tethys, which presented in this study (Figure 1).

2. SYSTEMATIC PALEONTOLOGY

The taxonomy of Loeblich & Tappan (1988) is followed in this study for the fifty-seven Campanian-Neogene Textulariid and Miliolid benthic foraminiferal specie were erected by the present author during the time span of about forty years (1984-2023) from many countries in the Northern Tethys and Southern Tethys, which are illustrated in Plate 1.

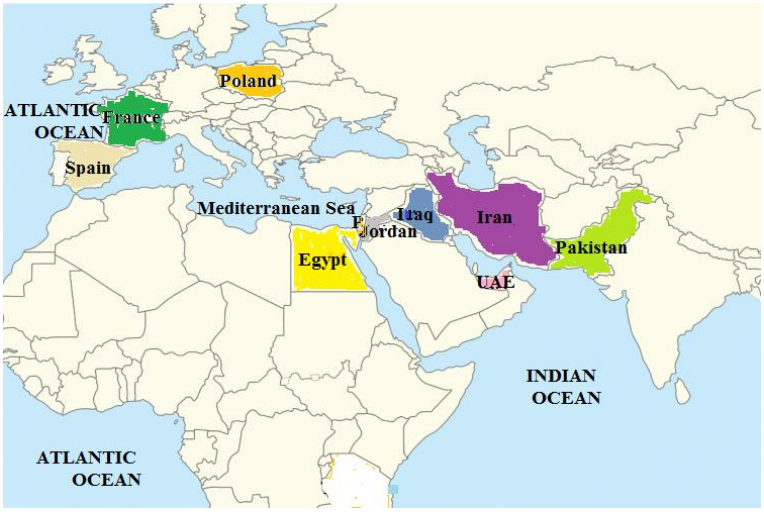

Figure 1: Geographic distribution of the identified agglutinated and porcelaneous benthic foraminiferal species were erected from many counties in the Southern Tethys (Egypt, Palestine, Jordan, Iraq, UAE, Iran and Pakistan) and also Northern Tethys (Spain, France and Poland).

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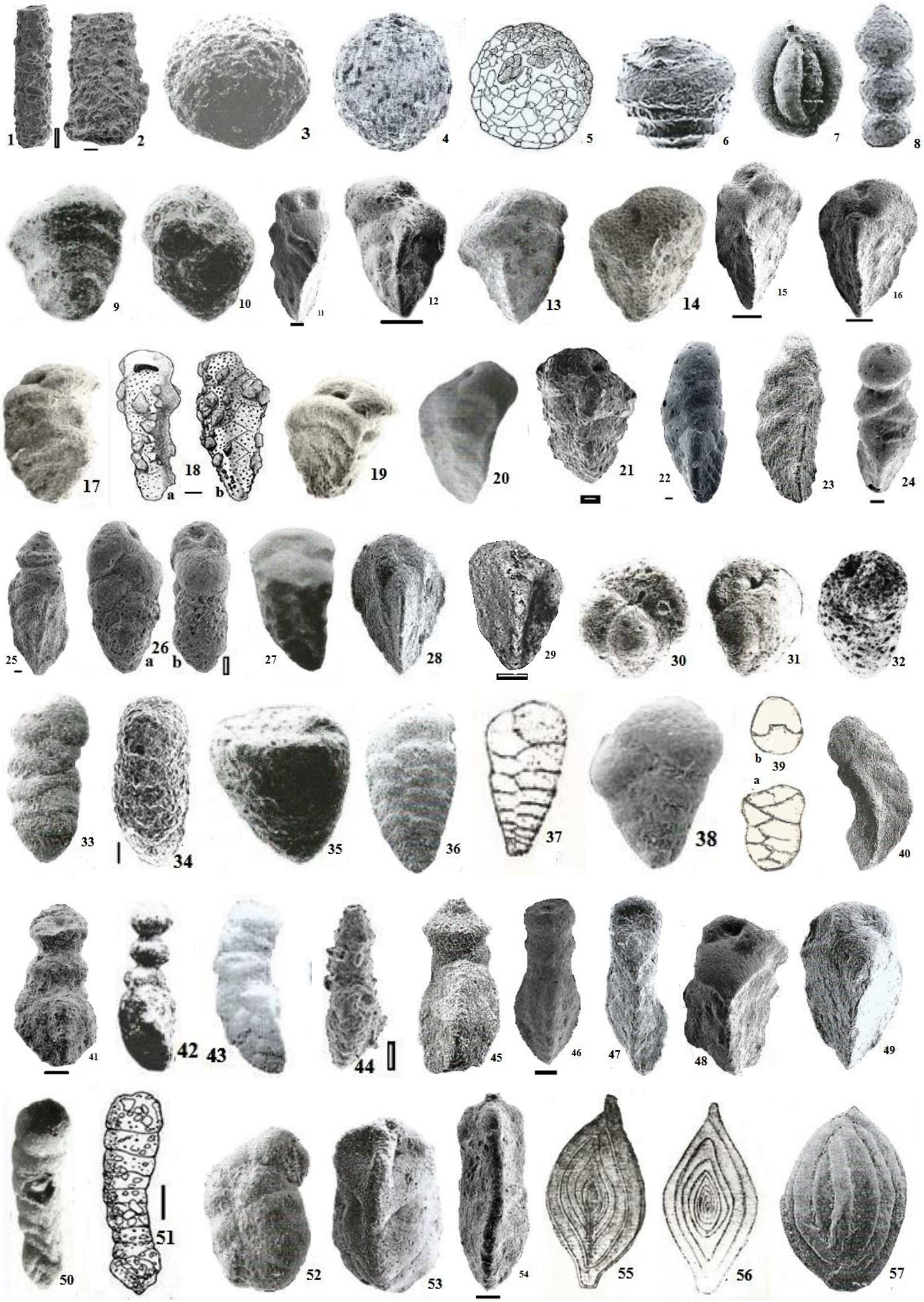
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Plate 1

