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Evolutionary Aspects of the Miogypsinidae from Azkand Formation (Oligocene-Miocene) in Kirkuk Area, Iraq

Imad M. Ghafor
Department of Geology
College of Science
Sulaimanya University

Qahtan A. Muhammed
Kirkuk Technical College
Kirkuk, Iraq

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ABSTRACT

The biometric analysis on *Miogypsina* from bioclastic limestone (Azkand Formation) in Kirkuk area, Iraq reveals that the evolutionary trend based on a distinct overall change in morphology of the nepiont, which change is in agreement with the principle of nepionic acceleration as defined by Tan Sin Hok,1936. The oldest species of *Miogypsinoides* represented by *Miogypsinoides complanata* and *Miogypsinoides formosensis* accompanied by the association *Miogypsina gunteri* which exhibit in the lower part of Azkand Formation of Late Oligocene age (Chattian). The early Miocene association of *Miogypsina* s.s. represented by *Miogypsina gunteri-tani* are often accompanied by *Miogypsinoides*. Most of these are close to *Miogypsinoides bantamensis*.

الخط التطوري لـ(Miogypsinidae) من تكوين ازقند (الاوليجوسين - المايوسين) في منطقة كركوك / العراق

عماد محمود غفور
قسم علوم الأرض/ كلية العلوم
جامعة السليمانية

قحطان احمد محمد
الكلية التقنية
كركوك / العراق

الملخص

ان دراسة التحليل القياسي الحياتي للجنس (*Miogysina*) المأخود والمستحصل من التتبعات للصخور الكلسية الحياتية المتمثلة بتكوين ازقند (اوليجوسين – مايوسين) من منطقة كركوك، العراق سيعكس الخط التطوري الرئيسي لها على اساس التغيرات المميزة في شكل وحجم الغرف الاولية وهذه التغيرات تتفق مع مبدأ (Nepionic acceleration) الذي حدد من قبل (Tan Sin Hok, 1936). ان تواجد الأنواع القديمة للجنس (*Miogysina)* متمثلة بالانواع (*Miogypsinoide complanata* *Miogypsinoides formosensis*) والتي غالباً مايصاحبه نوع من (*Miogypsina gunteri*) في الجزء السفلي من تكوين الأزقند (الاوليجوسين المتأخر) وان التجمعات للجنس (*Miogypsina*) من المايوسين المبكر (Aquitanian) متمثلة بالنوع (*Miogypsiona gunteri- tani*) غالباً ما يصاحبه نوع من (*Miogypsinoides*) والتي على الأكثر تعود للنوع (*Miogypsinoides bantamensis*).

INTRODUCTION

The succession of *Miogypsina* species in the Oligocene carbonate rocks (Azkand Formation) during the biometric analysis study on Miogypsinidae in Kirkuk area Iraq, provides us with unique proof for the general validity of the principle of the nepionic acceleration (Tan Sin Hock, 1936a) in the evolution of the Miogypsinidae. Most investigated *Miogypsina* association are derived from the Azkand Formation in Khabaz well-3 and Qarah Chauq Dagh sections (Fig.1). A major deviation from the earlier established evolution, Aquitanian occurrences of two morphometric units close to *Miogypsinoides bantamensis*, instead of only one. They were named *Miogypsinoides* I and II. This divergence from the overall line of evolution will be discussed in this paper.

The evolutionary patterns in our *Miogypsina* will be dealt with in more detail, which actually was the main purpose of our investigation. The morphometric series will be compared with the results of earlier published detailed studies on other Orbitoidal foraminifera and current evolutionary theories.

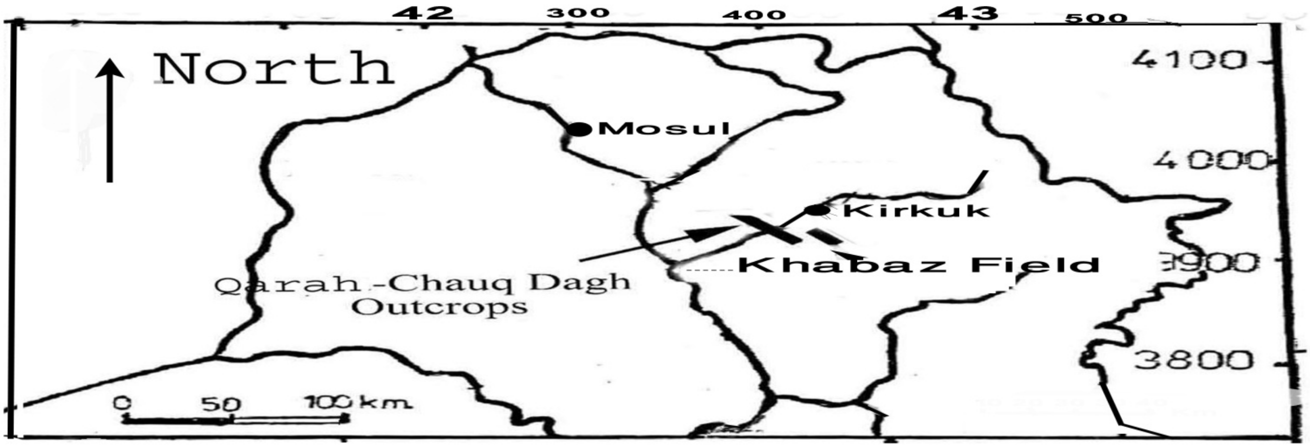

Fig.(1): Location map of the studied area

Fig. 1 : Location map of the studied area.

