

Lower Cretaceous Charophyte biozonation in the Maestrat Basin (Iberian Ranges, Spain). A reply to P.O. Mojon [1996]

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ABSTRACT. — Modifications proposed by Mojon [1996] to the lithostratigraphy and sequence boundaries of the continental Lower Cretaceous of the Maestrat Basin (Eastern Iberian Ranges) would seem to be based on an erroneous equivalence between lithostratigraphic and biostratigraphic units. Thus, for instance, particular formations such as those of Polacos or Cantaperdius, are included by Mojon within Herbers Fm on the basis of biostratigraphic identity. The new taxa proposed by Mojon do not, moreover, seem entirely coherent: for example *Globator fallax* MOJON 1996 is a younger synonym for *Globator maillardii* var. *incrassatus* (MARTÍN-CLOSAS & GRAMBAST-FESSARD 1986) MARTÍN-CLOSAS 1996 and *Globator trochiliscoides* subsp. *mutabilis* MOJON 1996 is a form ranging within the population variability of *Globator maillardii* var. *steinhauseri* (MOJON in Detraz and Mojon 1989) MARTÍN-CLOSAS 1996. An emendation is proposed to the new genus *Favargerella* MOJON 1996 as it would seem not to include fructifications but rather sterile thalli of *Asciidiella stellata* (MARTÍN-CLOSAS & GRAMBAST-FESSARD 1986) MARTÍN-CLOSAS ex SCHUDACK 1993. The two new biozones, M6 and M7a, proposed by Mojon do not appear to be based on new biostratigraphic data [new taxa] but on taxonomic changes of already known species. The result of such confusions is the erroneous datation of several stratigraphic units in the Maestrat Basin.

KEY WORDS. — Lower Cretaceous, Charophytes, Biostratigraphy, Maestrat Basin, Iberian Ranges.

Biozonation des Charophytes du Crétacé inférieur du Bassin du Maestrat (Chaîne Ibérique, Espagne). Une réplique à P.O. Mojon [1996]

RÉSUMÉ. — Les modifications des unités stratigraphiques du Crétacé inférieur continental du Bassin du Maestrat (Chaîne Ibérique Orientale) proposées par Mojon [1996] semblent être le résultat d'une équivalence erronée entre unités lithostratigraphiques et biostratigraphiques. Ceci se traduit par le fait que certaines formations comme par exemple Polacos ou Cantaperdius ont été rattachées à la Formation Herbers sur la base d'une apparente équivalence biostratigraphique. Les nouveaux taxa créés par Mojon [1996] ainsi que les changements taxonomiques qu'il propose ne semblent pas acceptables. *Globator fallax* MOJON 1996 serait un synonyme plus jeune de *Globator maillardii* var. *incrassatus* (MARTÍN-CLOSAS & GRAMBAST-FESSARD 1986) MARTÍN-CLOSAS 1996. *Globator trochiliscoides* subsp. *mutabilis* entre dans la variabilité des populations de *Globator maillardii* var. *steinhauseri* (MOJON 1989) MARTÍN-CLOSAS 1996. Nous proposons une émendation du nouveau genre *Favargerella* MOJON 1996 qui est apparemment formé de restes végétatifs d'*Asciidiella stellata* (MARTÍN-CLOSAS & GRAMBAST-FESSARD 1986) MARTÍN-CLOSAS ex SCHUDACK 1993 et non de fructifications. Les deux nouvelles biozones M6 et M7a proposées par Mojon ne peuvent pas être acceptées car elles ne se basent pas sur des renseignements biostratigraphiques nouveaux [nouveaux taxons] mais sur des changements de noms de taxons déjà connus. A la suite de ces confusions plusieurs formations du Bassin du Maestrat ont été datées de façon erronée par Mojon [1996].

