Ezzatina: A new Foraminiferal Genus from the Upper Eocene in Egypt

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Abstract: A new foraminiferal genus *Ezzatina* with relative 6 new species, *Ezzatina abdallahi, E. bassiounii, E. egyptiaca, E. faragi, E. hassaneini,* and *E. fayoumensis,* have been recorded from the basal part of the Upper Eocene sediments exposed at west of Fayoum area. The newly recorded foraminifers are benthic, fine, calcareous, perforate, planispiral to biserial chamber arrangement, twisted during the growth. These morphologic features assigned this genus and its species to the family Bolivinidae. The genotype and the six type species were described and microphotographed. The probable phylogenitic trend and the evolutionary relationships of the genus *Ezzatina* among the genera of the family Bolivinidae are demonstrated in the suggested phylogenitic tree.
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Key wards: New Genus, Ezzatina, Foraminifera, Upper Eocene, Phylogeny.

1. Introduction

The Eocene deposits at Fayoum area were subjected to extensive micropaleontological studies since Ansary[1] , Abdel-Kareem [2], Abdou & Abdel-Kareem [3], Shama [4] , Bassiouni *et al*. [5], Strougu & Haggag [6], Haggag [7- 9], Abdel Ghany [10], Allam *et al*. [11], Boukhary *et al*., [12], Anan [13], Haggag & Bolli [14], Abdallah *et. al.* [15], Omar [16], Helal [17], Ismail & Abd El -Azeam [18] and Abd El-Azeam [19].

Abd Elshafy *et al*. [20] reinvestigated the Eocene exposures at Wadi El Rayan southwest Fayoum area and subdivided it into Gehannam Formation (middle – upper Eocene), Birket Qaroun and Qasr El Sagha formations (upper Eocene). In 2008, Abd El-Azeam [19] zoned the middle and upper Eocene exposures at Wadi El Hitan area based on 49 planktonic and benthic foraminiferal species.

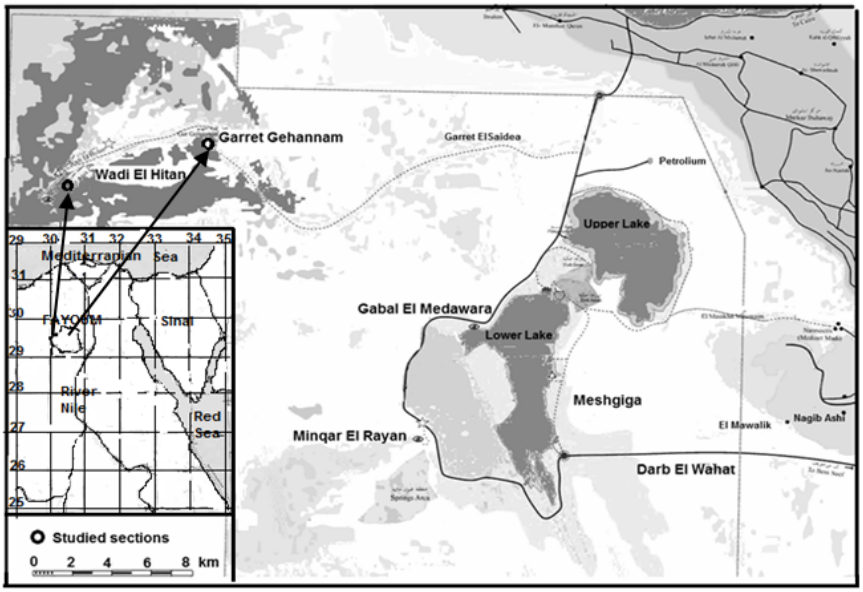

Fig. 1: Location map of the studied area.

In the present study the author investigated about 60 rock samples from the upper Eocene exposures at Gabal Garret Gehannam in Wadi El Rayan area for their foraminiferal content. It is found that the foraminiferal associations are mostly the same as those which were recorded from Wadi El Hitan Abd El-Azeam [19] except the association of the lowermost bed of the upper Eocene which contains new foraminifers in the fine residue. This stimulated a reinvestigation of the fine residue of Wadi El Hitan

samples, previously studied by Abd El-Azeam [19]. Only and at the same level (basal bed of the upper Eocene), the author found nearly the same new association but fairly with richer abundance, more divers and in better state. Identification, description, Scanning Electron Microscopy, nomenclature and systematic arrangement of the newly recorded foraminifera from the basal bed at both studied sections at Wadi El Hitan and Garret Gehannam represent the main target of the present study.

The studied section at Wadi El Hitan lies at Lat 29° 17' 50" N, Long 30° 2' 16 "E , while that at Garret Gehannam lies at. Lat 29' 19' 2" N, Long 30' 9' 14 "E. at about 12 km. northeast of Wadi El Hitan (Figs.1, 2).