The importance data of the Miogypsinidae are discussed from the Oligocene-Miocene carbonates (Azkand Formation) which are subdivided into four units (I, II, III and IV). Fig.(2).

PREVIOUS RESEARCH

Tan sin Hok visualised as early as in 1936 and 1937 the broad outlines of the scheme of evolution in the Miogypsinidae. The early works Miogypsinidae were reviewed by Drooger (1952, 1963), it has been well recognized that features which best show evolutionary change in the Miogypsinidae are in the embryonic –nepionic stage and hence classification could best be based upon these early developmental stages. Ujiie (1966) discussed the evolutionary lines of Miocene *Miogypsinoides* population from Japan by using parameters x,γ,α and β.

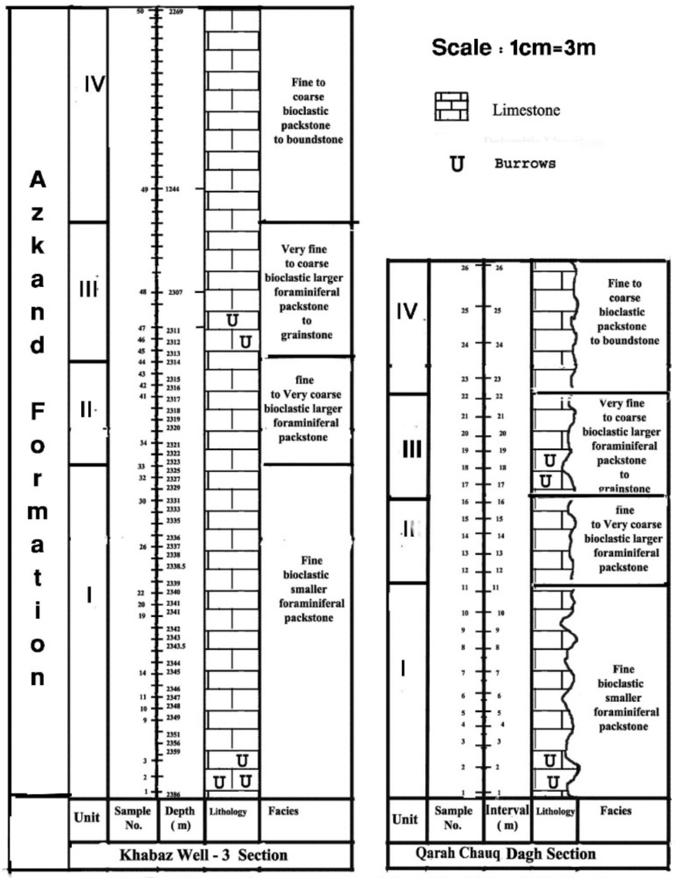

Fig (2) : Lithostratigraphic columns of the section Khabaz Well - 3 and Qarah Chauq Dagh sections

Fig. 2 : Lithostratigraphic columns of the section Khabaz Well-$_3$ and Qarah Chauq Dagh sections.

Raju (1974,1991) strictly following Drooger's method proposed the zonal scheme at the same time discussed phylogenitic trends from Kutch and Cauvery basins in India.

The detailed research on the phylogeny of *Miogypsina* made this genus a very useful tool for chronostratigraphic correlations, especially on regional scale (Drooger and Laagland, 1986).

A biometric research have been performed on Miogypsinids from north Italy by Mortara (1987) indicated strong correlation between x, γ, D_2/D_1

The biometric analysis of Miogypsinidae with their evolutionary aspects investigated by Wildenborg (1991) near Mineo (Sicily) states that the morphometeric series of *Miogypsina* is not complete because of hiatuses in the local environment. Al-Omari and Sadek (1972, 1975) identified many *Miogypsina* from Iraq based on statistical study on Miogypsinidae associations.

METHODS OF INVESTIGATION

Drooger (1952, 1963 and 1993) has introduced a number of counts and measurements for Miogypsinidae species. Only the few characteristic parameters that define species are considered in this paper (Fig.3). These are:

(X): The total number of nepionic chambers in the initial spiral excluding the two embryonic chambers and including the closing chamber, if present.

(γ): This angular parameter is quantitative measure of the orientation of the nepiont in the foraminiferal test. A detailed description of the way of measuring γ was given by Amato and Drooger (1969).

Two line segments determine this variable. The first one starts at the center of the protoconch and passes through the center of the deuteroconch and continues through the apex of the test, coinciding with the apical –frontal line. The zero of the γ-scale has been arbitrarily fixed at the configuration where both line segments coincide in individuals with one whorl or less.

