



REVIEW ARTICLE

Contribution to the Paleontology, Stratigraphy and Paleogeography of Ninety-seven Southern Tethyan Agglutinated Foraminiferal Species

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ABSTRACT

Ninety-seven Campanian-Paleogene smaller agglutinated benthic foraminiferal species belonging to thirty-five genera from ten countries in the Southern Tethys (Algeria, Egypt, Palestine, Jordan, Iraq, Qatar, UAE, Iran, Pakistan, India) have been studied. The modern taxonomical consideration of the species is used. Eighty-nine of the recorded species were previously noted in the literature, while eight of them are believed here as new: *Haplophragmoides iranica*, *Pseudogaudryinella iraqensis*, *Arenobulimina beitjebrinensis*, *A. jerusalemensis*, *Textulariella sinaensis*, *Dorothia iranica*, *Clavulinoides iranica*, and *Textularia salahii*. Forty species of them are recorded from Egypt (about 41%), twenty-seven from Pakistan (~ 28%), ten from UAE (~ 10.5%), six from Qatar (~ 6%), four from each of Algeria and Iran (~ 4%), three from Jordan (~ 3%), two from each of Palestine and Iran (~ 2%), and only one from each of Iraq and India (~ 1%). Most of the Southern Tethyan recorded species are endemic to their original description, while five of them are also recorded in some Northern Tethyan countries (Spain, France, Italy, Hungary and Slovenia): *Bathysiphon saidi*, *Haplophragmoides desertorum*, *Spiroplectinella esnaensis*, *Siphogaudryina africana* and *Textularia crookshanki*. The Southern Tethyan assemblage indicates an open marine environment, which represents middle-outer neritic environment (100-200 m depth), and shows an affinity with Midway-Type Fauna (MTF) of the United States Gulf Coastal area.

1. Introduction

An attempt has been made to bring together many scattered data in the literature under a unifying theme for the holotypes and paratypes of ninety-seven agglutinated foraminiferal species of the Order Astrorhizida Lankester

in ten countries in the Southern Tethys (Algeria, Egypt, Palestine, Jordan, Iraq, Qatar, UAE, Iran, Pakistan, India, Figures 1-2). All the recorded species were erected from the Campanian-Early Paleogene time, and one from Recent. Some species of them are also recorded in other countries in both the Southern Tethys (i.e. Tunisia, Libya)

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and Northern Tethys (i.e. Spain, France, Italy, Hungary, Slovenia). Eight species of them are believed here as new: *Haplophragmoides iranica*, *Pseudogaudryinella iraqensis*, *Arenobulimina beitjebrinensis*, *A. jerusalemensis*, *Textulariella sinaensis*, *Dorothia iranica*, *Clavulinoides iranica* and *Textularia salahii*.

2. Previous Studies

Many studies have been made to erect, illustrate and describe the ninety-seven agglutinated benthic foraminiferal species belonging to thirty-five genera are recorded in this study, which related to ten countries in the Southern Tethys, which done by many authors from these countries. Four species of them from Algeria by Ten Dam & Sigal^[1], forty species from Egypt by many authors: Omara^[2], Nakkady^[3,4], LeRoy^[5], Said & Kenawy^[6], Anan^[7-13], El-Dawy^[14], Ali^[15], two species from Palestine by Anan (this study), three species from Jordan by Futyán^[16], one species from Iraq by Anan (this study), six species from Qatar by Hewaidy & Al-Hitmi^[17,18], ten species from UAE by Anan^[19-21,13], four species from Iran by Anan (this study), twenty-seven from Pakistan by Haque^[22-24], and Anan^[13], and one species from India by Habibnia & Mannikeri^[25].

3. Systematic Paleontology

The taxonomy of Kaminski^[26] (2014) is followed in this study for ninety-seven agglutinated foraminiferal benthic species were erected from ten countries in the Southern Tethys. The new taxonomic considerations are used for many recorded species. These species are illustrated in Plates 1 and 2.

Order Astrorhizida Lankester, 1885;
Suborder Astrorhizina Lankester, 1885;
Superfamily Astrorhizoidea Brady, 1881;
Family Rhabdamminidae Brady, 1884;
Genus *Bathysiphon* Sars, 1872;

1) *Bathysiphon paleocenica* El-Dawy^[14], p. 42, pl. 1, Figure 1 - (Pl. 1, Figure 1).

2) *Bathysiphon saidi* (Anan)^[8] - Anan^[27], p. 19, pl. 1, Figure 2. (= *Rhabdammina saidi* Anan^[8], p. 218, Figure 8.1) - (Pl. 1, Figure 2).

Suborder Hemisphaeramminiae Loeblich & Tappan, 1961;

Family Saccamminidae Brady, 1884;
Genus *Orbulinoides* Saidova, 1975;

3) *Orbulinoides arabica* Anan^[10], p. 531, Figure 4.1 - (Pl. 1, Figure 3).

Suborder Ammodiscina Mikhalevich, 1980;

Superfamily Ammodiscoidea Reuss, 1862;
Family Ammodiscidae Reuss, 1862;
Genus *Ammovertella* Cushman, 1928;
Type species *Ammodiscus (Psammophis) invertus* Schellwien, 1898;

4) *Ammovertella qatarica* Hewaidy & Al-Hitmi^[18], p. 12, Figure 5.1, 5.2 - (Pl. 1, Figure 4).

Genus *Repmanina* Suleymanov, 1966;
5) *Repmanina mazoni* Anan^[20], p. 85, pl. 1, Figure 4. (= *Repmanina* sp. Anan^[28], p. 244, Figure 4.7) - (Pl. 1, Figure 5).

Order Schlumbergerinida Mikhalevich, 1980;
Suborder Schlumbergerinina Mikhalevich, 1980;
Superfamily Rzehakinoidea Cushman, 1933;
Family Rzehakinidae Cushman, 1933;
Genus *Rzehakina* Cushman, 1928;
6) *Rzehakina khatiyahi* Hewaidy & Al-Hitmi^[18], p. 13, Figure, 5.3, 5.4 - (Pl. 1, Figure 6).

Family Miliamminidae Saidova, 1981;
Genus *Miliamina* Heron-Allen & Earland, 1930;
7) *Miliamina kenawyi* Anan^[8], p. 218, Figure 8.2 - (Pl. 1, Figure 7).