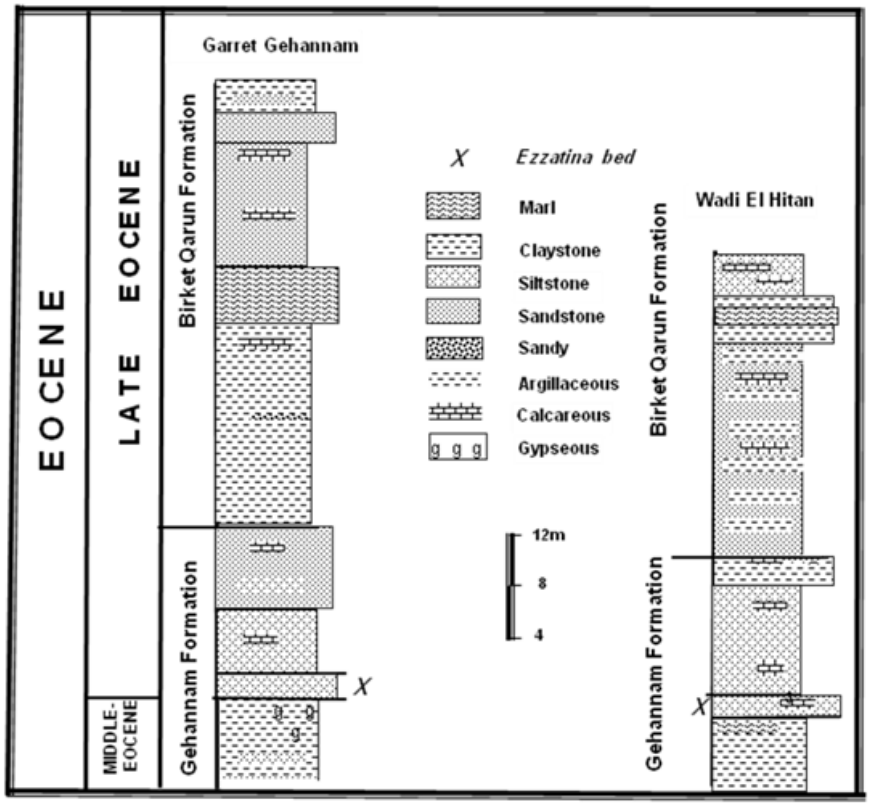

Fig.(2): Lithostratigraphic succession of the Eocene deposits at north-west of Fayoum area.

The new Foraminifera recorded in this study are restricted to the basal part of the upper Eocene (upper part of the Gehannam Formation) in both Wadi El Hitan and Garret Gehannam areas (Fig.2). Foraminiferal investigation reveals the identification of one new genus *Ezzatina* and relative 6 new species: *Ezzatina abdallahi, E. bassiounii, E. egyptiaca, E. faragi, E. hassaneini, and E. fayoumensis,*

The genotype of the genus and the holotypes (type species) of each of the new species are described, photographed and systematically arranged. They belong to the Family Bolivinidae according to Loeblich and Tappan [21].

The type slides of the described foraminifera are deposited in the Museum of the Geology Department, Faculty of Science, Zagazig University, Egypt (abbreviated Z U-E.1-6).

Systematic paleontology

Phylum: ***Protozoa***
Class**:** ***Sarcodina***
Order: ***Foraminiferida*** (*Eichwald*) [22]
Suborder**:** ***Rotalina*** (*Delage and Herouard*)[23]
Superfamily**:** ***Bolivinacea*** *(Glaessner)* [24]
Family**:** ***Bolivinidae*** *(Glaessner)* [24]
Genus*: Ezzatina* new genus
(Figures 3-8)

Etymology: In honor of Prof. Ezzat Abd-Elshafy, the Erudite Egyptian stratigrapher and paleontologist.

Type species:
Ezzatina egyptiaca.

Diagnosis: Test calcareous perforate, planispiral to biserial, twisted during growth; the final chamber occupies subcentral position, aperture rounded, terminal, toothed and surrounded by imperforate lip.

Stratotype: The holotype is recorded from the Gehannam Formation (upper Eocene) in Wadi El Hitan, Fayoum area.

Description: Test free, very small, elongate, lanceolate, inflated, slightly compressed consists of 3 to 5 triangular chambers in minute planispiral part, followed by a moderately large biserial part, this biserial part is twisted during the growth. The chambers are inflated, globular to rectangular; the final chamber occupies subcentral position and caps the proceeding ones (Fig.3-A_1, A_2). Wall calcareous, highly perforate; surface microundulated. Aperture terminal rounded, bordered by an imperforate lip and contains internal teeth plates (Fig.3 -A_3).
Comparison: This genus is similar to *Bolivina* d′Orbigny in its highly perforate calcareous wall and similar to *Tappanina* Montanaro Gallitelli in the twisting biserial test. It differs from all of Bolivinidae genera as *Latibolivina* Saidova, *Grimsdaleinella* Bolli, and *Gabonita* Dieni in the planispiral to biserial chamber arrangement.