γ : is positive if the first principal auxiliary chamber points to the frontal margin of the test. Otherwise γ is negative. In the later case it is measured by rotating the embryonic line segment in the direction of coiling towards the apical frontal line segments.

(α): The arc length of the circumference of the protoconch underlying the shorter spiral.

(β): The arc length of the circumference of the protoconch underlying both protoconchal spirals .

(V): This parameter depends on two angular variables, γ and β, in the following way: $V= 100\,\alpha/0.5\beta= 200\alpha/\beta$.

The dimensionless ratio, which scale ranges from 0 to 100 indicates the degree of symmetry of the protoconchal spirals.

(D_1): The maximum diameter of the protoconch is measured perpendicular to the embryonic line and includes half of the thickness of the walls

(D_2): These parameters represent the largest diameter of the deuteroconch, determined parallel to the measurement line of D_1.

(P): Percentage of specimens with two principle auxiliary chambers.

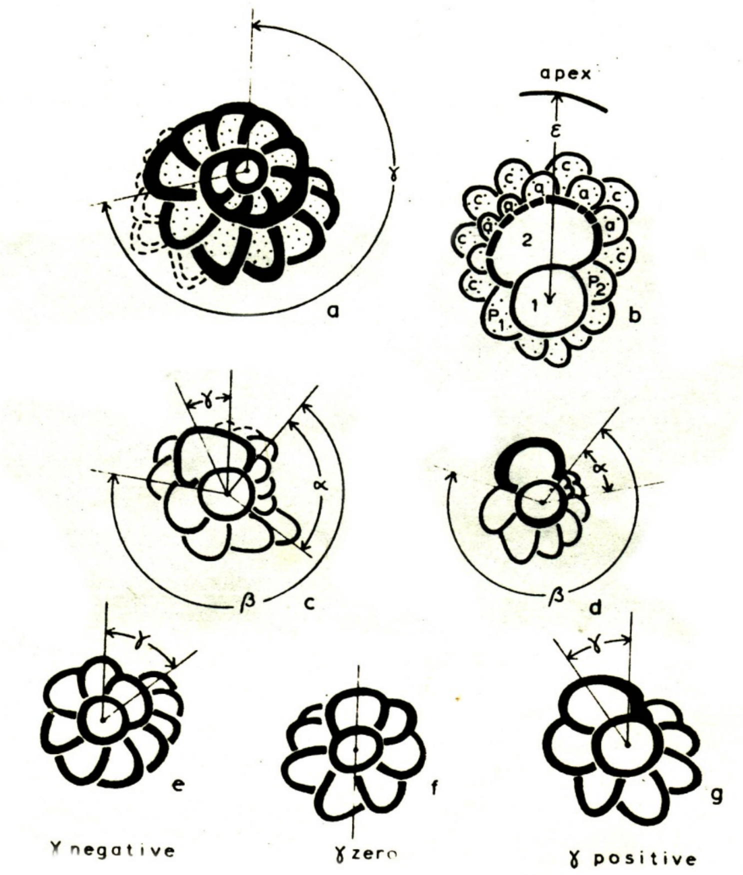

Fig. 3 : Schematic drawing the median sections of the embryonic-nepionic stage of Miogypsinidae illustrating the derivation of (α, β andγ). 1 = protoconch, 2 = deuteroconch. 1 and 2 constitute the embryonic stage; chambers around the embryonic stage (doted in figs. a, b) constitute the nepionic stage. P_1 = first principal auxiliary chamber, P_2=second principal auxiliary chamber; a=accessory auxiliary chamber, c=closing chamber. (after Raju, 1974 and Drooger,1993)

THE DEVIATION FROM THE GENERAL DEVELOPMENT PATTERN IN *MIOGYPSINA*

The two groups of *Miogypsinoides* specimens, both close to *M. bantamensis* are found to a company *M.gunteri-tani* in the Aquitanian carbonates of the Azkand Formation in Khabaz well-3 and Qarah Chauq Dagh sections. The two biometric units, *Miogypsinoides* I, and II, differ primarily in embryonic size and show relatively minor morphometric differences in nepionic configuration. The mean protoconch diameter of *Miogypsinoides* I varies from about (100-120µm), whereas *Miogypsinoides* II is marked by a mean diameter of the protoconch of about (210-220µm). The chronostratigraphic range *of Miogypsinoides* I continues into the Late Aquitanian, where it associates the successive species *Miogypsina gunteri,* and *Miogypsina tani*. The Late Aquitanian *Miogypsinoides* I displays small shift in its nepionc variables with respect to its early Aquitanian ancestor; (X) decreases from about (13 to 14) in the early Aquitanian to about (11 to 12) in the Late Aquitanian . A part from this shift that occurs close to the chronostratigraphical boundary, neither *Miogypsinoides* I nor *Miogypsinoides* II shows a significant net change in their nepionic variables. In both nepionic and embryonic characteristics *Miogypsinoides* I is very close to primitive *Miogypsina gunteri*, *Miogypsinoides* II display distinct morphological overlap with the other older *Miogypsinoides complanata* and with the *Miogypsinoides formosensis.* So far, the simultaneous existence of the type of *Miogypsinoides* in the Aquitanian is not known in the literature. Three hypotheses will be offered to explain the co-occurrences, first of all some remarks will be made on the habitats of both types on the basis of our own observations, the *Miogypsinoides bantamensis* probably preferred a hard substrate and some what shallower depth relative to *Miogypsina s.s.* as in Unit (IV) for both Aquitanian *Miogypsinoides* the whole rock thin sections gave no reliable indication on the paleoenvironment, especially because of the low frequencies in this interval. The biometric data on *Miogypsinoides* I, and II give possibly a clue to the relative position of the habitats of both units (III and IV) Figs. 4,5). In the successive samples of the Units (I and II) in both sections, the frequency of type II, relative to type I is the largest in the upper part of this unit which has been thought to represent the deeper facies of this interval, Thus, *Miogypsinoides* II seems to prefer shallower habitats with respect to *Miogypsinoides* I and also with respect to *Miogypsina* s.s. In contrast the low frequency distributions of *Miogypsinoides* II will be shown and clear in the units (III and IV) as compared to *Miogypsinoides* I which shows highly distribution.