Genus *Agglutinella* El-Nakhal, 1983;
8) *Agglutinella reinemundi* (Haque^[23], 1960) - Anan^[20], p. 55, pl. 1, Figure 10 (= *Triloculina reinemundi* Haque^[23], p. 19, pl. 2, Figure 5) - (Pl. 1, Figure 8).

9) *Agglutinella sori* (Haque^[23]) - Anan, 2021a^[20], p. 55, pl. 1, Figure 11 (*Triloculina sori* Haque^[23], p. 20, pl. 5, Figure 9) - (Pl. 1, Figure 9).

Genus *Dentostomina* Cushman, 1933;
10) *Dentostomina ammobicarinata* (Haque^[23]) - Anan^[20], p. 44, pl. 1, Figure 5 (= *Triloculina ammobicarinata* Haque^[23], pl. 6, Figure 6) - (Pl. 1, Figure 10).

11) *Dentostomina ammoirregularis* (Haque^[23]) - Anan^[20], p. 44, pl. 1, Figure 6 (= *Triloculina ammoirregularis* Haque^[23], pl. 6, Figure 4) - (Pl. 1, Figure 11).

12) *Dentostomina gapperi* (Haque^[22]) - Anan^[20], p. 44, pl. 1, Figure 7 (= *Quinqueloculina gapperi* Haque^[22], p. 54, pl. 32, Figure 11) - (Pl. 1, Figure 12).

Family Ammomassilinae Mikhalevich & Kaminski, 2008;

Genus *Ammomassilina* Cushman, 1933;
13) *Ammomassilina misrensis* Anan^[21] - Anan^[21], p. 88, pl. 1, Figure 22 (= *Ammomassilina* sp. Anan^[8], p. 219, Figure 8.5) - (Pl. 1, Figure 13).

Order Lituolida Lankester, 1885;
 Suborder Lituolina Lankester, 1885;
 Superfamily Lituoloidea de Blainville, 1827;
 Family Haplophragmoididae Maync, 1952;
 Genus *Asanospira* Takayanagi, 1960;

14) *Asanospira diyabi* Hewaidy & Al-Hitmi ^[18], p. 13, Figure 5.5, 5.6 - (Pl. 1, Figure 14).

15) *Asanospira jalehaensis* Hewaidy & Al-Hitmi ^[18], p. 13, Figure 5.7, 5.8 - (Pl. 1, Figure 15).

Suborder Hormosinina Mikhalevich, 1980;
 Superfamily Hormosinoidea Haeckel, 1894;
 Family Glaucoamminidae Saidova, 1981;
 Genus *Psammolingulina* Silvestri, 1904;

16) *Psammolingulina bahri* Anan ^[21] - Anan ^[21], p. 85, pl. 1, Figure 4 (= *Psammolingulina* sp. Anan ^[28], p. 244, Figure 4.8) - (Pl. 1, Figure 16).

Suborder Lituolina Lankester, 1885;
 Superfamily Lituoloidea de Blainville, 1827;
 Family Haplophragmoididae Maync, 1952;
 Genus *Haplophragmoides* Cushman, 1910;

17) *Haplophragmoides desertorum* LeRoy ^[5], p. 36, pl. 1, Figures 21, 22 - (Pl. 1, Figure 17).

18) *Haplophragmoides iranica* Anan, n. sp. (= *Haplophragmoides* sp., Salahi ^[29], p. 316, pl. 5, Figure 13).

Holotype: The illustrated specimen in Pl. 1, Figure 18; Pl. 2, Figure 1.

Dimension: Diameter 0.17 mm.

Depository: The geological Museum of Ferdowsi University of Mashhad, Iran.

Etymology: After the Islamic Republic of Iran.

Type locality: Khangiran Formation, Kopet-Dagh Basin, NE Iran.

Age: Middle Eocene.

Diagnosis: This species has closed coiled planispiral test, composed of three coils, the last coil composed of about 10 number of chambers in the last-formed coil, wall arenaceous and fine in texture, sutures distinct and depressed, periphery broadly rounded, aperture at the ventral border or on the lower portion of the apertural face of the chamber.

Remarks: This species differs from *H. desertorum* LeRoy in its three coiled whorls than one, tight than wide umbilicus, and higher diameter test.

Family Lituolidae de Blainville, 1827;
 Genus *Ammobaculites* Cushman, 1910;

19) *Ammobaculites bhallai* Habibnia & Mannikeri ^[25], p. 3, pl. 1, Figures 2-4 - (Pl. 1, Figure 19).

20) *Ammobaculites khargaensis* Nakkady ^[4], p. 456,

pl. 6, Figure 1 - (Pl. 1, Figure 20).

21) *Ammobaculites schwageri* Said & Kenawy ^[6], p. 121, pl. 1, Figure 8 - (Pl. 1, Figure 21).

Subfamily Flabellammininae Podobina, 1978;
 Genus *Triplasia* Reuss, 1854;

22) *Triplasia palmate* Hewaidy & Al-Hitmi ^[18], p. 14, Figure 5.9, 5.10 - (Pl. 1, Figure 22).

Suborder Spiroplectamminina Mikhalevich, 1992;
 Superfamily Spiroplectamminoidea Cushman, 1927;
 Family Spiroplectamminidae Cushman, 1927;
 Genus *Spiroplectinella* Kisel'man, 1927;

23) *Spiroplectinella esnaensis* (LeRoy ^[5]) - Aubert & Berggren ^[30], p. 409, pl. 1, Figure 6 (= *Spiroplectammina esnaensis* LeRoy ^[5], p. 50, pl. 1, Figures 11, 12) - (Pl. 1, Figure 23).

24) *Spiroplectinella hamdani* (Anan ^[19] - Anan ^[27], p. 79, pl. 1, Figure 2 (= *Spiroplectammina hamdani* Anan ^[7], p. 652, pl. 1, Figure 14) - (Pl. 1, Figure 24).

25) *Spiroplectinella henryi* (LeRoy ^[5]) - Hewaidy et al. ^[31], p. 20, pl. 3, Figure 20 (= *Spiroplectammina henryi* LeRoy ^[5], p. 50, pl. 2, Figure 15) - (Pl. 1, Figure 25).

26) *Spiroplectinella knebeli* (LeRoy ^[5]) - Anan ^[27], p. 80 (= *Spiroplectammina knebeli* LeRoy ^[5], p. 51, pl. 2, Figures 10, 11) - (Pl. 1, Figure 26).