Ezzatina egyptiaca new sp.
(Figure 3: $A_1 – A_4$)
Etymology: After Egypt.
Holotype:
The holotype is illustrated by (Figure 3: A_1)
Depository: Holotype and figured types are deposited in the museum of the Geology Department, Faculty of Science, Zagazig University, and abbreviated Z U-E.1

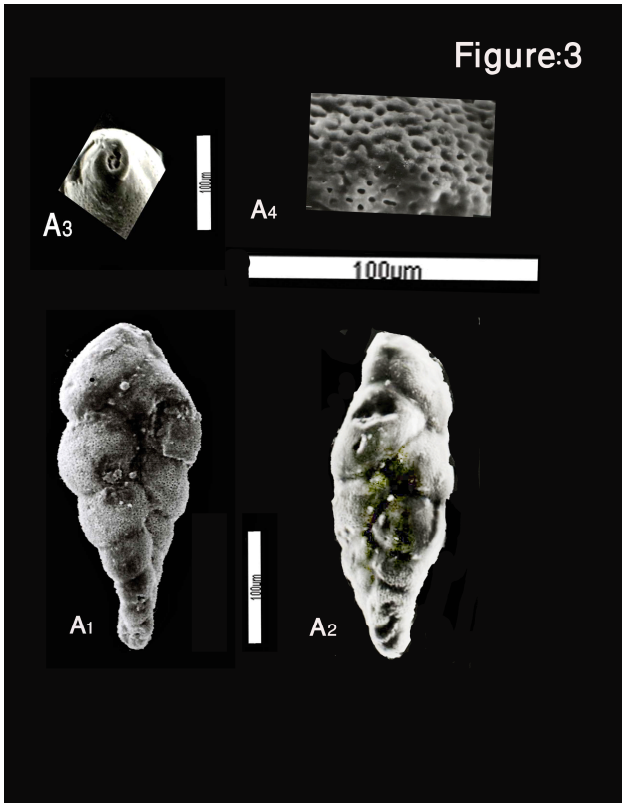

Fig. (3): *Ezzatina Egyptiaca,* A_1-Side view of the holotype; A_2- Side view of the paratype; A_3 – Apertural view of the holotype and A_4-Wall texture of the holotype.

Description: Test free, very small, elongate, inflated; consists of 5 chambers in a minute planispiral part followed by moderately large biserial part consists of 6 chambers in each row, increasing gradually in size; the biserial part is slightly twisted during the growth (Figures 3- A_1,A_2). The chambers are globular; the last chamber is tapered towards the aperture. Sutures are curved, depressed. Wall micro-undulated, calcareous and highly perforate; pores are rounded and ovoid sometimes two or three pores are conjugated together (Figure 3- A_4). Equatorial periphery lobulate and transverse periphery rounded. Aperture terminal, rounded, crenulated, surrounded with thickened imperforate lip and has an internal elongate toothplate (Figure 3- A_3).
Measurements:
Length: 0.3 mm., maximum width: 0. 1mm.
Occurrence: It is recorded from the Gehannam Formation (upper Eocene) at Wadi El Hitan and Garret Gehannam sections, Fayoum area.
Material: 21 tests.

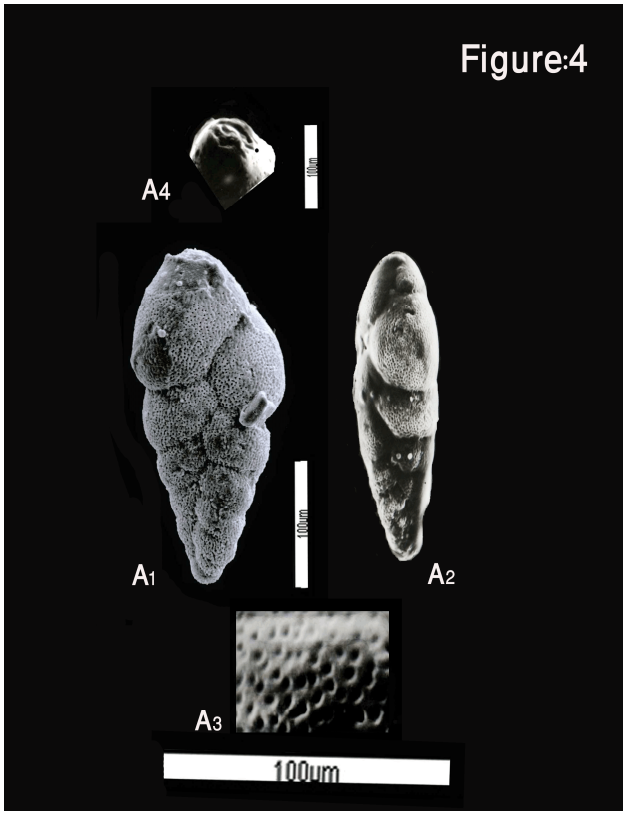

Fig. (4): *Ezzatina abdallahi,* A_1-Side view of the holotype; A_2- Side view of the paratype; A_3- Wall texture of the holotype; A_4- Aperture view of the holotype.