According to (Wildenborg, 1991) the Chattian and early Aquitanian shows an excellent analogue of the differentiation in the *Miogypsinoides* and *Miogypsina s.s* ., as in the studied area early *Miogypsinoides* possibly split into two branches one with lateral chamber complexes *(Miogypsina s.s.)* and the other preserving the massive side walls of *Miogypsinoides* . Simultaneously, the *Miogypsina s.s.* branch underwent a reduction of the mean embryon size with respect to *Miogypsinoides* II, rather later still showing distinct increase of embryonic size with respect to the supposedly ancestral *Miogypsinoides complanata* and *Miogypsinoides formosensis*.

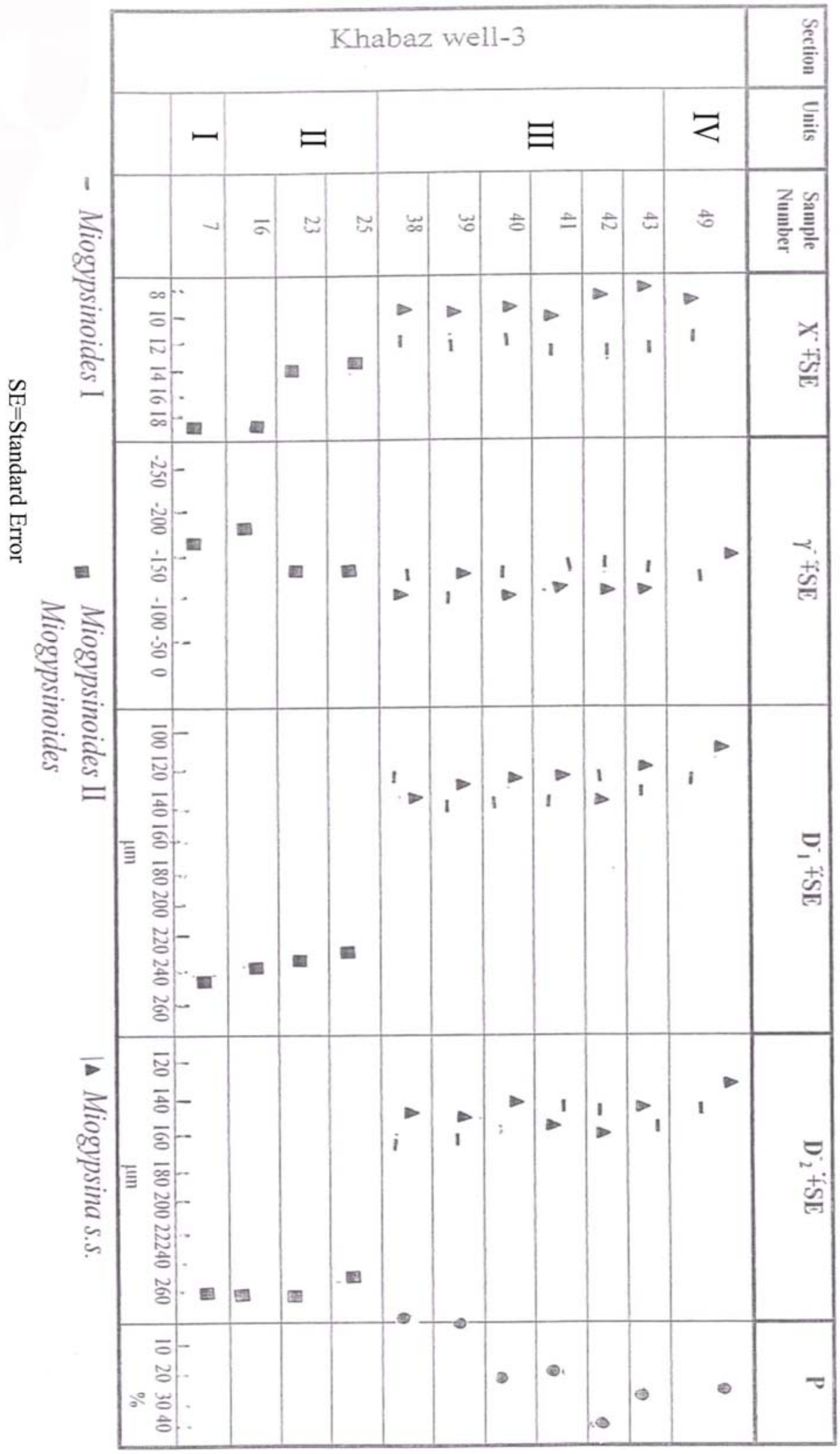

Fig. (4): $\bar{X}$, $\bar{\gamma}$, $\bar{D}_1$, $\bar{D}_2$ and P of *Miogypsina* in the samples of Units (I,II,III and IV) of **Khabaz well-3** section.

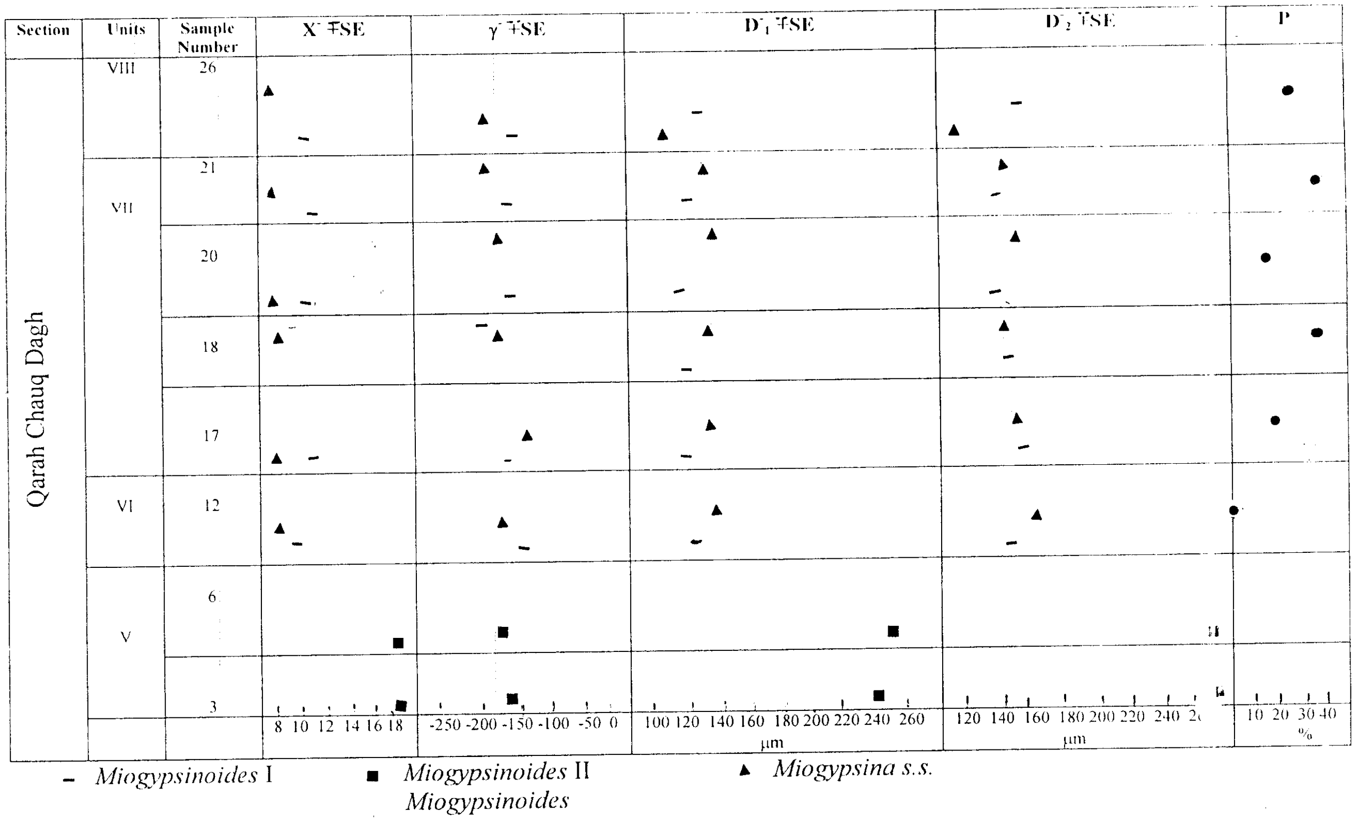

Fig. (5): X', γ', D'_1, D'_2 and P of *Miogypsina* in the samples of Units (V, VI, VII and VIII) of Qarah Chauq Dagh section .

