PALEOECOLOGICAL SIGNIFICANCE OF BRYOZOAN IN LOWER PLIOCENE FROM ASILAH (NW MOROCCO)

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Abstract: The bryozoan community of the Lower Pliocene section of Oulad Messaoud near Asilah (NW Morocco) is studied. The paleontological results, the distribution of zoarial growth forms along the section and the comparison with molluscs community suggest that the faunas have been deposited in a deltaic area.

Key words: Bryozoa, paleoecology, Lower Pliocene, Morocco.

Resumen: La comunidad de briozoos de la sección de edad Plioceno inferior de Oulad Messaoud junto a Asilah (NW de Marruecos) es estudiada en este trabajo. Los resultados paleontológicos , la distribución de formas de crecimiento a lo largo de la sección y la comparación con la comunidad de moluscos sugieren que las faunas fueron depositadas en un área deltaica.

Palabras clave: Briozoos, paleoecología, Plioceno inferior, Marruecos.

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The Neogene deposits of northern Morocco have been studied from a paleontological point of view since the beginning of this century: these studies have been summarized by Ben Moussa (1994). Some faunistic groups are well represented: planktonic foraminifera (Wernli, 1988), bivalvia (Ben Moussa, 1994) and bryozoa (El Hajjaji , 1992).

On the atlantic area in the south of Tanger, there are two Neogene basins:

- Charf-el-Akab where Medioni & Wernli (1978) owing to biostratigraphic markers recognized three cycles: Upper Tortonian (*Globorotalia menardii* zone), Messinian (*Globorotalia dutertrei* zone) and Pliocene (*Globorotalia margaritae* zone) ;
- in the Asilah Basin there is only Early Pliocene (PL1-PL2) pointed out by the occurrence of *Globorotalia margaritae* and *Globorotalia puncticulata*. Bivalves from Asilah were studied by Ben Moussa (1994). González-Delgado *et al.* (1996) dealed with benthic foraminifera and molluscs.

Sratigraphy and lithology

The outcrop of Oulad Messaoud (Fig. 1) is situated at 9 km north of the city of Asilah on the eastern side of the Main Road number 2 connecting Tanger to Rabat.

A rich diversified macrofauna has been found, dominated by molluscs - especially bivalvia - associated with bryozoa and some barnacles.

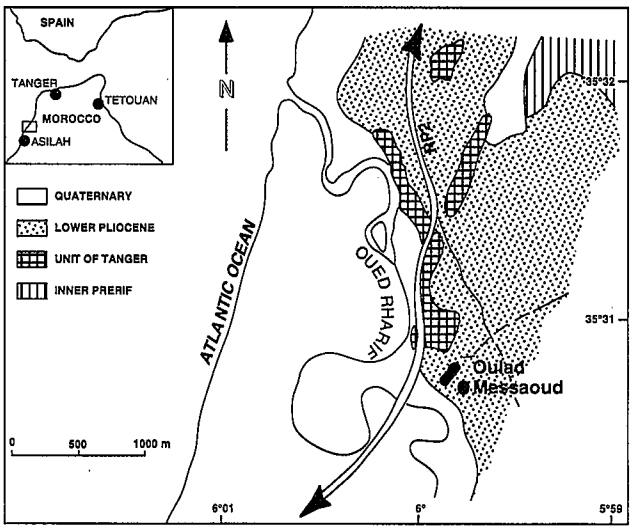

Figure 1. - Geological sketch map of Asilah region and localization of Oulad Messaoud section.

The sedimentary Pliocene section (Fig. 2) overlays uncomformably upon Cretaceous calcareous marls of the «Unit of Tanger». From bottom to top, one observes:

- 1.6 m of fine sands (A level) where four species of bivalves are abundant and predominant: *Chlamys opercularis* (Linné), *Chlamys scabrella* (Lamarck), *Ostrea edulis lamellosa* Brocchi and *Spisula subtruncata* (Da Costa);
- 5.5 m of fine clayey sands (B level) where there are numerous bivalves dominated by the species