Ezzatina abdallahi new sp.
(Figure 4: A_1-A_4)
Etymology: In the memory of the late Prof. A.M. Abdallah an outstanding Egyptian stratigrapher.
Holotype: The holotype is illustrated in (Figure 4-A_1)
Depository: Holotype and figured types are deposited in the museum of the Geology Department, Faculty of Science, Zagazig University, and abbreviated Z U-E.2
Description: Test free, very small, elongate, and inflated; consists of a minute planispiral part followed by moderately large biserial part consists of six chambers in each row, increasing proportionally in size; the biserial part is slightly twisted during the growth (Figure 4-A_1). The chambers are inflated; rectangular to globular (Figure 4-A_1). Sutures are straight, depressed. Wall rough, calcareous, highly perforate, pores are rounded, ovate, and elongate (Figure 4-A_3). Equatorial periphery lobulate and transverse periphery rounded. Aperture terminal, rounded, wide, and surrounded by thin lip and an internal ovate toothplate (Figure 4- A_3).
Measurements: Length: 0.28 mm., maximum width: 0. 1mm.
Comparison: This species differs from *E. egyptiaca* in its very small planispiral part, less twisting test, straight sutures and the aperture with ovate toothplate.
Occurrence: It is encountered from the Gehannam Formation (upper Eocene) at both Wadi El Hitan and Garret Gehannam sections, Fayoum area.
Materials: 42 tests.

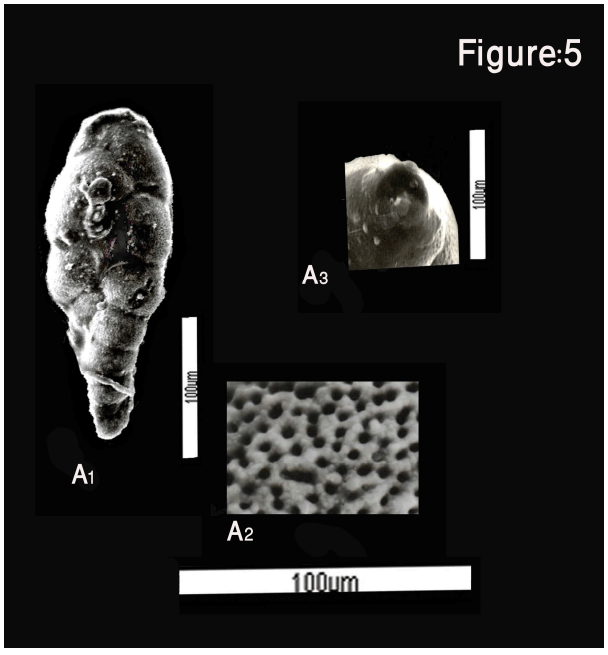

Fig. (5): *Ezzatina bassiounii,* A1-Side view of the holotype; A_2 - Apertural view of the paratype; A_3-Wall Texture of the holotype.

Ezzatina bassiounii new sp.
(Figure 5:A_1-A_3).
Etymology: In honor of Prof. A. M. Bssiouni, the outstanding Egyptian micropaleontologist.
Holotype: The holotype is illustrated in (Figure 5: A_1).
Depository: Holotype and figured types are deposited in the museum of the Geology Department, Faculty of Science, Zagazig University, and abbreviated Z U-E.3.
Description: Test free, very small, elongate and inflated, consists of 4 very small chambers in planispiral part followed by moderately large biserial part made up of 6 globular chambers in each row, increasing rapidly in size; the biserial part is very closely twisted during the growth (Figure 5- A_1). Sutures are pronounced, curved, depressed. Wall finely undulated, calcareous, highly perforate, some pores are rounded others are ovoid some pores are conjugated together (Figure 5-A_2). Equatorial periphery lobulate and transverse periphery rounded. Aperture terminal, rounded, surrounded with thick lip and contains triangular tooth plate covering one third of the aperture (Figure 5- A_3).
Measurements: Length: 0.25 mm, maximum width: 0.08mm.
Variability: This species is characterized by the more twisting test, wider wall pores and the rounded aperture with triangular tooth plate.
Comparison: It differs from *E. egyptiaca, E. abdallahi,* in the closely twisting test, sudden enlargement of the biserial part, moderately wide pore spaces of the calcareous perforate wall and the triangular apertural tooth plate.
Occurrence: It is picked from the Gehannam Formation (upper Eocene) in Wadi El Hitan, Fayoum area.
Materials: 8 tests.
Ezzatina faragi new sp.
(Figure 6: A_1 - A_3)