This splitting into two branches could well represent the adaption to specific habitats deeper than those of *Miogypsinoides* II. There is close resemblance between the embryons and nepionics of *Miogypsinoides* I the most primitive *Miogypsina s.s. (Miogypsina gunteri*) . This brings us to explain the existence of *Miogypsinoides* I in the regions of the studied sections. Both taxa with small embryons would belong to one monophylogenitic group. Taking into account the probable difference in preference for the type of substrate, and may assume a case of different adaptive evolution, *Miogypsinoides* I would have adapted to hard substrate of some what greater depth, and this corresponds to the hypothesis proved by (Wildenborg, 1991). The (D^{-}_{1}-X^{-}) and (D^{-}_{1}-V^{-}) scatter diagrams in figures (6 and 7), illustrate that our associations of early *Miogypsinoides* and *Miogypsina s.s.* fit rather well within the range of the *Miogypsina* data from French, Italian and Sicily localities. They differ from the more southern occurrence in having in the whole larger mean protoconch sizes. However the Aquitanian, *Miogypsinoides* I is close to the *Miogypsinoides* associations from localities in Africa., viz Egypt (Souaya,1961); Morocco (Brönnimann,1940); Drooger,1954b.

In the preceding discussion, it has been presented to explain the types of *Miogypsinoides* in addition to *Miogypsina s.s.* . in the studied sections of Aquitanian. A local region of all taxa would invoke a rather complicated evolutionary exceeds or series of events in a time interval close to the chattian-Aquitanian boundary , Unfortunately , our record for this period is far from complete.

As seen in Figures. (6 and 7), we prefer the hypothesis of migration of *Miogypsinoides* I from a southern subprovince. There are good agreements to defend the postulate that the studied section was split into a northern and southern subprovince. The studied area that was part of the Africa realm with its specific evolution of *Miogypsina*. At some time during the early Aquitanian, *Miogypsinoides* I a typical form of the African subprovince, migrated into the studied area.

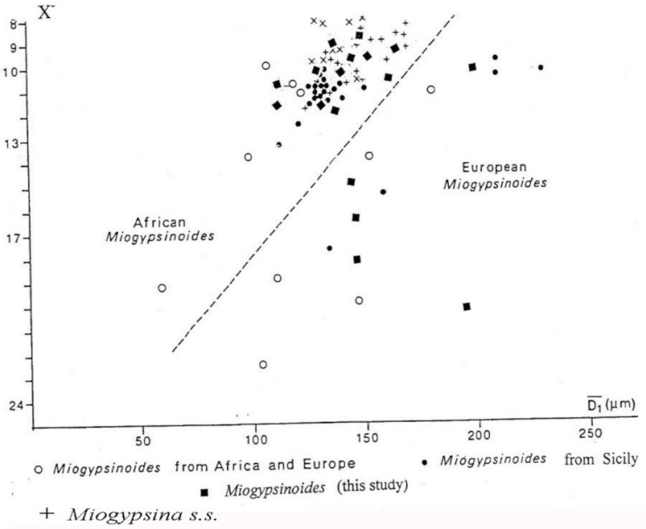

Fig. 6 : D^{-}_{1}-X^{-} diagram of *Miogypsinoides* in the Khabaz well-3 and Qarah Chauq Dagh sections. Dashed lines separate Europian assemblages of *Miogypsinoides* from assemblages of African origin and assemblages from Sicily. (Literature data from Drooger and Raju,1973; De Mulder, 1975 and Wildenborg,1991).

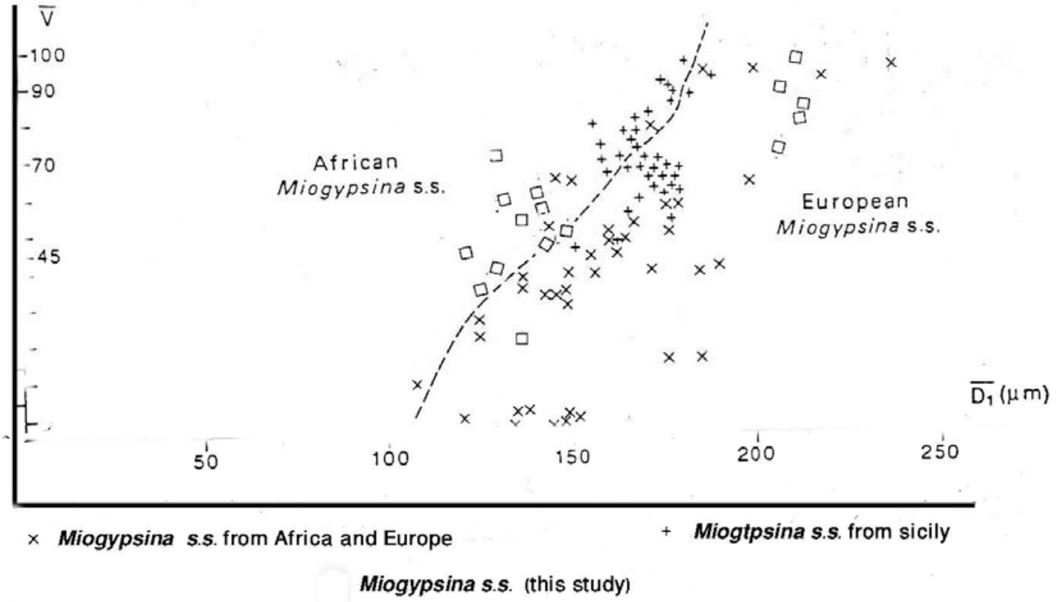

Figure 7 D'_1-V' diagram of *Miogypsna s.s.* in the Khabaz well-3 and Qarah Dagh sections, Dashed lines separate European assemblages of *Miogypsina s.s.* from assemblages of African origin and assemblages of Sicily.(Literature data from Drooger & Raju, 1973; Brun & Wong, 1974; De Mulder, 1975 and Wildenborg, 1991)