27) *Spiroplectinella paracarinata* Said & Kenawy ^[6] - Anan ^[12], p. 20, pl. 1, Figure 1 (= *Spiroplectammina paracarinata* Said & Kenawy ^[6], p. 122, pl. 1, Figure 13). (Pl. 1, Figure 27).

28) *Spiroplectinella ushballi* (Haque ^[23]) - Anan ^[13], p. 10, pl. 1, Figure 1 (= *Textularia ushballi* Haque ^[23], p. 18, pl. 3, Figure 7) - (Pl. 1, Figure 28).

Suborder Trochamminina Saidova, 1981;
 Superfamily Trochamminoidea Schwager, 1877;
 Family Trochamminidae Schwager, 1877;
 Genus *Trochammina* Parker & Jones, 1859;

29) *Trochammina dohaensis* Hewaidy & Al-Hitmi ^[18], p. 14, Figure 5.11, 5.12 - (Pl. 1, Figure 29).

Suborder Verneuilinina Mikhalevich & Kaminski, 2004;

Superfamily Verneuilinoidea Cushman, 1911;
 Family Prolixoplectidae Loeblich & Tappan, 1985;
 Genus *Plectina* Marsson, 1878;

30) *Plectina emiratensis* Anan ^[10], p. 534, Figure 4.2 - (Pl. 1, Figure 30).

Family Tritaxiidae Plotnikova, 1979;
 Genus *Tritaxia* Reuss, 1860;

31) *Tritaxia barakai* Said & Kenawy ^[6], p. 123, pl. 1, Figure 18 - (Pl. 1, Figure 31).

32) *Tritaxia elongata* (Haque ^[22]) – Anan ^[32], p. 31, pl. 1, Figure 1 (= *Clavulinoides lakiensis elongata* Haque ^[22], p. 45, pl. 21, Figure 13) - (Pl. 1, Figure 32).

33) *Tritaxia limbata* (Haque ^[22]) – Anan ^[32], p. 31, pl. 1, Figure 2 (= *Clavulinoides lakiensis limbata* Haque ^[22], p. 45, pl. 21, Figure 8) - (Pl. 1, Figure 33).

Family Reophaecellidae Mikhalevich & Kaminski, 2004;

Genus *Gaudryina* d'Orbigny, 1839;

34) *Gaudryina aissana* Ten Dam & Sigal ^[1], p. 31, pl. 2, Figure 2 - (Pl. 1, Figure 34).

35) *Gaudryina ameeri* Anan ^[12], p. 63, pl. 1, Figure 7 - (Pl. 1, Figure 35).

36) *Gaudryina arabica* Anan ^[13], p. 28, pl. 1, Figure 11 - (Pl. 1, Figure 36).

37) *Gaudryina ennakhali* Anan ^[13], p. 28, pl. 1, Figure 10 - (Pl. 1, Figure 37).

38) *Gaudryina limbata* Said & Kenawy ^[6], p. 123, pl. 1, Figure 23 - (Pl. 1, Figure 38).

39) *Gaudryina nitida* Haque ^[22] - Anan ^[13], p. 10, pl. 1, Figure 2 (= *Gaudryina pyramidata* Cushman *nitida* Haque ^[22], p. 41, pl. 9, Figure 2) - (Pl. 1, Figure 39).

40) *Gaudryina osmani* Anan ^[13], p. 28, pl. 1, Figure 14 - (Pl. 1, Figure 40).

41) *Gaudryina rectiangulata* Ten Dam & Sigal ^[1], p. 31, pl. 2, Figure 3 - (Pl. 1, Figure 41).

42) *Gaudryina speijeri* Anan ^[12], p. 66, pl. 1, Figure 10 - (Pl. 1, Figure 42).

43) *Gaudryina salimi* Anan ^[13], p. 28, pl. 1, Figure 12 - (Pl. 1, Figure 43).

44) *Gaudryina textulariformis* Nakkady ^[4], p. 457, pl. 6, Figure 3 - (Pl. 1, Figure 44).

Genus *Pseudogaudryinella* Cushman, 1936;

45) *Pseudogaudryinella iraqensis* Anan, n. sp. (= *Tritaxia whitei* of Jaff & Lawa ^[33], p. 14, pl. 2, Figures 14, 15).

Holotype: Illustrated specimen in Pl. 1, Figure 45; Pl. 2, Figure 2.

Dimension: Length 0.45 mm, width 0.17 mm.

Depository: Department of Geology, University of Sulaimani, Iraq.

Etymology: After the Iraq Republic.

Type locality: Shiranish Formation, Kurdistan region, Northeast Iraq.

Age: Campanian.

Diagnosis: Test elongate, early stage triserial triangular in section, followed by biserial, and finally uniserial rounded in section, aperture terminal in the last chamber

and rounded.

Remarks: This species belongs to the genus *Pseudogaudryinella* and differs from the genus *Tritaxia* in having a biserial stage intercalated between the triserial and uniserial ones, and differs from the genus *Gaudryina* in becoming uniserial in adult.

Genus *Siphogaudryina* Cushman, 1935;

46) *Siphogaudryina africana* (LeRoy ^[5]) - Anan ^[11], p. 272, pl. 1, Figure 7 (= *Gaudryina africana* LeRoy ^[5], p. 30, pl. 1, Figures 7, 8) - (Pl. 1, Figure 46).

47) *Siphogaudryina daviesi* (Haque ^[22]) - Anan ^[32], p. 31, pl. 1, Figure 3 (= *Gaudryina daviesi* Haque ^[22], p. 37, pl. 31, Figure 14) - (Pl. 1, Figure 47).

48) *Siphogaudryina elongata* (Haque ^[22]) – Anan ^[34], p. 272, pl. 1, Figure 9 (= *Gaudryina laevigata* Franke *elongata* Haque ^[22], p. 35, pl. 9, Figure 5) - (Pl. 1, Figure 48).

49) *Siphogaudryina elegantissima* (Said & Kenawy ^[6]) - Anan ^[24], p. 3, pl. 1, Figure 3 (= *Gaudryina elegantissima* Said & Kenawy ^[6], p. 123, pl. 1, Figure 21) - (Pl. 1, Figure 49).