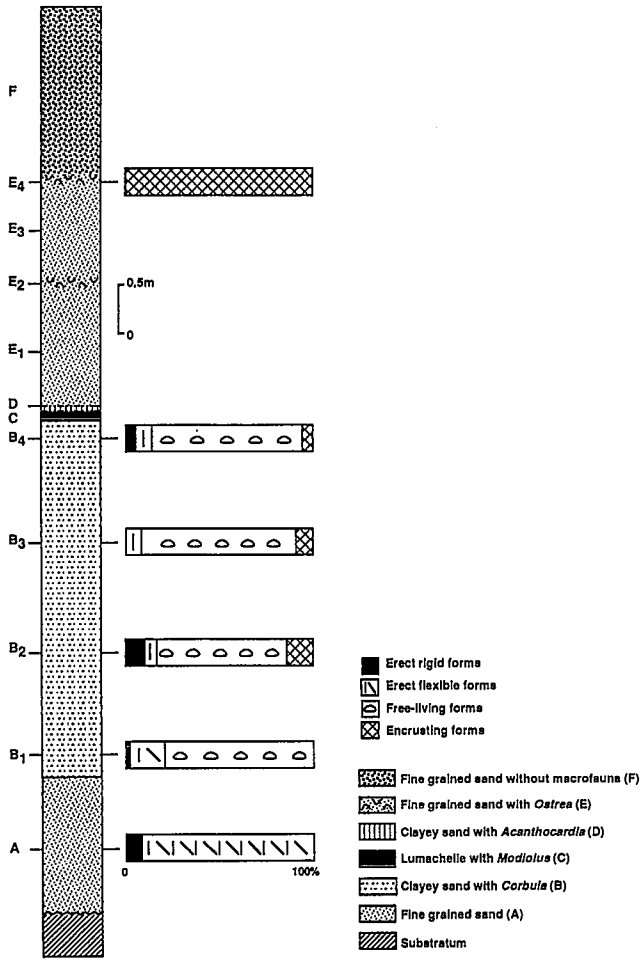

Figure 2. - Lithologic log of the stratigraphic section of Oulad Messaoud showing the location of samples (A, B1 to B4, E4) and distribution of zoarial growth forms along the section.

Corbula gibba (Olivi);

- then there is a shelly bank, 30 cm thick, true lumachelle with *Modiolus adriaticus* (Lamarck) (C);
- above there are about 15 to 20 cm of fine clayey sands (D) with *Acanthocardia paucicostata* (Sowerby);
- after we have 4 m thick fine sands (E) with intercalated fossiliferous beds of 30 to 40 cm rich in *Ostrea edulis lamellosa* Brocchi and *Pecten benedictus* Lamarck (E3, E4) ;
- the section is terminated by less than 2 m of fine sands (F) without macrofauna but where benthic foraminifera and ostracoda are present.

Bryozoa from Oulad Messaoud

Six samples of 4 kg (Fig. 2 and 3) have been collected along the section. After washing and filtering, bivalvia and bryozoa have been recorded. The specimens have been determined and their number accounted. The bryozoan faunistic list is given on figure 3 ; there are 25 species classified according to the four main growth forms used by modern authors:

1. Erect rigid forms:

- bilaminar, 2 species *Smittina cervicornis* (Pallas) and *Metrarabdotos moniliferum* (Milne-Edwards),
- vinculariiforms dominated by *Hornera frondiculata* Lamouroux and *Omalosecosa ramulosa* (Linné),
- reteporiforms represented by the genus *Reteporella* (= *Sertella*).

2. Erect flexible forms. Here only cellariiforms are represented. There are three species: *Cellaria fistulosa* Linné, *Cellaria salicornioides* Lamouroux and *Melicerita charlesworthi* Milne-Edwards. *C. fistulosa* is predominant and can represent up to 56% of the fauna.

3. Free-living forms or lunulitiforms. There are 4 species in our samples.

4. Encrusting forms i.e. membraniporiforms (12 species) and celleporiforms (one species).

The graphic representation (Fig. 2) of percentages of zoarial groups shows that their distribution within the Oulad Messaoud section is not in any order. Three assemblages can be distinguished:

Assemblage 1 within the level A: erect flexible forms (cellariiform) are predominant (92.5 percent of the bryozoan fauna). The erect rigid forms (two bilaminar and one vinculariiform) represent 7.5 %.

Assemblage 2 within the B level (4 samples have been collected, B1 to B4). The free-living forms (lunulitiform) are abundant, they represent 69 to 82%. The appearance of 5 encrusting species is due to the presence of substrates; in our material, the substrates have disappeared at the time of fossilisation, probably they were non-calcified algal fronds, sea-fans or posidonias.

Assemblage 3 within the E level has been collected in a bank rich in shells of bivalvia. All the species of bryozoa are encrusting. One species - *Membranipora tenuis* Desor - is dominating (46%).