(1) *Bathysiphon alegretae,* (2) *B. saidi,* (3) *Orbulinelloides arabicus* (4) *O. kaminskii,* (5) *O. sztrakosae* (6) *Repmanina mazeni,* (7) *Miliammina kenawyi,* (8) *Psammolingulina bahri,* (9) *Spiroplectinella hamdani,* (10) *Plectina emiratensis,* (11) *Gaudryina acuta,* (12) *G. ameeri,* (13) *G. arabica,* (14) *G. ennakhali*, (15) *G. jaffi,* (16) *G. lawai,* (17) *G. osmani,* (18) *G. pozaryskai,* (19) *G. salimi,* (20) *G. speijeri*, (21) *G. stasseni*, (22) *Pseudogaudryinella baliniaki,* (23) *P. iranensis*, (24) *P. iraqensis* (25) *P. ortizae*, (26) *Siphogaudryina ortizae* (27) *S. strougoi*, (28) *Verneuilina iraqensis* (29) *V. jordanica*, (30) *Arenobulimina beitjebrinensis* (31) *A. jerusalemensis* (32) *A. kaminskii*, (33) *Dorothia iranica,* (34) *D. sztrákosae***,** (35) *Marssonella hafitensis,* (36) *Textularia fahmyi*, (37) *T. haquei,* (38) *T. salahii***,** (39) *Textulariella sinaensis,* (40) *Clavulinoides iranica***,** (41) *Pseudoclavulina hewaidyi*, (42) *P. futyani*, (43) *P. youssefi,* (44) *P. thomasae*, (45) *P. iranica*, (46) *P. farisi***,** (47) *Pseudogaudryina dababiyaensis* (48) *P. kurdistanensis* (49) *P. iraqensis***,** (50) *Clavulina pseudoparisensis* (51) *C. sztrákosae* (52) *Haplophragmoides iranica* (53) *Tritaxia kaminskii* (54) *T. longa* (55) *Spiroloculina haquei* (56) *S. pakistanica* (57) *Ammomassilina misrensis*.(scale bar=100 µm)

2.1 Foraminiferida Eichwald, 1830

2.1.1 Suborder Textulariina Delage & Hérouard, 1896

(1) *Bathysiphon alegretae* Anan, 2023a, p. 33, pl. 1, fig. 1.

(2) *B. saidi* (Anan, 1994) (=*Rhabdammina saidi* Anan,1994, p. 218, fig. 8. 1).

(3) *Orbulinelloides arabicus* Anan, 2003, p. 531, fig. 4. 1.

(4) *O. kaminskii* Anan, 2021a, p. 55, pl. 1, fig. 6 (=*Psammosphaera* sp. Kaminski & Huang, 1991, p. 178, pl. 1, fig. 11).

(5) *O. sztrakosae* Anan, 2021a, p. 54, pl.1, fig.5 (=*Psammosphaera* sp. Sztrákos, 2000, p.156, pl.1, fig. 2).

(6) *Repmanina mazeni* Anan, 2021b, p. 85, pl. 1, fig. 4**.**

(7) *Miliammina kenawyi* Anan, 1994, p. 218, fig. 8. 2.

(8) *Psammolingulina bahri* Anan, 2021b, p. 85, pl.1, fig. 4.

(9) *Spiroplectinella hamdani* (Anan, 1993) (=*Spiroplectammina hamdani* Anan,1993, p. 652, pl.1, fig.14).

(10) *Plectina emiratensis* Anan, 2003, p. 534, fig. 4. 2.