MOTS CLÉS. — Crétacé inférieur, Charophytes, Biostratigraphie, Bassin du Maestrat, Chaîne Ibérique

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1. – INTRODUCTION

The Maestrat Basin constitutes one of the main points of reference for Lower Cretaceous Charophyte biostratigraphy, worldwide. Not only is the continental sedimentation extremely well developed and continuous throughout this basin, but it presents marine interdigitations which allow us to correlate marine (foraminifera, ammonites) and charophyte biozonations. During the sixties and seventies Lower Cretaceous charophyte biostratigraphy underwent significant advances thanks the cooperation between Louis Grambast (Montpellier) and geologists working in the Maestrat Basin, such as Pierre Combes (Montpellier) and Joseph Canérot (Toulouse). As a result of this cooperation, the first Lower Cretaceous charophyte biozonation was proposed by Grambast [1974], constituting the basis of all biozonations subsequently proposed.

In the eighties Sequence Stratigraphy arose as a result of a new paradigm developed in stratigraphy based on the concept that basins are systems working by the third law of thermodynamics [Haq *et al.* 1987]. The methods of Sequence Stratigraphy were soon applied to the Maestrat Basin [Salas, 1987, 1989; Salas and Casas, 1993] and this led to a complete revision of the stratigraphic framework previously proposed. New formations and depositional sequences were defined and correlated in both the marine and continental realms and the sedimentary evolution of the basin was established with previously unknown detail [Salas *et al.* 1995]. This revision of the stratigraphy of the Maestrat Basin required biostratigraphical support which was provided, in the continental realm, by charophyte biostratigraphy [Martín-Closas, 1989]. New biozones were defined by Martín-Closas and Grambast-Fessard [1986] and Martín-Closas [1989] as a result of a better understanding of charophyte phylogeny and evolution. Martín-Closas and Salas [1988, 1989] proposed new correlations between the marine and continental biozonations as a result of detailed cartographic and stratigraphic correlations. For this latter purpose, previous taxonomic studies on ammonites and orbitolinids were necessary by Martínez, Grauges and Salas [1994] and Schroeder [in Martín-Closas and Salas, 1988] respectively. The final product of new biostratigraphical results was integrated in a general chart of European Charophyte Biozonation published by Riveline *et al.* [1996].

We should not overlook the fact that biostratigraphy is a multidisciplinary science requiring close cooperation between geologists and palaeontologists. Studying the biostratigraphical succession of a particular stratigraphic section is not sufficient to establish a biozonation. The charophyte biozonation of the Maestrat Basin is the result of the integration of hundreds of charophyte samples studied in dozens of stratigraphic sections, all of them correlated in a general basinal framework which is consistent with a well established basin evolution.

Mojon [1996] presented a review of Lower Cretaceous charophyte biostratigraphy, which basically questions our findings in the Maestrat Basin. Mojon's paper proposes significant changes in the definition of charophyte species, charophyte biozones and even in the stratigraphy of the Maestrat Basin, with which we fail to agree. The aim of this reply is to clarify the confusions arising from Mojon's paper, as it is our belief that they hinder a good understanding of the stratigraphy and biostratigraphy of the Maestrat Basin, which is now a key-basin in the Lower Cretaceous of Tethys.

2. – STRATIGRAPHY

The lithostratigraphic framework of the Maestrat Basin is formed by a number of units (formations and members) defined by Salas [1987] on the basis of lithology in accordance with the norm established by the International Stratigraphic Code but also taking into account sedimentary unconformities, as is recommended by the Code. These formations were subsequently integrated in the sequence stratigraphy framework [Salas, 1987; Salas *et al.*, 1995]. As is frequently the case in current stratigraphic practice, temporal isolines (biozone boundaries) may not correspond to lithologic changes, which means that the basis of a formation or a sequence does not necessarily correspond to a biozone boundary. This highly common stratigraphic situation appears to have been overlooked by Mojon, who attempts to modify formation definitions and boundaries solely on the basis of biostratigraphic changes. This conceptual confusion is evident in the description that Mojon gives of one of the best

FIG. 1 a-d. – Stratigraphic section of Els Mangraners with comparison of stratigraphic analysis by Mojon [1996] and Salas *et al.* [1995]. For each author, the first column shows lithostratigraphic units. In the second column significant samples and their biostratigraphic attribution have been marked. Third column gives the chronostratigraphic attribution. In Salas *et al.* [1995] fourth column the sequence stratigraphy interpretation is presented.