Paleoecological significance

From 1936 Stach showed that there is a close relation between the colony form of living bryozoa and ecological conditions (depth, degree of wave agitation, sedimentation,...). He defined nine zoarial forms for Cheilostomata. Subsequent studies (Lagaaij & Gautier, 1965; Labracherie & Prud'homme, 1967; Schopf, 1969; Brood, 1972) led to increase this number: for instance, Brood described eleven types only for Cyclostomata ! So, it was necessary to reduce and clarify terminology. Nelson *et al.* (1988), McKinney & Jackson (1989) defined and used the four categories foregoing described: erect rigid, erect flexible, free-living and encrusting.

Owing their works and using too the actualism principle - several species are still living in recent seas - we try to reconstitute the environment of Asilah area during the lower Pliocene.

In the level A, erect flexible forms are dominant, they are cellariiform i.e. colonies erect, with subcylindrical

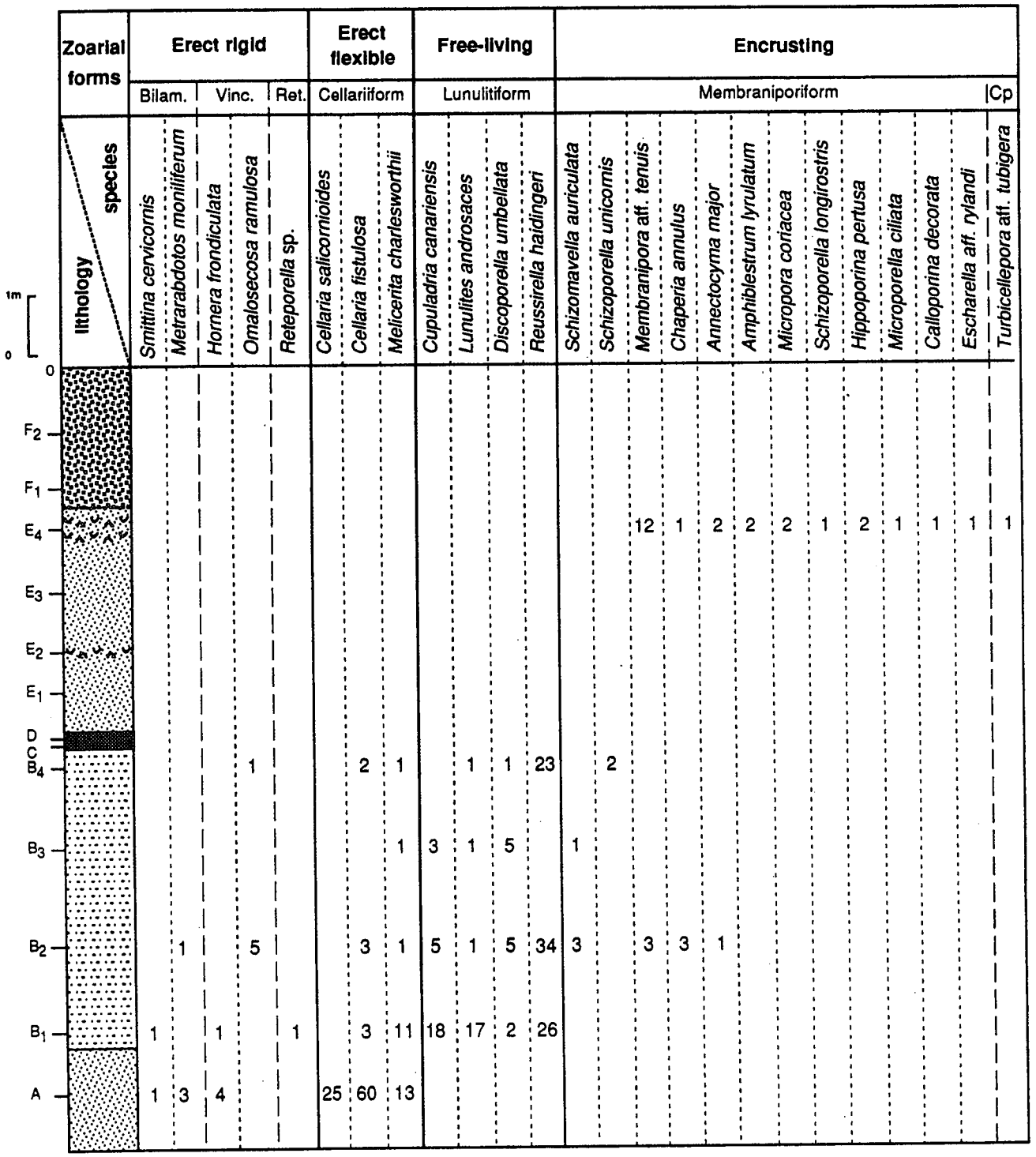

Figure 3. - List of species of bryozoa and their frequence (number of specimens in each sample) within Oulad Messaoud section. Species are listed according to the zoarial growth forms. For lithology, see figure 2.