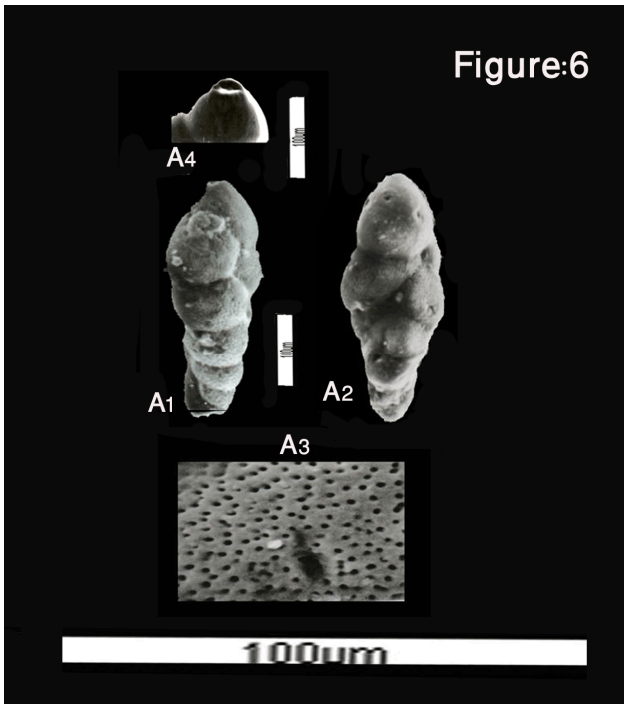

Fig. (6): A-*Ezzatina faragi*, A_1-Side view of the holotype; A_2- Side view of the paratype; A_3-Wall texture of the holotype; A_4- Apertural view of the holotype.

Etymology: In memory of the Late Prof. I.A.M. Faragi, one of the leaders in the Egyptian geology in the late Century.
Holotype: The holotype is illustrated by (Figure: 6, $A_{1,}$)
Depository: Holotype and figured types are deposited in the museum of the Geology Department, Faculty of Science, Zagazig University, and abbreviated Z U-E.4.
Description: Test free, very small, elongate, inflated; consists of three inflated chambers in moderately small planispiral part followed by moderately large biserial part consists of 5 globular chambers in each row, increasing gradually in size, the last chamber is larger and pyriform in shape. The biserial part is more twisted during the growth (Figure: 6- $A_{1,}$ A_2). Sutures are definite, curved, depressed. Wall smooth, calcareous, highly perforate; pores are fine, ovoid; some of them are attached together forming numerous slit grooves scattered through the test wall (Figure: 6- $A_{2,}$ A_3). Equatorial periphery lobulate and transverse periphery rounded. Aperture terminal, narrow, rounded, surrounded with thick raised lip and contains subcirculer toothplate. (Figure: 6- A_4).
Measurements: Length: 0.3 mm. maximum width: 0. 1mm.

Variability: This species is distinguished by the twisting test, pyriform last chamber, rounded narrow aperture and the attached wall pores.
Comparison: This species differs from the other *Ezzatina* species in the moderately larger planispiral part, the more inflated chambers with final pyriform one, the finer wall pores, the scattered grooves on the surface and the subcirculer apertural tooth plate.
Occurrence: This species is described from the Gehannam Formation (upper- Eocene) in Wadi El Hitan and Garret Gehannam sections at Fayoum area.
Materials: 8 tests.

Ezzatina fayoumensis. new sp.
(Figure 7:A_1-A_4).
Etymology: After Fayoum area.
Holotype: The holotype is illustrated by (Figure: 7-A_1).
Depository: Holotype and figured types are deposited in the museum of the Geology Department, Faculty of Science, Zagazig University, and abbreviated Z U-E.6.

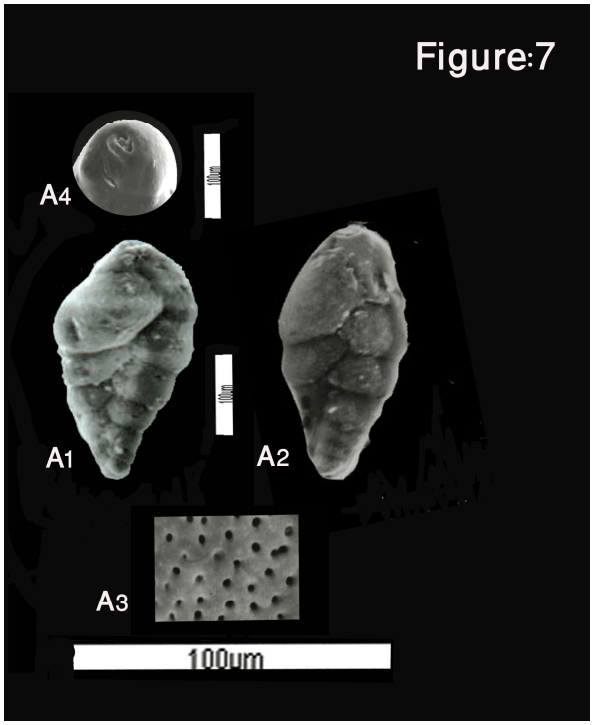

Fig. (7*):* *Ezzatina fayoumensis*, A_1-Side view of the holotype; A_2-Side view of the paratype; A3-Wall texture of the holotype; A_4- Apertural view of the holotype.