(11) *Gaudryina acuta* Anan, 2023a, p. 38, pl. 1, fig. 3 (=*G. austinana* Cushman - Jaff & Lawa, 2019, p. 14, pl. 2, fig. 4).

(12) *G. ameeri* Anan, 2012, p. 63, pl. 1, fig. 7.

(13) *G. arabica* Anan, 2022a, p. 39, pl. 1, fig. 5 (=*G. pyramidata* Cushman - Abdelghany, 2003, p. 398, fig. 7.1).

(14) *G. ennakhali* Anan, 2022a, p. 28, pl. 1, fig. 10 (=*G. pyramidata* Cushman - Tjalsma & Lohmann, 1983, p. 12, pl. 8, fig. 1).

(15) *G. jaffi* Anan, 2023b, p. 38, pl. 1, fig. 5 (=*G. pyramidata* Cushman - Jaff & Lawa, 2019, p. 14, pl. 2, fig. 6)

(16) *G. lawai* Anan, 2023b, p. 39, pl. 1, fig. 7 (=*Verneuilina muensteri* Reuss - Jaff & Lawa, 2019, p. 14, pl. 2, fig. 9).

(17) *G. osmani* Anan, 2022a, p. 28, pl. 1, fig. 13 (=*G.* cf. *pyramidata* Cushman - Tjalsma & Lohmann, 1983, p. 31, fig. 8.2).

(18) *G. pozaryskai* Anan, 2023a, p. 33, pl. 1, fig. 3.

(19) *G. salimi* Anan (2022a, p. 28, pl. 1, fig. 12) (=*G. pyramidata* Cushman - Tjalsma & Lohmann, 1983, p. 12, pl. 2, fig. 4).

(20) *G. speijeri* Anan, 2012, p. 66, pl. 1, fig. 10.

(21) *G. stasseni* Anan, 2023a, p. 33, pl. 1, fig. 4.

(22) *Pseudogaudryinella baliniaki* Anan, 2023b, p. 93, pl. 6, fig. 2.

(23) *P. iranensis* Anan, 2022b, p. 16, pl. 1, fig. 5 (=*Gaudryina* sp. Salahi, 2021, p. 314, pl. 4, fig. 23).

(24) *P. iraqensis* Anan, 2023b, p. 94, pl. 6, fig. 4 (=*Tritaxia whitei* (Cushman & Jarvis) - Jaff & Lawa, 2019, p. 14, pl. 2, figs. 14,15).

(25) *P. ortizae* Anan, 2023b, p. 94, pl. 6, fig. 5.

(26) *Siphogaudryina ortizae* Anan*,* 2023a, p. 34, pl. 1, fig. 8.

(27) *S. strougoi* Anan, 2002, p. 141, fig. 2. 1.

(28) *Verneuilina iraqensis* Anan, 2022b, p. 33, pl. 1, fig. 3.

(29) *V. jordanica* Anan, 2022b, p. 33, pl. 1, fig. 4.

(30) *Arenobulimina beitjebrinensis* Anan, 2022b, p. 25, pl. 1, fig. 58.

(31) *A. jerusalemensis* Anan, 2022b, p. 26, pl. 1, fig. 59.

(32) *A. kaminskii* Anan, 2023c, p. 71, pl. 1, fig. 6.

(33) *Dorothia iranica* Anan, 2022b, p. 26, pl. 1, fig. 61.

(34) *D. sztrákosae* Anan, 2023a, p., pl. 1, fig. 6.

(35) *Marssonella hafitensis* Anan, 2003, p. 535, fig. 4.3.

(36) *Textularia fahmyi* Anan, 1994, p. 218, fig. 8.3.

(37) *T. haquei* Anan, 2020, p. 3, pl. 1, fig. 6.

(38) *T. salahii* Anan, 2022b, p. 28, pl. 1, fig. 96.

(39) *T. sinaensis* Anan, 2022b, p. 31, pl. 2, fig. 5.

(40) *Clavulinoides iranica* Anan, 2022b, p. 27, pl. 1, fig. 68.

(41) *Pseudoclavulina hewaidyi* Anan, 2008, p. 248, pl. 1, fig. 1.

(42) *P. futyani* Anan, 2021b, p. 87, pl. 1, fig. 16.

(43) *P. youssefi* Anan, 2021b, p. 88, pl. 1, fig. 18.

(44) *P. thomasae* Anan, 2023a, p. 35, pl. 1, fig. 9.

(45) *P. iranica* Anan, 2022b, p. 16, pl. 1, fig. 6.

(46) *P. farisi* Anan, 2023d, p. 37, pl. 1, fig. 1.

(47) *P. dababiyaensis* Anan, 2022b, p. 15, pl. 1, fig. 2.

(48) *P. kurdistanensis* Anan, 2022b, p. 15, pl. 1, fig.3.

(49) *P. iraqensis* Anan, 2022b, p. 15, pl. 1, fig. 4.