FIG. 1 a-d. – *Coupe stratigraphique d'Els Mangraners avec comparaison des analyses stratigraphiques réalisées par Mojon [1996] et Salas et al. [1995]. La première colonne de chaque auteur indique les unités lithostratigraphiques. La deuxième colonne présente des échantillons sélectionnés avec leur attribution biostratigraphique. Dans la troisième colonne l'attribution chronostratigraphique est donnée. Dans la quatrième colonne de Salas et al. [1995] la stratigraphie séquentielle est interprétée.*

MOJÓN 1996

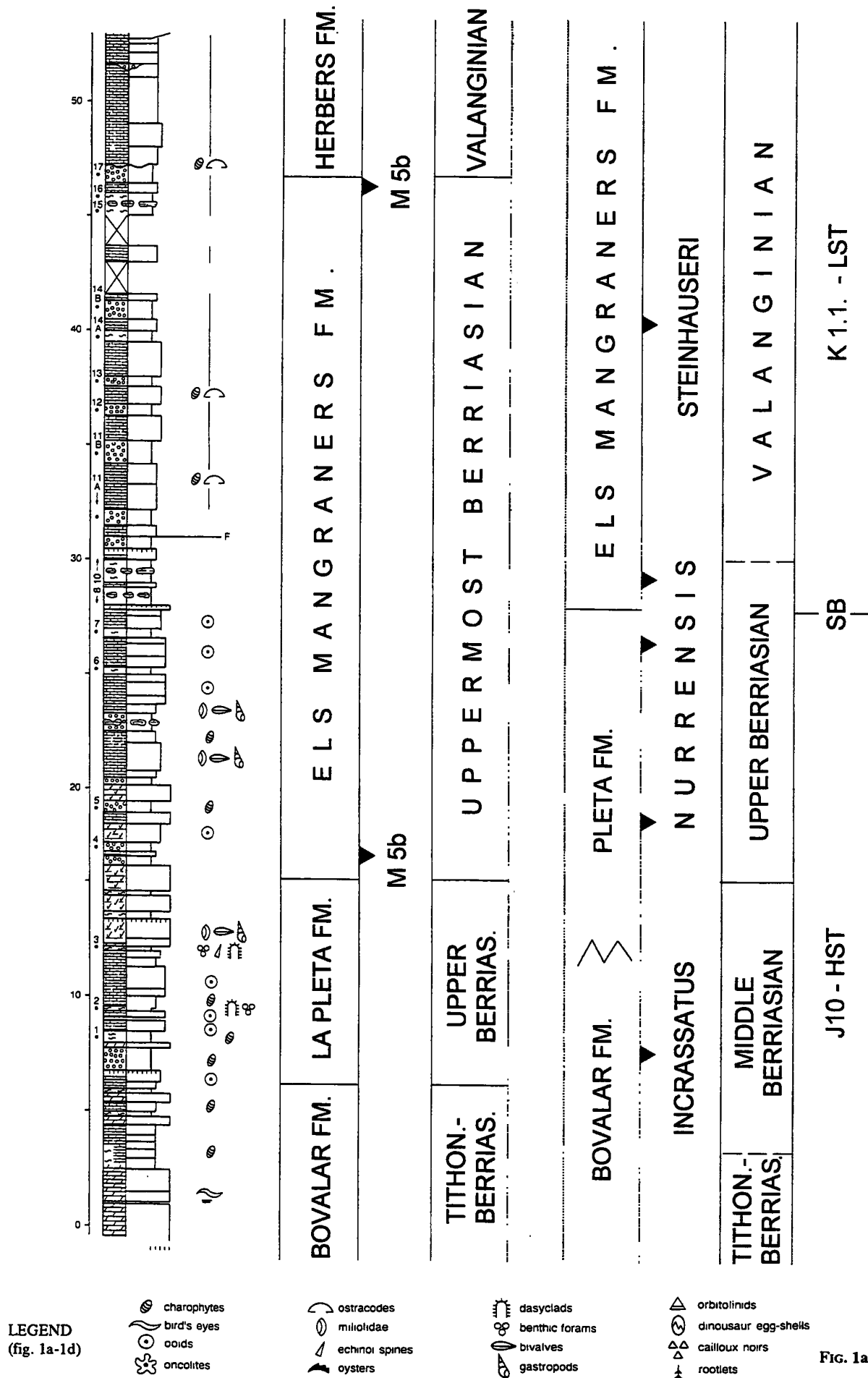
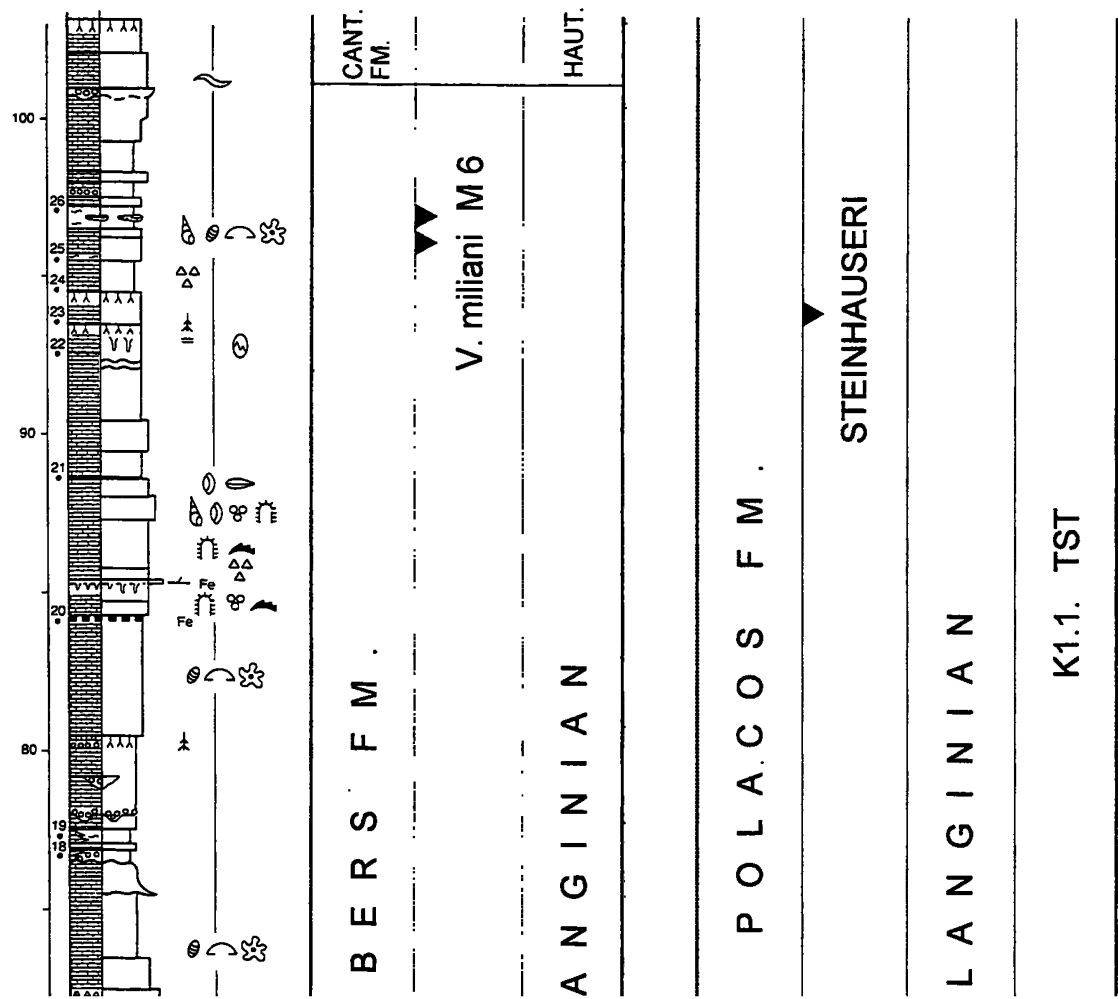
SALAS *et al.* 1995