50) *Siphogaudryina nammalensis* (Haque ^[22]) - Anan ^[34], p. 273, pl. 1, Figure 11 (= *Gaudryina* (*Siphogaudryina*) *carinata* Franke *nammalensis* Haque ^[22], p. 40, pl. 3, Figure 2) - (Pl. 1, Figure 50).

51) *Siphogaudryina nekhleensis* (Said & Kenawy ^[6]) - Anan ^[12], p. 20, pl. 1, Figure 4 (= *Gaudryina nekhleensis* Said & Kenawy ^[6], p. 124, pl. 1, Figure 24) - (Pl. 1, Figure 51).

52) *Siphogaudryina strougoi* Anan ^[9], p. 141, Figure 2.1 - (Pl. 1, Figure 52).

53) *Siphogaudryina tellburmaensis* (Futyan ^[16]) - Anan ^[35], p. 3, pl. 1, Figure 3 (= *Gaudryina tellburmaensis* Futyan ^[16], p. 521, pl. 81, Figures 1, 2) - (Pl. 1, Figure 53).

Genus *Verneuilina* d'Orbigny, 1839;

54) *Verneuilina aegyptiaca* Said & Kenawy ^[6], p. 122, pl. 1, Figure 16 - (Pl. 1, Figure 54).

55) *Verneuilina laevigata* Haque ^[22], p. 34, pl. 21, Figures 9, 12 - (Pl. 1, Figure 55).

56) *Verneuilina luxorensis* Nakkady ^[3], p. 683, pl. 89, Figure 6.7 - (Pl. 1, Figure 56).

Order Loftusiida Kaminski & Mikhalevich, 2004;

Suborder Ataxophragmiina Fursenko, 1958;

Superfamily Ataxophragmiacea Schwager, 1877;

Family Ataxophragmiidae Schwager, 1877;

Genus *Arenobulimina* Cushman, 1927;

57) *Arenobulimina aegyptiaca* Said & Kenawy ^[6], p. 126, pl. 1, Figure 42 - (Pl. 1, Figure 57).

58) *Arenobulimina beitjebrinensis* Anan, n. sp. (=

Arenobulimina sp. A. Almogi-Labin et al. [36], p. 578, pl. 2, Figure 5).

Holotype: Illustrated specimen in Pl. 1, Figure 58; Pl. 2, Figure 3.

Diameter: Length 0.25 mm, width 0.20 mm.

Etymology: After the type locality.

Type locality: Beit Jebrin, Palestine (Figure 3).

Stratigraphic level and age: *Gansserina gansseri* Zone, Late Maastrichtian.

Diagnosis: Test arenaceous, conical, trochospirally en-rolled, tapering initial part with four-five chambers, later four chambers in the last whorl, chambers inflated, sutures distinct depressed, aperture an interiomarginal loop.

Remarks: This species differs from usually four making up at last whorl, tapering initial part, distinct loop-shaped aperture, older stratigraphic level. It is recorded, so far, from Palestine.

59) *Arenobulimina jerusalemensis* Anan, n. sp. (= *Arenobulimina* sp. B. Almogi-Labin et al. [36], p. 578, pl. 2, Figure 4).

Holotype: Illustrated specimen in Pl. 1, Figure 59; Pl. 2, Figure 4.

Diameter: Length 0.50 mm, width 0.50 mm.

Etymology: After the type locality, Palestine.

Type locality: southwest Jerusalem.

Stratigraphic level and age: *Gansserina gansseri* - *Abathomphalus mayaroensis* Zones, Late Maastrichtian .

Diagnosis: Low trochospiral test, four chambers in the last whorl, distinct inflated chambers, sutures depressed, aperture an interiomarginal loop.

Remarks: It differs from *A. beitjebrinensis* in its shorter length test, and younger stratigraphic level.

Family Textulariellidae Grönhagen & Luterbacher, 1966;

Genus *Textulariella* Cushman, 1927;

60) *Textulariella sinaensis* Anan, n. sp. (= *Textulariella* sp. Said & Kenawy [6], p. 127, pl. 1, Figure 43).

Holotype: Illustrated specimen in Pl. 1, Figure 60; Pl. 2, Figure 5.

Diameter: Length 0.4 mm, breadth 0.4 mm.

Depository: USNM P. 3988.

Etymology: After the Sinai Peninsula, Egypt.

Type locality: Giddi section, northern Saini, Egypt (Figure 3).

Stratigraphic level and age: Danian.

Diagnosis: Test very fine arenaceous and smoothly finished, more or less cylindrical in shape, initial part trochospiral coil, but biserial in the later part and increasing rapidly as added, sutures slightly limbate, aperture a low opening at the middle of the final chamber.

Remarks: This Danian species has cylindrical test, which differs from the conical and tapering sharply early

stage of the Maastrichtian-Danian *T. cretosa*.

Order Textulariida Delage & Hérourard, 1896, emended by Kaminski, 2004;

Suborder Textulariina Delage & Hérourard, 1896;

Superfamily Eggerelloidea Cushman, 1937;

Family Eggerellidae Cushman, 1937;

Genus *Dorothia* Plummer, 1931;

61) *Dorothia iranica* Anan, n. sp. (= *Tritaxilina* sp., Salah [29], p. 316, pl. 5, Figure 7).

Holotype: The figured specimen in Pl. 1, Figure 61; Pl. 2, Figure 6.

Dimension: Length 0.8 mm, width 0.3 mm.

Depository: The geological Museum of Ferdowsi University of Mashhad, Iran.

Etymology: After the Islamic Republic of Iran.

Type locality: Khangiran Formation, Kopet-Dagh Basin, NE Iran.

Age: Early Eocene.

Diagnosis: The genus *Tritaxilina* has fusiform test, early portion triserial, roughly triangular in transverse section, the angles much rounded; later portion biserial or finally uniserial, circular in section, apical end somewhat pointed, apertural end truncate or broadly rounded; chambers numerous; the wall thick, of fine arenaceous material; sutures distinct, depressed; aperture in the young as in *Verneuilina*, in the adult becoming terminal and central with a border of inwardly projecting teeth. The genus *Dorothia* has triserial early portion followed by biserial chambers, without uniserial end portion.

Remarks: This species differs from *Dorothia bulletta* (Carsey) by its more elongated test, more depressed sutures and more large numbers of the inflated biserial chambers.