(50) *Clavulina pseudoparisensis* Anan, 1984, p. 239, pl. 1, figs. 6, 7.

(51) *C. sztrákosae* Anan, 2023a, p. 35, pl. 1, fig. 11.

(52) *Haplophragmoides iranica* Anan, 2022a, p. 24, pl. 1, fig. 18.

(53) *Tritaxia kaminskii* Anan, 2021b, p. 86, pl. 1, fig. 12.

(54) *T. longa* Anan, 2023d, p. 39, pl. 1, fig. 11.

2.1.2 Suborder Miliolina Delage & Hérouard, 1896

(55) *Spiroloculina haquei* Anan, 2021b, p. 44, pl. 1, fig. 1.

(56) *S. pakistanica* Anan, 2021b, p. 44, pl. 1, fig. 2.

(57) *Ammomassilina misrensis* Anan, 2021c, p. 88, pl. 1, fig. 22.

3. PALEOGEOGRAPHY

The paleogeographic maps were used by many authors proved that the Tethyan Realm had been connected with the Atlantic Ocean to the west and Indo-Pacific Ocean from the east via the Mediterranean Sea (Figure 2) (Solakius et al., 1990, Zachos et al.,1993; Rosenbaum et al 2002; Morsi et al., 2008; Stassen et al., 2012; Finger, 2013; Anan, 2022a).

4. PALEOENVIRONMENTS

The arenaceous foraminifera tend to increase in cooler environment, which means that increase in shallow-water environments or in upper bathyal environment or more deeper (Murray, 1973). A study infer that certain hydrographic properties (low oxygen, high CO3, low pH, and thus more corrosive waters) favor the development of agglutinated assemblages (Miller et al., 1982). The tubular taxa (e.g. *Bathysiphon*) are rare in neritic settings but common in bathyal facies, while elongated serial taxa (e.g. *Gaudryina, Siphogaudryina, Dorothia, Pseudoclavulina*, *Clavulina*) are most common in the upper to middle bathyal assemblages (Nagy et al., 2000). The modern smaller agglutinating foraminifera occur in all marine environments, from marginal to deep, and some are tolerant of hyposalinity as well as normal marine salinity; and/or of hypoxia or dysoxia (Jones, 2014). Recent studies noted that the probable environment of *Bathysiphon* spp. are upper-middle bathyal, but bathyal

and abyssal for *Clavulinoides* and *Gaudryina* (Jaff & Lawa, 2019). The agglutinated tests are weakly held by organic material, which potentially oxidized within the surface layer of sediments (Orabi, 2020). Most recorded species in this study were erected from the Southern Tethys (in Egypt, UAE, Iraq, Iran and Pakistan), and Northern Tethys (in Spain, France, Poland) indicate an open connection of the both sides of the Tethys and represent middle-outer neritic environment (100-200 m) and show an affinity with Midway-Type Fauna "MTF", while the other faunal assemblage in Atlantic and Pacific Oceans belong to deep water agglutinated foraminifera "DWAF", which may live around carbonate compensation depth "CCC", and suggested a lower slope setting at about 1000 m water depth in an open marine basin.

Figure 2: The paleogeographic map at K/T boundary showing the connected seas from west (USA, Atlantic Ocean, Brazil) to east (Indian and Pacific Oceans) via the Mediterranean Sea, as well as the locations of the Northern Tethys localities (Spain, France, Poland) and Southern Tethys localities (Egypt, Palestine, Jordan, Iraq, Iran, UAE, Pakistan; Solakius et al., 1990).

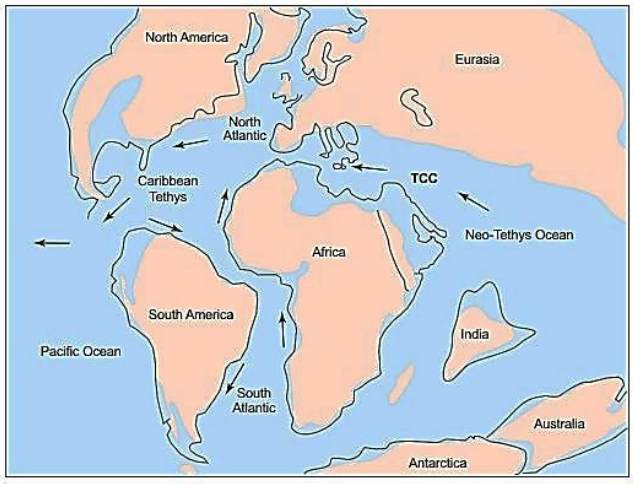

Figure 3: Paleogeography of the Neo-Tethys ocean during the Late Cretaceous-Paleogene times showing the flow direction of the Tethyan Circumglobal Current (TCC) in all directions (Abed, 2013).

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