flexible branches jointed by chitinous nodes, attached to substratum by chitinous rootlets; zooecia are opened on all sides. *Cellaria fistulosa* is predominant (57%). This fact remembers what Lagaaij & Gautier (1965) described within the marine sediments of the Rhône delta where *Cellaria fistulosa* has been collected in practically all the samples and always with high percentages.

Cellariiforms are found preferentially in regions of vigorous water motion and high rate of sedimentation (>100 cm/10^3 years): these conditions are reached in deltaic bottom environments. Caulet (1972) dealing with organogenic sediments of algerian precontinent remarks that the very proximal sands (- 10m) have only cellariiforms.

In the level B (4 samples B1 to B4), the free-living forms are numerous and predominant. These colonies, commonly termed lunulitiform, are either conical or shaped like a disc or a cup; zooecia open on outer face.

Observations of living colonies show that zoaria have an apex-up natural position (Greeley, 1967) . They occur on sediments ranging from fine sands to muddy bottoms, swept by moderate currents and they are abundant in shoal water. They are collected alive only from warm water with normal salinity. Several studies on free-living forms (Lagaaij, 1963; Cook, 1963; Greeley, 1967; Hakansson & Winston, 1985) show that they are particularly abundant in circumtropical deltaic areas: they constitute often oligospecific communities. In fossil assemblages, important concentrations of free-living forms are rare (Baluk & Radwanski, 1984a, b). However, in the Italian Miocene or Plio-Pleistocene, the percentage of lunulitiforms can be more than 95 per cent of the bryozoan fauna. Di Geronimo *et al.* (1992), interpreting these data, point out that lunulitiforms can be regarded as instability indicators: when stress conditions are established only lunulitiforms (or cellariiforms) are able to survive.

In the level E, one sample has been collected in a bank where molluscs are numerous. Bryozoa are exclusively encrusting on the inner or outer face of the valves. One species is predominant - *Membranipora tenuis* Desor - representing up to 46 per cent of the bryozoan fauna. This still living species is found in littoral areas.

Bryozoa and associated faunas

Mihraje *et al.* (1996) gave a faunistic list composed of 44 species of Bivalvia and an analysis of their taphonomy. Bivalvia are the organisms predominant in the macrofauna of Oulad Messaoud section. We attempt to compare their results with those obtained with bryozoa.

In the level A, there are 16 species of bivalvia; this level is called level with *Chlamys opercularis* and *Spisula subtruncata* by Mihraje *et al.* (1996) because these two species represent respectively 26 and 12 per cent of the bivalvia fauna. *Ostrea edula lamellosa* and *Chlamys scabrella* are also numerous (16 and 13%). Bivalve shells are disarticulated and fragmentation is high: this fact suggests that the turbidity or wave agitation was high and the rate of sedimentation low. In the Mediterranean, *Spisula subtruncata* is an exclusive species of biocenosis of fine sand well calibrated (Pérès & Picard, 1964), this biocenosis spread from 2.5 meters. The presence almost exclusive of cellariiform bryozoa (erect flexible) strengthens this interpretation.

The level B with 35 species of bivalvia is called *Corbula gibba* level because this species constitutes 79 to 89 % of the fauna. This small bivalve is an opportunistic species exclusive of unstable soft bottoms (Pérès & Picard, 1964). Di Geronimo *et al.* (1992) showed that lunulitiform or free-living bryozoans can be regarded as instability indicators having the same value of such bivalvia species. In the bryozoa, and mollusc alike, the specific diversity increases in this level B in regard to level A: this corresponds to a heterogeneous mediolittoral community, where suspensive nutritive particles are abundant.

At last, at the middle and top of the outcrop, the occurrence of thin beds with a great amount of bivalvia (Fig. 3, C, D, E2 and E4) and sometimes of encrusting bryoza (E4) indicates an infralittoral to mediolittoral environment with strong water energy and a variable rate of sedimentation.