62) *Dorothia nammalensis* Haque [22], 1956 – Anan [13], p. 11, pl. 1, Figure 9 (= *Dorothia pupoides* (d'Orbigny) *nammalensis* Haque [22], p. 53, pl. 32, Figure 4) - (Pl. 1, Figure 62).

63) *Dorothia sinaensis* Said & Kenawy [6], p. 128, pl. 2, Figure 1 - (Pl. 2, Figure 63).

Genus *Marssonella* Cushman, 1933;

64) *Marssonella hafitensis* Anan [10], p. 535, Figure 4.3 - (Pl. 1, Figure 64).

65) *Marssonella nammalensis* Haque [22] - Anan [13], p. 11, pl. 1, Figure 10 (= *Marssonella oxycona* (Reuss) *nammalensis* Haque [22], p. 50, pl. 3, Figure 4) - (Pl. 1, Figure 65).

Genus *Eggerella* Cushman, 1935;

66) *Eggerella maqfiensis* LeRoy [5], p. 28, pl. 1, Figures 1, 2 - (Pl. 1, Figure 66).

Genus *Clavulinoides* Cushman, 1937;

67) *Clavulinoides algerianus* Ten Dam & Sigal ^[1], p. 33, pl. 2, Figure 11- (Pl. 1, Figure 67).

68) *Clavulinoides iranica* Anan, n. sp. (= *Heterostomella austinana* of Salah ^[29], p. 314, pl. 4, Figure 25).

Holotype: The illustrated specimen in Pl. 1 Figure 68; Pl. 2, Figure 7.

Dimension: Length 1.10 mm, width 0.45 mm.

Depository: The geological Museum of Ferdowsi University Of Mashhad, Iran.

Etymology: After the Islamic Republic of Iran.

Type locality: Khangiran Formation, Kopet-Dagh Basin, NE Iran.

Age: Middle Eocene.

Diagnosis: The genus *Clavulinoides* has triserially early chambers arranged and later abruptly becoming uniserial, while the genus *Heterostomella* has triserial early stage followed by biserial chamber arranged. The species *C. iranica* has curved triangle test in cross section and discoidal last chamber.

Remarks: This species is characterized by its curved test than other most species of the genus which have nearly rectilinear tests.

69) *Clavulinoides lakiensis* Haque ^[22], p. 43, pl. 21, Figure 7; p. 54, pl. 32, Figure 1 - (Pl. 1, Figure 69).

70) *Clavulinoides spatha* Haque ^[22] - Anan ^[13], p. 12, pl. 1, Figure 18 (= *Clavulinoides lakiensis spatha* Haque ^[22], p. 44, pl. 21, Figure 6) - (Pl. 2, Figure 70).

Genus *Pseudoclavulina* Cushman, 1937;

71) *Pseudoclavulina barnardi* (Futyani ^[16]) - Anan ^[13], p. 3, pl. 1, Figure 7 (= *Clavulina barnardi* Futyani ^[16], p. 522, pl. 81, Figure 3 (*non* Figure 4) - (Pl. 1, Figure 71).

72) *Pseudoclavulina farafraensis* LeRoy ^[5], p. 44, pl. 2, Figure 9 - (Pl. 1, Figure 72).

73) *Pseudoclavulina futyani* Anan ^[11], p. 87, pl. 1, Figure 16 (= *Clavulina barnardi* Futyani ^[16], p. 522, pl. 81, Figure 4 (*non* Figure 3) - (Pl. 1, Figure 73).

74) *Pseudoclavulina globulifera* Ten Dam & Sigal ^[1], p. 32, pl. 2, Figures 5-7 - (Pl. 1, Figure 74).

75) *Pseudoclavulina hewaidyi* Anan ^[11], p. 248, pl. 1, Figure 1 - (Pl. 1, Figure 75).

76) *Pseudoclavulina maqfiensis* LeRoy ^[5], p. 44, pl. 2, Figures 16, 17 - (Pl. 1, Figure 76).

77) *Pseudoclavulina pseudoarenata* Said & Kenawy ^[6], p. 125, pl. 1, Figure 33 - (Pl. 1, Figure 77).

78) *Pseudoclavulina youssefi* Anan ^[20], p. 88, pl. 1, Figure 18 (= *Tritaxia* sp. Ali ^[15], pl. 3, Figure 14) - (Pl. 1, Figure 78).

Genus *Valvureussella* Hofker, 1957;

79) *Valvureussella karreri* (Said & Kenawy ^[6]) - Hewaidy & Al-Hitmi ^[17], p. 481, pl. 6, Figures 7, 8 (= *Verneu-*

ilina karreri Said & Kenawy ^[6], p. 122, pl. 1, Figure 17) - (Pl. 1, Figure 79).

Family Valvulinidae Berthelin, 1880;

Genus *Clavulina* d'Orbigny, 1826;

80) *Clavulina paxilliformis* Haque ^[22], p. 49, pl. 12, Figures 6, 8 - (Pl. 1 Figure 80).

81) *Clavulina pseudoparisensis* Anan ^[7], p. 239, pl. 1, Figures 6, 7 - (Pl. 1, Figure 81).

82) *Clavulina symmetrica* Haque ^[22] - Anan ^[13], p. 12, pl. 1, Figure 19 (= *Clavulina paxilliformis symmetrica* Haque ^[22], p. 50, pl. 24, Figure 6) - (Pl. 1, Figure 82).

Genus *Valvulina* d'Orbigny, 1826;

83) *Valvulina elongata* Haque ^[22], p. 47, pl. 21, Figure 11 (= *Valvulina nammalensis* Haque ^[22], (*non* 10) - (Pl. 1, Figure 83).

84) *Valvulina nammalensis* Haque ^[22], p. 47, pl. 21, Figure 10 (*non* Figure 11) - (Pl. 1, Figure 84).

Superfamily Textulariodea Ehrenberg, 1838;

Family Thomasinellidae Loeblich & Tappan, 1984;

Genus *Thomasinella* Schlumberger, 1893;

85) *Thomasinella aegyptia* Omara ^[2], p. 885, pl. 101, Figure 1 - (Pl. 1, Figure 85).

86) *Thomasinella fragmentaria* Omara ^[2], p. 884, text-Figure 1.6 - (Pl. 1, Figure 86).