Description: Test free, very small, elongate, inflated; consists of three inflated chambers in very small planispiral part followed by moderately large biserial part consists of 6 rectangular chambers in each row,

inflated, wider than high, increasing rapidly in size, the last two chambers are very large compared with the other proceeding ones; the biserial part is slightly twisted during the growth (Figure: 7- A_1, A_2). Sutures are distinctive, straight, depressed. Wall smooth, calcareous, perforate; pores are rounded to ovoid, simple ((Figure: 7- A_3). Equatorial periphery lobulate and transverse periphery rounded. Aperture terminal, narrow, elongated surrounded with thick raised lip and contains irregular teethplates. (Figure: 7-A_4).

Measurements: Length: 0.2 mm. maximum width: 0. 1mm.

Variability: This species characterized by the large last two chambers, the smooth wall with fine pores compared with the other species of the genus, the elongated aperture and the raised lip.

Comparison: *Ezzatina fayoumensis* differs from other Ezzatina species in the rectangular chambers, the smaller rounded wall pores and the elongated aperture.

Occurrence: It is described from the Gehannam Formation (upper Eocene) in Wadi El Hitan and Garret Gehannam sections, Fayoum area.

Materials: 4 tests.

Ezzatina hassaneini new sp.
(Figure: 8, A_1-A_4)

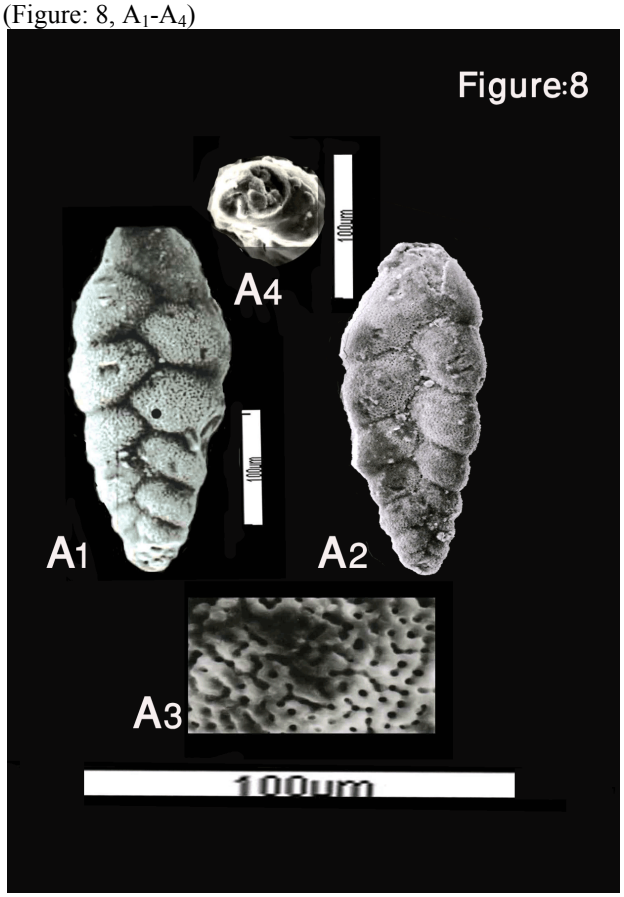

Fig. (8): *Ezzatina hassaneini,* A_1-Side view of the holotype; A_2–Side view of the paratype; A_3-Wall texture of the holotype; A_4-Apertural view the holotype.

Etymology: In the memory of the Late Prof. A.M. Hassanein the, outstanding Egyptian biostratigrapher.

Holotype: The holotype is illustrated by (Figure: 8-A_1).

Depository: Holotype and figured types are deposited in the museum of the Geology Department, Faculty of Science, Zagazig University, and abbreviated Z U-E.6

Description: Test free, very small, elongate, inflated; consists of 4 very small chambers in planispiral part followed by moderately large biserial part consists of 6 chambers in each row, increasing proportionally in size, caped by one truncate chamber; the biserial part is very slightly twisted during the growth. The chambers are inflated; wider than high, rectangular (Figure: 8-A_1, A_2). Sutures are obvious, straight between chambers and zigzag between the rows, depressed. Wall rough, calcareous, highly perforate, some pores are rounded most of them are conjugated together forming elongated, curved and three rayed grooves. (Figure: 10-A_3). Equatorial periphery lobulate and transverse periphery rounded. Aperture terminal, rounded, wide surrounded with thin raised lip and contains irregular toothplates covering most of the aperture (Figure: 8- A_4).