FIG. 1a

MOJON 1996

SALAS *et al.* 1995



MOJON 1996

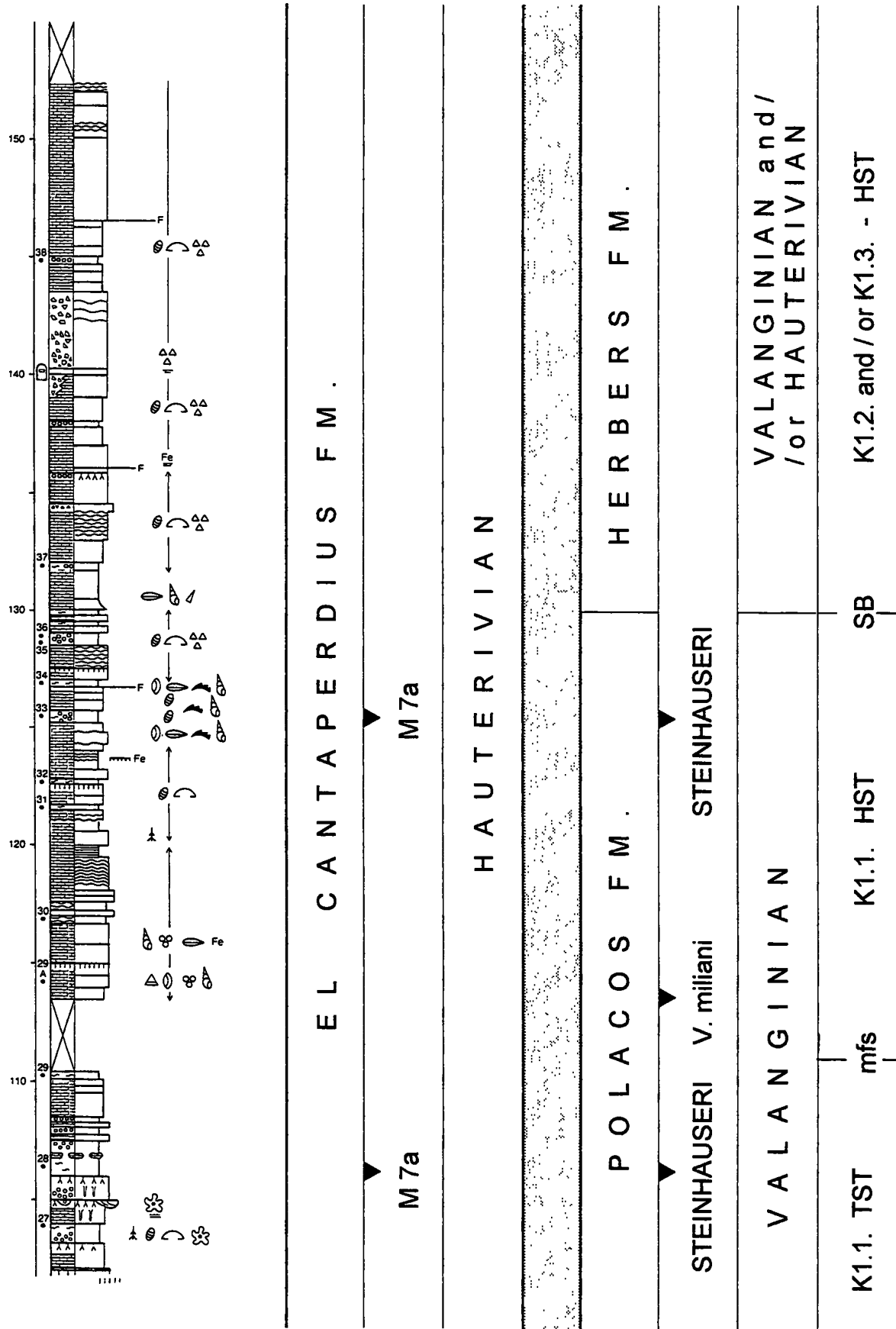
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FIG. 1c