Family Textulariidae Ehrenberg, 1838;

Genus *Bigenerina* d'Orbigny, 1826;

87) *Bigenerina khirthari* Haque ^[23], p. 18, pl. 3, Figure 4 - (Pl. 1, Figure 87).

88) *Bigenerina metingensis* Haque ^[24], p. 18, pl. 2, Figures 13, 14 - (Pl. 2, Figure 88).

89) *Bigenerina nodosa* Haque ^[22], p. 33, pl. 3, Figures 7, 8 - (Pl. 2, Figure 89).

Genus *Textularia* DeFrance, 1824;

90) *Textularia crookshanki* Haque ^[22], p. 32, pl. 9, Figure 9 - (Pl. 2, Figure 90).

91) *Textularia fahmyi* Anan ^[8], p. 218, Figure 8.3 - (Pl. 2, Figure 91).

92) *Textularia farafraensis* LeRoy ^[5], p. 51, pl. 2, Figures 3, 4 - (Pl. 2, Figure 92).

93) *Textularia haquei* Anan ^[35], p. 3, pl. 1, Figure 6 (= *Textularia* sp. Haque ^[22], p. 32, pl. 9, Figures 10, 11) - (Pl. 2, Figure 93).

94) *Textularia nilotica* (Schwager ^[37]) - LeRoy ^[5], p. 52, pl. 2, Figures 1, 2 (= *Plecanium niloticum* Schwager ^[37], p. 115, pl. 26, Figure 14) - (Pl. 2, Figure 94).

95) *Textularia punjabensis* Haque ^[22], p. 31, pl. 9, Figure 12 - (Pl. 2, Figure 95).

96) *Textularia salahii* Anan, n. sp. Pl. 2, Figure 34 (= *Textularia* sp. Salahi^[29], p. 316, pl. 5, Figures 9, 10).

Holotype: The illustrated specimen in Pl. 1, Figure 96; Pl. 2, Figure 8.

Dimension: Length and width of the top specimen: 0.30 mm.

Type locality: Kopet-Dagh Basin, NE Iran.

Age: Middle Eocene.

Etymology: After prof. Amir Salahi, Ferdowsi University of Mashhad, Iran.

Diagnosis: Test medium, length equal the top part of the last biserial inflated chambers, expanding uniformly, periphery broadly round, sutures depressed and nearly straight, wall moderately smooth.

Remarks: This species differs from the other species of *Textularia* by its smaller size, not elongated test, three additional biserial chambers.

97) *Textularia schwageri* LeRoy^[5], p. 51, pl. 2, Figures 5, 6 - (Pl. 1, Figure 97).



Figure 1. The geographic distribution of the recorded benthic foraminiferal species in the ten countries in the Southern Tethys (Algeria, Egypt, Palestine, Jordan, Iraq, Qatar, UAE, Iran, Pakistan and India).

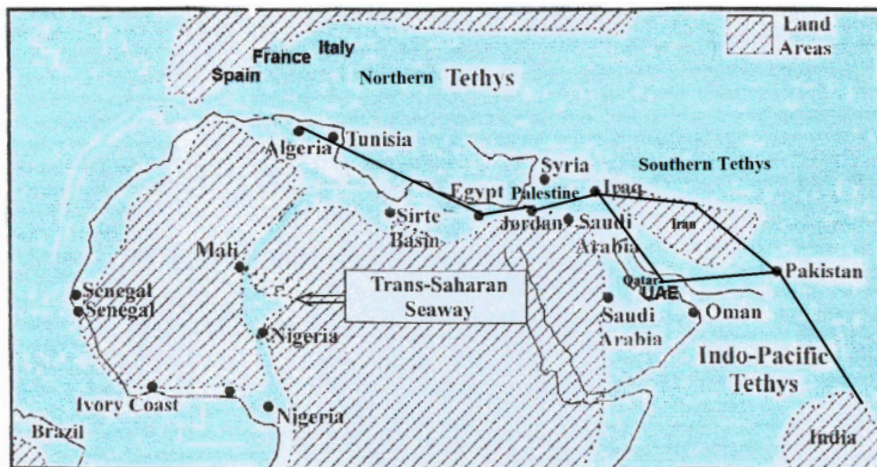


Figure 2. The open sea water between the ten countries in the Southern Tethys during the Paleocene (after Morsi et al.^[48], with some modification).



Figure 3. Location map of Giddi and Nekhl sections (Sinai, Egypt), and Beit Jebrin and Jerusalem (Palestine) (after Said & Kenawy ^[6]).



Figure 4. The paleogeographic distribution of the benthic foraminiferal species from the Southern Tethyan: Mali, Nigeria, Tunisia, Libya, Egypt, Jordan, Iraq, UAE, Pakistan, which also recorded in different localities of European Northern Tethys: Spain, Gulf of Biscay, France, Italy, Hungary, Slovenia (after Anan ^[42]).