Measurements: Length: 0.35 mm. maximum width: 0.1mm.

Variability: This species is differentiated by its very low twisting, final truncate chamber capping the biserial part and the wide rounded aperture.

Occurrence: Gehannam Formation (upper Eocene) in both Wadi El Hitan and Garret Gehannam sections, Fayoum area.

Materials: 21 tests.

Phylogeny

Before this study, it is known that the family Bolivinidae includes 11 genera according to Loeblich and Tappan [21]. Depending on their historic appearance these genera are the *Bolivina* d`Orbigny [25], *Brizalina* Costa [26], *Tappanina* Montanaro Gallitelli [27], *Loxostomoides* Reiss [28], *Grimsdaleinella* Bolli [29], *Afrobolivina* Reyment [30], *Altistoma* de Klaz, Le Calvez and .Rerat [31], *Latibolivina* Srinivasan [32], *Gabonita* Dieni [33], *Bolivinellina* Saidova [34], and *Ludgunum* Saidova [34] Now the 12th one is the newly recorded genus *Ezzatina* Abd El-Azeam. The stratigraphic ranges of these genera are shown in Fig.9. The probable phylogenitic trend and the evolutionary relationships among these genera are demonstrated in the

suggested phylogenitic tree (Fig.10) and briefly outlined here under.

Grimsdaleinella Bolli [29] is the oldest Bolivinid genus of appearance in the geologic history. It began since the Turonian in Trinidad and then rapidly extinct through the Coniacian (Fig.9). The genotype of this genus is the main ancestor of the family Bolivinidae since it carries its main morphological features as the calcareous perforate wall, the elongate, compressed test, biserial arrangement of chambers and the loop shaped basal aperture. Three descendents with analogues morphological characters were split from this root; these are the genera *Tappanina* Montanaro Gallitelli, *Loxostomoides* Reiss and *Gabonita* Dieni, but each of them has its own characteristic morphologic features.

Fig. (9): The stratigraphic ranges of the foraminiferal genera of the family Bolivinidae

The genus *Tappanina* Gallitelli appeared for the first time with the beginning of the Coniacian (Fig. 9), it has a biserial elongated test, slightly twisted with inflated chambers, carinate, rectangular or ovoid in section, the aperture is basal with an elevated lip at one margin and has a folded internal tooth plate.

The early Eocene saw extinction of *Tappanina* Montanaro Gallitelli gave rise to the appearance of the two descendents *Altistoma* de Klaz, Le Calvez and Rerat (middle Eocene) and *Ezzatina* (the new genus) which was evolved during the late Eocene (Fig. 10) with the analogous elongated tests, inflated chambers and lobulate periphery. The genus *Ezzatina* is characterized by the twisted test, as its ancestor *Tappanina* Gallitelli as well as the appearance of a minute planispiral part racing the biserial arrangement; the final chamber capping the proceeding ones and the rounded, terminal aperture is surrounded by thickened lip with an internal tooth plate. The genus *Altistoma* de Klaz, Le Calvez and Rerat has a very small triserial part in the early stage, rapidly widening with strongly overlapping chambers, the aperture a high symmetrical arch in a depression in the face of the final chamber.

The genus *Loxostomoides* Reiss had evolved through the Senonian, it is characterized by a narrow, elongate test, oval in section; chambers low, broad, and arranged biserially in the early stage, later chambers higher, and uniserial; lower margin of the chamber with slight directed projections overlying the depressed sutures; aperture areal, slightly eccentric in the uniserial stage, with narrow bordering lip and an internal tooth plate. It disappeared with the close of the Paleocene. Its descendent *Bolivinellina* Saidova had appeared at the beginning of the Pliocene with similar characters as the elongate test, narrow, oval section; chambers high, slightly inflated; biserial throughout; sutures oblique, slightly depressed; distal part of the chambers clear translucent and poreless; wall perforate only in the proximal chamber half; aperture a basal loop-shaped opening with narrow lip and internal toothplate.

Gabonita Dieni appeared in the Coniacian and disappeared at the end of the Paleocene (Fig.9). It is