Conclusion

The variations of the bryozoan assemblages suggest an instable sedimentary bottom with almost continuous arrival of fine detritic sediments. Some brief stops in sedimentation are proved by the development of very homogeneous paleobenthos (*Ostrea edulis lamellosa* and *Pecten benedictus* levels) or even monospecific (*Modiolus adriaticus* lumachelle).

The study of bryozoan assemblages and their comparison with bivalvia fauna allow a better comprehension of the conditions of life and sedimentation. It seems that the sandy-clayey series of Oulad Messaoud has been deposited in a protected area of deltaic environment between -10 to -30 m (Fig. 4).

References

Baluk, W. & Radwanski, A. (1984a): Middle Miocene (Badenian) free-living bryozoans from the Vienna Basin. *Annal. Naturhistor. Museums*, Wien, 86/A: 13-40.

Baluk, W. & Radwanski, A. (1984b): Free-living bryozoans from the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Central Poland). *Acta Geol. Pol.*, Warszawa, 34/3-4: 239-251.

Ben Moussa, A. (1994): Les bivalves néogènes du Maroc septentrional (façades atlantique et méditerranéenne). Biostratigraphie, paléobiogéographie et paléoécologie. *Docum. Lab. Géol.*, Lyon, 132: 1-281.

Brood, K. (1972): Cyclostomatous bryozoa from the Upper Cretaceous and Danian in Scandinavia. *Acta Univ. Stockholm., Stockholm Contributions in Geology*, 26, 464 pp +78 pl.

Caulet, J. (1972): Les sédiments organogènes du Précontinent algérien. *Mém. Mus. natn. Hist. nat.*, Paris, sér. C, 25, 289pp.

Cook, P.L. (1963): Observations on live lunulitiform zoaria of Polyzoa. *Cah. Biol. marine*, Roscoff, 4: 407-413.

Di Geronimo, I., Rosso, A. & Sanfilippo, A. (1992): Bryozoans as sedimentary instability indicators. *Rivista itali. Paleontol. Stratig.*, 98/2: 229-242.

El Hajjaji, K. (1992): Les Bryozoaires du Miocène supérieur du Maroc nord-oriental. *Docum. Lab. Géol.*, Lyon, 123: 1-355.

González-Delgado, J.A., Civis, J., Alonso Gavilán, G., Andrés I. & Ben Moussa, A. (1996): Paleontología y estratigrafía del Plioceno inferior de la cuenca de Asilah (NW de Marruecos). *Geogaceta*, 20 (1): 231-234.

Greeley, R. (1967): Natural orientation of lunulitiform bryozoans. *Geol. Soc. Amer. Bull.*, 78: 1179-1182.

Hakansson, E. & Winston, J.E. (1985): Interstitial bryozoans: unexpected life forms in a high energy environment. In: *Bryozoa: Ordovician to Recent* (C. Nielsen & G. Larwood