EVOLUTION IN *MIOGYPSINOIDES*

Tan Sin Hock, 1936a, 1937; Barker and Grimsdale, 1937; Drooger, 1963) agree that *Miogypsinoides* evolved from a Rotalia-like ancestor (*Pararotalia* or *Neorotalia*), because of certain similarities between the individuals of *M.complanata* and associated *Pararotalia*. Raju, (1974) recorded that the Indian material for small individuals of both *M.cf. bermudezi* and *M.complanata* show several morphological characteristics-ornamentation, trochospiral stage, umbilical plug-similar to those associated individuals of *Pararotalia*. These data leave little doubt that early *Miogypsinoides* evolved from a *Pararotalia* ancestor.

Drooger, (1984) discussed in detail the evolutionary patterns in Orbitoidal Foraminifera, in which he included Miogypsinidae with an available data and has attempted to explain evolutionary processes with reference to pulsating, this later term was used by Drooger and Raju, (1978), in explaining the succession of Miogypsinidae, in depending on the mean values of (X) in encompassing the species. In the preceding discussion and as seen in table (1), it is clearly visible the gradual change in the mean values of (X) progressively from the lower part to upper part of the Azkand Formation in Khabaz well-3 and Qarah Chauq Dagh sections, in the lower most Units (I and II) reflect individuals with large embryon size with mean values of (X) ranging between (19-13) which indicate to *Miogypsinoides complanata* and *Miogypsinoides formosensis* respectively. The occurrence of these species with other associated foraminifera includes *Lepidocyclina. morgani* which is an indication for Late Oligocene (Chattian) (Drooger and Raju, 1973). In Unit (III), consists two groups of *Miogypsinoides* individuals, the two biometric units, *Miogypsinoides* I and II, differ primarily in embryonic size, the mean protoconch diameter of *Miogypsinoides* I varies from about (110 to 120 µm) whereas *Miogypsinoides* II is marked by (210 to 230 µm) and their mean values of X varies between (13-10), both of species close to *Miogypsinoides bantamensis*, type II assemblages are classified as *M.ex. interc. bantamensis –dehaartii* and those of type I are named *M.ex.interc. formosensis-bantamensis*, co-occurring with *Miogypsina gunteri-tani*, the appereance of these species give indication to the Early Aquitanian. The *Miogypsinoides* types I range up into the unit (IV) with mean values of (X) differ between (11-13) are mainly close to *Miogypsinoides bantamensis*. (Table 1, Fig. 8).

Table 1 : Species list of *Miogypsinoides* and pertinent, biometric data; N=Number of observations on X in a sample or a sample suite; if N<11, then the name is presented in parenthese, SE= Standard Error

Section	**Sample**	**X^{-}**	**SE**	**N**	***Miogypsinoides*** **Ex. interc.**
Khabaz well-3					
	49	12.3	0.35	13	*bantamensis*
	43	12.3	0.30	15	*bantamensis*
	42 (Type II)	10.5	0.23	14	*bantamensis-dehaartii*
	42 (Type I)	12.3	0.23	18	*formosensis-bantamensis*
	41	12.3	0.36	12	*bantamensis*
	40	12.6	0.27	15	*bantamensis*
	39	12.4	0.26	15	*bantamensis*
	38	12.3	0.27	18	*bantamensis*
	25	15.1	0.25	17	*formosensis*
	23	15.3	0.27	15	*formosensis*
	16	19.3	0.27	15	*complanata*
	7	18	0.32	14	*complanata*
Qarah Chauq Dagh					
	26				
	21	11.6	0.31	14	*bantamensis*
	20	11.7	0.29	14	*bantamensis*
	18(Type II)	10.4	0.31	18	*bantamensis-dehaarti*
	18(Type II)	11.4	0.27	17	*formosensis-bantamensis*
	17	11.9	0.30	15	*bantamensis*
	12	12.6	0.33	15	*formosensis*
	6	19.8	0.34	12	*complanata*
	3	19.1	0.31	12	*complanata*

Fig. 8 : Evolution of *Miogypsinoides* from the Units (I, II, III and IV) of the sections Khabaz well-$_3$ and Qarah Chaug Dagh.