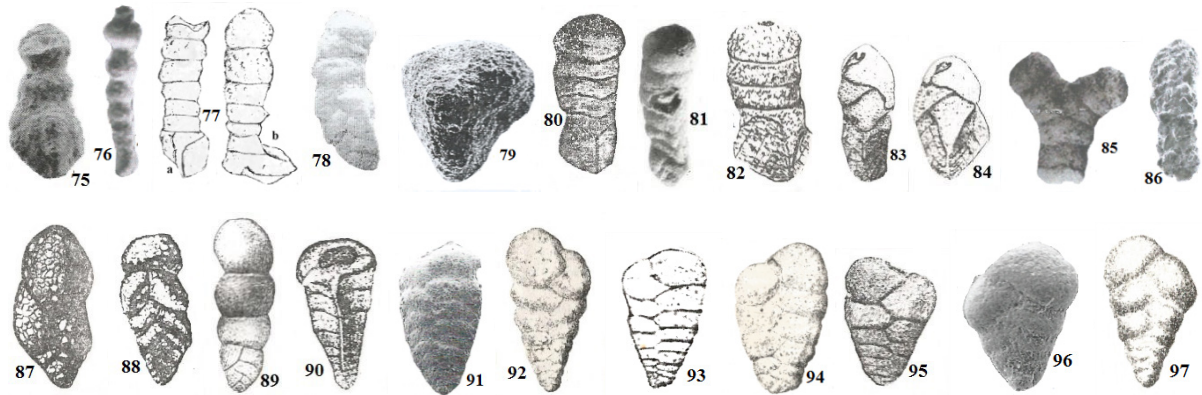


Plate 1

Figure 1. *Bathysiphon paleocenica* El-Dawy ^[14] × 10, **2.** *B. saidi* ^[9] × 10, **3.** *Orbulinoides arabica* Anan ^[10] × 30, **4.** *Ammovertella qatarica* Hewaidy & Al-Hitmi ^[118] × 20, **5.** *Repmanina mazenii* (Anan) ^[20] × 15, **6.** *Rzehakina khatiyahi* Hewaidy & Al-Hitmi ^[118] × 10, **7.** *Miliammina kenawyi* Anan ^[9] × 15, **8.** *Agglutinella reinemundi* (Haque ^[23]) × 80, **9.** *A. sori* (Haque ^[23]) × 35, **10.** *Dentostomina ammobicarinata* (Haque ^[23]) × 15, **11.** *D. ammoirregularis* (Haque ^[23]) × 20, **12.** *D. gapperi* (Haque ^[22]) × 35, **13.** *Ammomassilina misrensis* Anan ^[21] × 20, **14.** *Asanospira diyabi* Hewaidy & Al-Hitmi ^[118] × 10, **15.** *A. jalehaensis* Hewaidy & Al-Hitmi ^[118] × 17, **16.** *Psammolingulina bahri* Anan ^[20] × 15, **17.** *Haplophragmoides desertorum* LeRoy ^[5] × 30, **18.** *H. iranica* Anan (n. sp.) × 35, **19.** *Ammobaculites bhallai* Habibnia & Mannikeri ^[25] × 15, **20.** *A. khargaensis* Nakkady ^[4] × 60, **21.** *A. schwageri* Said & Kenawy ^[6] × 20, **22.** *Triplasia palmate* Hewaidy & Al-Hitmi, ^[118] × 10, **23.** *Spiroplectinella esnaensis* (LeRoy ^[5]) × 20, **24.** *S. hamdani* (Anan ^[19]) × 15, **25.** *S. henryi* (LeRoy ^[5]) × 18, **26.** *S. knebeli* (LeRoy ^[5]) × 16, **27.** *S. paracarinata* Said & Kenawy ^[6] × 40, **28.** *S. ushballi* (Haque ^[23]) × 30, **29.** *Trochammina dohaensis* Hewaidy & Al-Hitmi ^[118] × 15, **30.** *Plectina emiratensis* Anan ^[10] × 20, **31.** *Tritaxia barakai* Said & Kenawy ^[6] × 15, **32.** *T. elongata* (Haque ^[22]) × 20, **33.** *T. limbata* (Haque ^[22]) × 40, **34.** *Gaudryina aissana* Ten Dam & Sigal ^[1] × 20, **35.** *G. ameerii* Anan ^[12] × 20, **36.** *G. arabica* Anan ^[23] × 35, **37.** *G. ennakhali* Anan ^[23] × 75, **38.** *G. limbata* Said & Kenawy ^[6] × 50, **39.** *G. nitida* (Haque ^[22]) × 40, **40.** *G. osmani* Anan ^[23] × 35, **41.** *G. rectiangulata* Ten Dam & Sigal ^[1] × 25, **42.** *G. speijeri* Anan ^[12] × 20, **43.** *G. salimi* Anan ^[23] × 35, **44.** *G. textulariformis* Nakkady ^[4] × 50, **45.** *Pseudogaudryinella iraqensis* Anan (n. sp.) × 10, **46.** *Siphogaudryina africana* (LeRoy ^[5]) × 10, **47.** *S. daviesi* (Haque ^[22]) × 20, **48.** *S. elongata* (Haque ^[22]) × 25, **49.** *S. elegantissima* (Said & Kenawy ^[6]) × 40, **50.** *S. nammalensis* (Haque ^[22]) × 30, **51.** *S. nekhlenis* (Said & Kenawy ^[6]) × 15, **52.** *S. strougoi* Anan ^[9] × 10, **53.** *S. tellburmaensis* (Futyan ^[16]) × 25, **54.** *Verneuilina aegyptiaca* Said & Kenawy ^[6] × 30, **55.** *V. laevigata* Haque ^[22] × 35, **56.** *V. luxorensis* Nakkady ^[3] × 30, **57.** *Arenobulimina aegyptiaca* Said & Kenawy ^[6] × 15, **58.** *A. beitjebrinensis* Anan (n. sp.) × 30, **59.** *A. jerusalemensis* Anan (n. sp.) × 30, **60.** *Textulariella sinaensis* Anan (n. sp.) × 20, **61.** *Dorothia iranica* Anan (n. sp.) × 50, **62.** *D. nammalensis* Haque ^[22] × 35, **63.** *D. sinaensis* Said & Kenawy ^[6] × 30, **64.** *Marssonella hafitensis* Anan ^[10] × 30, **65.** *M. nammalensis* Haque ^[6] × 50, **66.** *Eggerella maqfiensis* LeRoy ^[5] × 30, **67.** *Clavulinoides algerianus* Ten Dam & Sigal ^[1] × 35, **68.** *C. iranica* Anan (n. sp.) × 35, **69.** *laksiensis* Haque ^[22] × 35, **70.** *C. spatha* Haque ^[22] × 40, **71.** *Pseudoclavulina barnardi* (Futyan ^[16]) × 35, **72.** *P. farafraensis* LeRoy ^[5] × 20, **73.** *P. futyani* Anan ^[20] × 10, **74.** *P. globulifera* Ten Dam & Sigal ^[1] × 35, **75.** *P. hewaidyi* Anan ^[11] × 20, **76.** *P. maqfiensis* LeRoy ^[5] × 40, **77.** *P. pseudoarenata* Said & Kenawy ^[6] × 40, **78.** *P. youssefi* Anan ^[20] × 20, **79.** *Valvireussella karreri* (Said & Kenawy ^[6]) × 30, **80.** *Clavulina paxilliformis* Haque ^[22] × 15, **81.** *C. pseudopariensis* Anan ^[7] × 10, **82.** *C. symmetrica* Haque ^[6] × 45, **83.** *Valvulina elongata* Haque ^[22] × 20, **84.** *V. nammalensis* Haque ^[22] × 35, **85.** *Thomasinella aegyptia* Omara ^[2] × 8, **86.** *T. fragmentaria* Omara ^[2] × 10, **87.** *Bigenerina khirthari* Haque ^[24] × 30, **88.** *B. metingensis* Haque ^[22] × 50, **89.** *B. nodosa* Haque ^[22] × 45, **90.** *Textularia crookshanki* Haque ^[22] × 45, **91.** *T. fahmyi* Anan ^[8] × 20, **92.** *T. farafraensis* LeRoy ^[5] × 30, **93.** *T. haquei* Anan ^[35] × 22, **94.** *T. nilotica* (Schwager ^[37]) × 20, **95.** *T. punjabensis* Haque ^[22] × 35, **96.** *T. salahii* Anan (n. sp.) × 60, **97.** *T. schwageri* LeRoy ^[5] × 35.