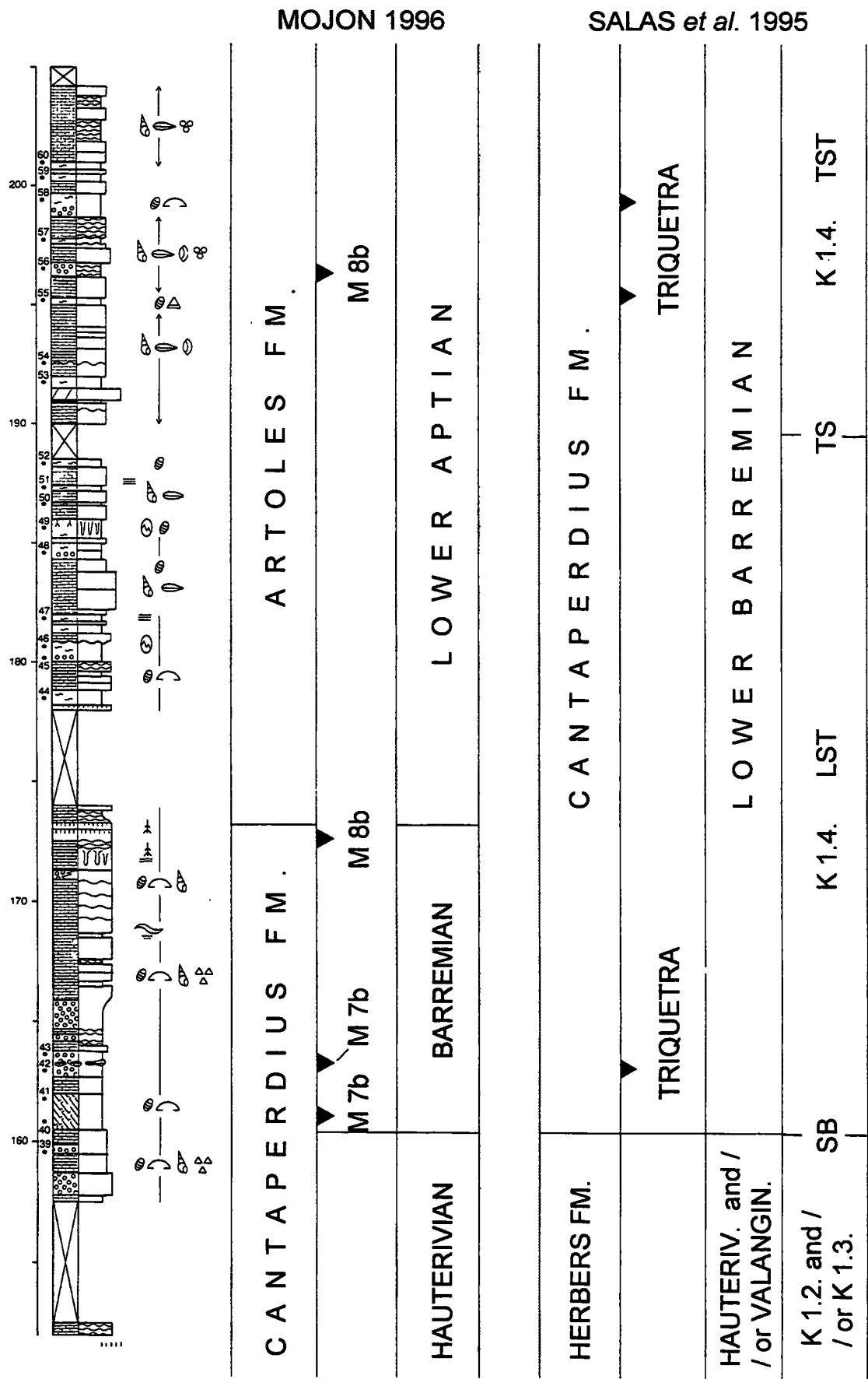


FIG. 1d

developed continental series, called Els Mangraners, which he resampled following a log published by Martín-Closas and Salas [1994] and Salas *et al.* [1995]. In this log not only the stratigraphic boundaries (including sequence boundaries) are indicated but also the numerals of charophyte samples marked in the field are represented, making it comparatively simple to locate any part of the section in the outcrop. With all this information available it is not easy to understand why Mojon [1996] changes definitions and boundaries of previously accepted stratigraphic units without apparent justification.