EVOLUTION IN *MIOGYPSINA S.S.*

In this and many earlier investigation it is the variable (V^{-}) that has been used to describe the nepionic evolution of Aquitanian *Miogysina s.s.* and to identify the successive biometric species (Wildenborg, 1991). (Fig. 9)

It has been suggested that the diameter of the protoconch may change in relation to water depth or some depth linked factor. According to theory (Drooger and Raju, 1973) protoconch diameter would increase toward greater depth. If, furthermore some correlation would exist between embryonic size and nepionic parameters, such ecological factors could indirectly have affected the values of (V) and (V^{-}).An examination of the intra – and intersample correlations between the embryonic and nepionic variables is needed to evaluate this constraint.

Fig. 9 : Frequency of *Miogypsina* s.s. in Units (I, II, III and IV) and shifts in V` and D` illustrating the supposed relation between low frequency zones and evolutionary change the lines (1-6) change in faunal composition.

Our discussion is that the positive correlation between (V^{-} and D^{-}_{1}) probably is not the result of functional relations between both statistics. If the mean size of the embryon was some how determined by a depth linked ecological factors, this effect probably was not reflected in parameter (V^-). On the contrary the supposed shallowing during the deposit of unit (II) would theoretically have caused a decrease in (D^-_1) instead of the general increase that we found. We think that we can role out the effects of environment on the succession of (V^-) values. This inclusion is in good harmony with the fact that intrasample (V^- - D^-_1) correlations are hardly ever of statistical significance.

According to certain evolutionary theories, we need low frequency populations for rapid changes in morphology. As a check on such a possible relation we plotted the relative frequency of *Miogypsina s.s.* in the Fig. (9) which shows two low frequency zones of *Miogypsina s.s.* have been entered the lowest (V^-) in Unit (II) are found in the low frequency interval between level (3) and (4) and correspond to a negative change followed by a leap forward at the top. We can not exclude the possibilities that the reworking of older *Miogypsina s.s.* must be held responsible for the negative shift. Also (D_1) shows a set back have way this lower most zone of low relative numbers. With increasing frequencies of *Miogysina s.s.* across level 4 is shown a notable increase, decrease and weak increase again into the middle low frequency zone followed by a staggered increase across level (6) toward the top, of unit (III). And the second low frequency interval is noted after level (6) toward the upper part of Unit (III).

The early frequency of *Miogypsina s.s.* has been seen across between levels (1) and (2) in unit (II) of Azkand Formation in Khabaz well-3 and Qarah Chauq Dagh sections correspond to the primitive type of *Miogypsina* associations with old Chattian *Miogypsinoides complanata* and *Miogypsinoides formosensis* with mean (X) values of these species range between (9-12).

The other increasing infrequency of *Miogypsina s.s.* has been seen across the level (6), especially in the top of Unit (III), which is characterized by the simultaneous occurrence of *Miogypsinoides* and *Miogypsina s.s.* in samples of Unit (III) and these species possess the mean values of X varies between (9-11). This frequency of *Miogypsina s.s.* are chosen to *Miogypsina gunteri-tani*. (Fig. 10, Table 2).

Table 2 : List of identified, biometric species of *Miogypsina* s.s. and relevant, statistical data, N = number of observations on X in one sample; σ p standard deviation of p. SE= Standard error

Section	**Sample**	**X^-**	**SE**	**N**	**P%**	**бp**	***Miogypsina/ M.ex. interc.***
Khabaz well-$_3$							
	49	9.51	0.46	12	25	1.6	*gunteri-tani*
	43	9.4	0.44	11	28	1.45	*gunteri-tani*
	42	10.1	0.36	15	35	1.41	*gunteri*
	41	10	0.35	14	21	1.41	*gunteri*
	40	10.8	0.41	13	23	1.36	*gunteri*
	39	10.5	0.37	11	0	1.1	*gunteri*
	38	11	0.48	12	0	1.54	*gunteri*
Qarah Chauq Dagh							
	26	9.1	0.35	12	25	1.32	*gunteri-tani*
	21	9.7	0.37	13	24	1.32	*gunteri-tani*
	20	10.3	0.36	14	15	1.27	*gunteri*

18	10.4	0.38	13	34	1.15	*gunteri*
17	10.3	0.3	12	17	1.31	gunteri
12	10.3	0.40	12	0	1.37	*gunteri*

In summary, we may suggest that there was some link in the evolution of our Chattian, Aquitanian, *Miogypsina* s.s., to episodes with low frequencies of this subgenus. Evolutionary changes seem to be of subordinate importance in the periods in between, when *Miogypsina* was relatively more frequent.

CONCLUSION

The evolutionary trend in *Miogypsina* based on the gradual changes in the mean values (X), the early frequency of *Miogypsina gunteri* with the mean values (X= 9-12) recorded from the lower part of the Azkand Formation in both sections associated with old Chattian *Miogypsinoides complanata* and *Miogypsinoides formosensis* with their mean values of (X-) between (13-17) but the *Miogypsina gunteri-tani* with their (X^-) values about (9-11) has occurred in the upper part of Azkand Formation (Early Aquitanian), Simultaneously with *Miogypsinoides bantamensis* with their mean values of (X^-) about (10-13).

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