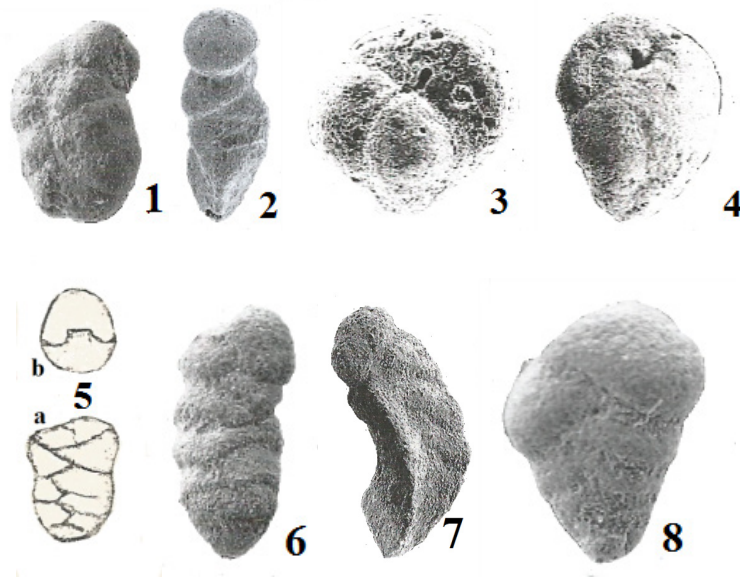


Plate 2 (n. sp.)

Figure 1. *Haplophragmoides iranica* Anan (n. sp.) $\times 40$, 2. *Pseudogaudryinella iraqensis* Anan (n. sp.) $\times 20$, 3. *Arenobulimina beitjebrinensis* Anan (n. sp.) $\times 70$, 4. *A. jerusalemensis* Anan (n. sp.) $\times 65$, 5. *Textulariella sinaensis* Anan (n. sp.) $\times 30$, 6. *Dorothisia iranica* Anan (n. sp.) $\times 120$, 7. *Clavulinoides iranica* Anan (n. sp.) $\times 80$, 8. *Textularia salahii* Anan (n. sp.) $\times 150$.

4. Paleogeography

The ninety-seven agglutinated benthic foraminiferal species were originally identified from ten countries in the Southern Tethys, as well as some of them were recorded also in some localities in the Southern and Northern Tethys. Many authors (i.e. Said & Kenawy ^[6], Haque ^[22], Keller ^[38], Rögl ^[39], Rosenbaum et al. ^[40], Meulenkamp & Sissingh ^[41], Anan ^[32,42]). The Tethys had been connected from west with Atlantic Ocean to east with the Pacific with the Pacific Ocean via the Mediterranean Sea during the Campanian-Paleogene time. Anan ^[42] has recorded many Southern Tethyan benthic foraminiferal species (Tunisia, Libya, Mali, Nigeria, Egypt, Jordan, Iraq, UAE, Qatar, Pakistan), which also recorded in different countries in the Northern Tethys in Europe (Spain, Gulf of Biscay, France, Italy, Hungary, Slovenia (Figure 4).

5. Paleoenvironment

Miller et al. ^[43] noted that certain hydrographic properties (low oxygen, high CO₃, low pH, and corrosive waters) favor the development of agglutinated assemblages. Loeblich & Tappan ^[44] noted that the foraminiferal Suborder Astrorhizina reinstated for the typical monothalamous agglutinated taxa whose cementing material is solely organic, and the Family Haplophragmoididae reinstated for multilocular agglutinated taxa with organic cement. Anan ^[27]

noted that most of the recorded species from the Middle-Upper Eocene of Jabal Hafit, UAE (e.g. *Bathysiphon saidi* and *Miliammina kenawyi*) are endemic to the tropical-subtropical regions. Jones ^[45] noted that 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 and appear better able than their calcareous benthic counterparts to tolerate conditions of high fresh-water flux, and of high sediment and organic carbon flux, and associated lowered oxygen availability. Moreover, the genera: *Gaudryina*, *Siphogaudryina*, *Verneuilina* in the Subfamily Verneuilininae is restricted to deep marine environments. Orabi ^[46] noted that the agglutinated tests are weakly held by organic material, which potentially oxidized within the surface layer of sediments. The recorded species represent middle-outer neritic environment (100-200 m) and show an affinity with Midway-Type Fauna (MTF), and the deeper water species have smooth tests, while the shallow water specimens have coarser grained.

6. Conclusions

The present study deals with the recording of ninety-seven identified species belonging to thirty-five agglutinated genera in ten localities of the Southern Tethys: Algeria, Egypt, Palestine, Jordan, Iraq, Qatar, UAE, Iran,

Pakistan and India. Most of these species are confined, so far, on their mentioned localities. Forty species of them are recorded from Egypt (about 41.5%), twenty-seven from Pakistan (~28%), ten from UAE (~10.5%), six from Qatar (~6%), four from Algeria (4.5%), three from Jordan (~3%), two from Palestine and Iran (~2%), and only one from each of Iraq and India (~1%). Seven species of them are believed here as new: Four species from Iran *Haplophragmoides iranica*, *Dorothia iranica*, *Clavulinoides iranica* and *Textularia salahii*; two species from Palestine *Arenobulimina beitjebrenensis* and *A. jerusalemensis*; one species from Iraq *Pseudogaudryinella iraqensis* and one species from Egypt *Textulariella sinaensis*. The recorded species represent middle-outer neritic environment (100-200 m) in an open marine basin and show an affinity with Midway-Type Fauna (MTF) of the United States Gulf Coastal area.

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Conflict of Interest

There is no conflict of interest.

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