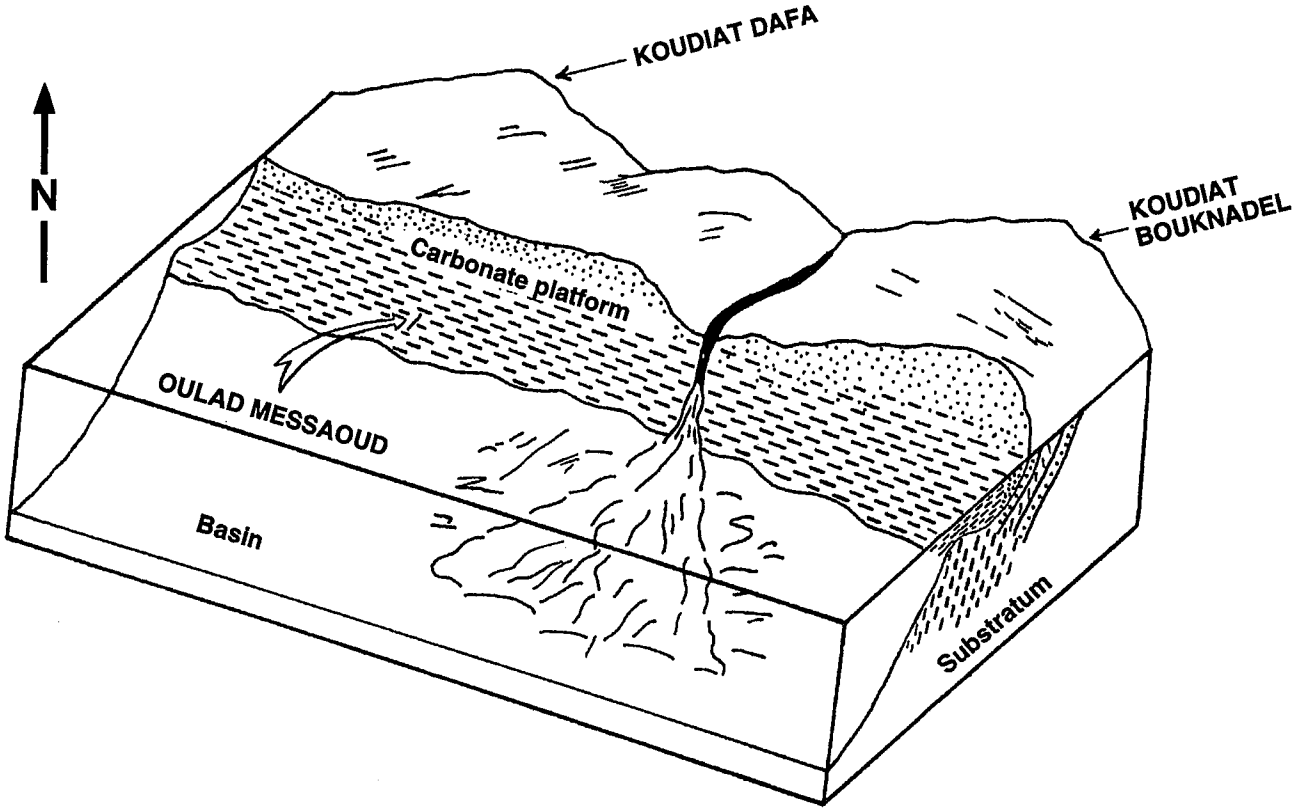

Figure 4. - Reconstruction of the environment during the Lower Pliocene in Asilah region.

eds.), *Olsen & Olsen*, Fredensborg, Denmark: 125-134.

Labracherie, M. & Prud'homme, J. (1966): Essai d'interprétation de paléomilieux grâce à la méthode de distribution des formes zoariales chez les bryozoaires. *Bull. Soc. géol. France,* sér. 7, 8: 102-106.

Lagaaij, R. (1963): *Cupuladria canariensis* (Busk) - portrait of a bryozoan. *Palaeontology*, 6/1: 172-217.

Lagaaij, R. & Gautier, Y.V. (1965): Bryozoan assemblages from marine sediments of the Rhône delta, France. *Micropaleontology*, 11/1: 39-58.

McKinney, F. & Jackson, J. (1989): Bryozoan Evolution. *Special topics in Paleontology*, 2, 238 p.

Medioni, R. & Wernli, R. (1978): Etude géologique du bassin post-nappe mio-pliocène du Charf-el-Akab (province de Tanger, Maroc). *Notes Serv. géol. Maroc*, 40/275: 107-133.

Mihraje, A., El Hajjaji, K. & Ben Moussa K. (1996): Taphofaciès à bivalves et paléoenvironnements du Pliocène inférieur d'Oulad Messaoud (Asilah, NW Maroc). *II Reunión de Tafonomía y Fossilización,* Barcelone : 233-240.

Nelson, C.S., Hyden, F.M., Keane, S.L., Leask, W.L. & Gordon, D.P. (1988): Application of bryozoan zoarial growth-form studies in facies analysis of non-tropical carbonate deposits in New Zealand. *Sedimentary Geology*, 60: 301-322.

Pérès, J.M. & Picard J. (1964): Nouveau manuel de bionomie benthique de la mer Méditerranée. *Rec. Trav. station mar. Endoume*, 31, 47: 5-137.

Schopf, T. J.M. (1969): Paleoecology of ectoprocts (Bryozoans). *Jour. Paleontology,* 43/2: 234-244.

Stach, L. (1936): Correlation of zoarial form with habitat. *Jour. Geology*, 44: 60-65.

Wernli, R. (1988): Micropaléontologie du Néogène post-nappes du Maroc septentrional et description systématique des foraminifères planctoniques. *Notes Mém. Serv. géol. Maroc*, Rabat, 331: 1-270.

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