analogous to *Tappanina* Montanaro Gallitelli in the inflated biserial twisted test, distinguished by, arched broad chambers, the basal part of chambers with strong reentrant, leaving a prominent ridge above the depressed sutures; aperture a low arch with narrow bordering lip on one side attached to the penultimate chamber with tooth plate attached to the apertural face. The three genera *Bolivina* d`Orbigny, *Afrobolivina* Reyment and *Brizalina* are considered here as descendents from *Gabonita* Dieni, (Fig.10). *Bolivina* d`Orbigny appeared at the Maastrichtian and ended at the close of the Paleocene. The *Bolivina* d`Orbigny like the proceeding Bolivinid genera in the biserial chamber arrangement and the basal loop shaped aperture bordered by thickened imperforate rim with internal tooth plate while the developed features are the compressed test, ovoid to triangular in outline; septa are flush to slightly depressed. The *Afrobolivina* Reyment test is large, calcareous perforate, biserial. Its sculpture is developed by the anastomosing imperforate longitudinal costae, the deep indentations and the proximal margin of the chamber commonly with lobs that project back over the proceeding chambers between the vertical indentations. Aperture areal to basal loop shaped without lip and internal folded tooth plate. *Brizalina* Costa appeared at the Campanian and present till now (Fig.9). It is similar to its ancestors in the biserial chamber arrangement and the basal loop shaped aperture with internal tooth plate but it has a pronounced morphological features as the lanceolate, compressed test, the acute periphery and the imperforate costae on the early half of the test.

Brizalina is common ancestor of *Latibolivina* Srinivasan and *Lugdunum* Saidova (Fig.10). *Latibolivina* Srinivasan appeared with the Late Eocene (Fig.9). It is closely similar to *Bolivina* d`Orbigny and *Brizalina* Costa but it has heavy ornamentation with anastomosing longitudinal costae that obscure the sutures. *Lugdunum* Saidova is the youngest and well developed genus in this family. It is distinguished by the carinate periphery; lenticular in section; chambers moderately inflated, biserially arranged, increasing in proportionate breadth as added; surface smooth to longitudinally costate; aperture basal, large and ovoid with bordering lip and an internal tooth plate.

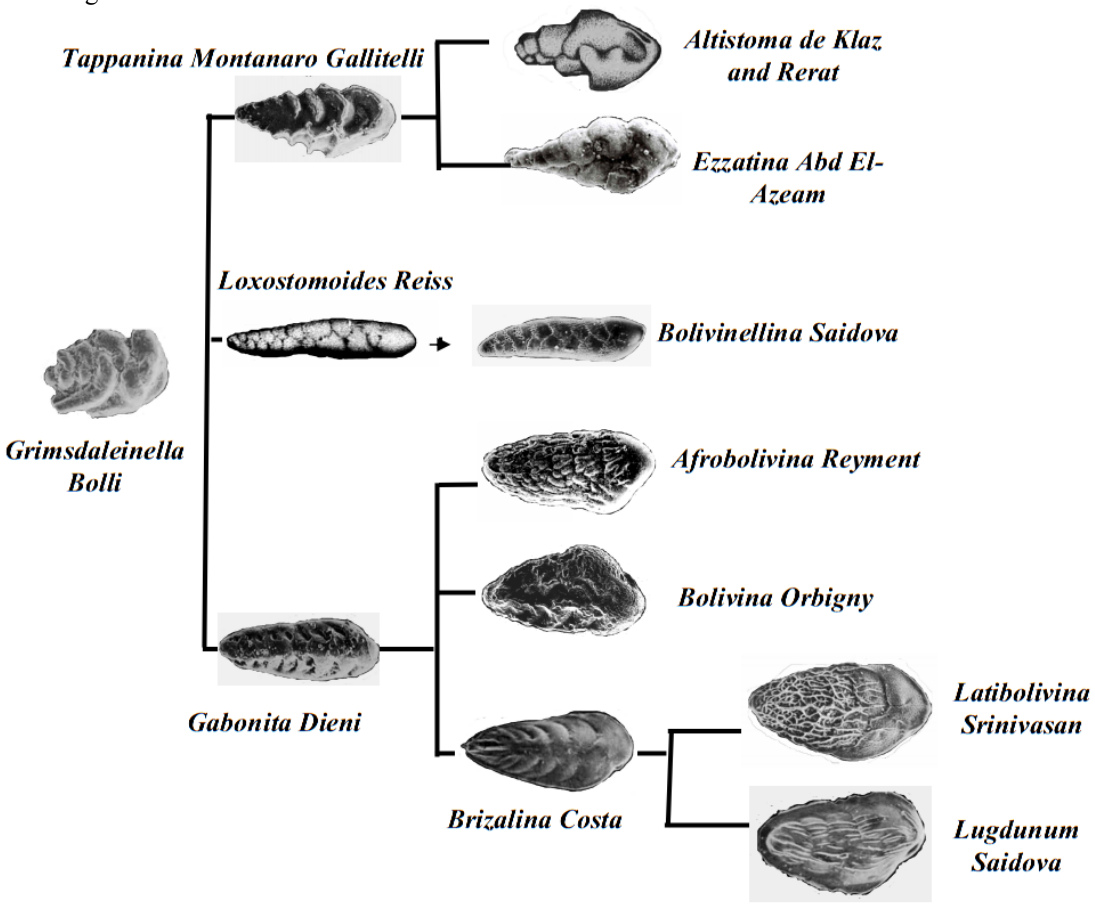

Fig. (10): Suggested phylogenitic tree of the family Bolivinidae

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