The Els Mangraners section is a key locality for charophyte biostratigraphy (fig. 1). Along the section, a number of formations crop out which typify the northern margins of the Maestrat Basin. The base of this section is formed from dolomitized grainstones of El Bovalar Limestones Formation which can be attributed to the Tithonian or Berriasian on the basis of the benthic foraminifer *Anchispirocyclina lusitanica* (EGGER 1902) rather than to the "Tithonian- « Portlandian »" [Mojon, 1996, p. 63]. Such an attribution is confusing and not easily acceptable since both chronostratigraphic terms refer to different scales (Tethyan and Boreal respectively according to Gradstein *et al.*, 1995, for example). Shoals of the El Bovalar Fm pass laterally, towards the basin margins, to tidal laminites of the La Pleta Formation (fig. 2). This feature, which is explicitly marked in figure 3.2. of Martín-Closas and Salas [1994] is overlooked by Mojon, who seeks instead to define an artificial boundary between the Bovalar and Pleta Formations on the basis of a rubefacted surface. In fact there are many such ferruginised layer tops at the base of Els Mangraners section, but they simply reflect the top of parasequences or shallowing-upward cycles, not major stratigraphic boundaries.

The Els Mangraners Limestones and Marls Formation was formally defined by Salas [1987] and largely comprises palustrine and lacustrine sediments. Tidalites are not to be found in this formation contrary to Mojon's [1996, p. 63] claims. The continental facies of Els Mangraners Fm occur frequently throughout the Maestrat Basin. They even reach the depositional centre of the basin, near Sant Mateu, where only a wedge of palustrine limestones and marls is interstratified between shallow marine carbonates belonging to other formations. It would seem from Mojon's [1996] figure 3 B that a significant part of La Pleta Fm, basically formed by tidal laminites, has been mistakenly attributed to Els Mangraners Formation. While both formations may belong to the same biozone, they are by no means equivalent since they are separated by a regional unconformity (fig. 2). Their age was not defined by "(lithostratigraphic) correlation and general setting" [Mojon, 1996, p. 63] but rather on the basis of charophyte associations [Martín-Closas and Salas, 1989; 1994] containing

species closely correlated with the ammonite biozonation according to Mojon *in* Détraz and Mojon [1989]. The basal level of Els Mangraners Fm is typically marly and palustrine and corresponds to level 4 of Mojon's [fig. 3 B] section, which is located about 10 m above the formation's lower boundary as indicated by the Swiss author.

The Herbers Limestones Formation was also defined in the margins of the Maestrat basin by Salas [1987]. It is characterised in the type locality by a thick series of massive lacustrine limestones containing charophytes of the Steinhauseri biozone. Mojon [1996, p. 65] believes that this formation is lagoonal in origin and yields marine fossils. However, here he would seem to have mistaken the Herbers Limestones Formation for the Polacos Limestones Formation, which is composed of shallow marine carbonates (fig. 1b). This formation yields *Valdanchella milianii* (SCHROEDER 1968), an orbitolinid marking the Lower Valanginian and charophytes of the Steinhauseri biozone [Martín-Closas and Salas, 1988]. The orbitolinid was noticed in sample 29 of the log of Els Mangraners published by Martín-Closas and Salas [1994, fig. 3.2.]. The Herbers Formation actually begins in the section of Els Mangraners above the last marine horizon of the Polacos Formation at about 130 m from the section basis (fig. 1c).

The Cantaperdius Lateritic Clays and Limestones Formation was also formally defined by Salas [1987] in a section located about five km north of the section sampled by Mojon [1996]. This Formation is bound at its base by a regional unconformity marked by a significant development of laterites (type 2 laterites of Combes, 1969). It includes mainly freshwater facies such as lacustrine and palustrine limestones with a significant development of hydromorphic soils and lateritic clays (fig. 1d). From the definition of this formation by Salas [1987] it is clear that a lateritic level defines its base which yields charophytes of the biozone Triquetra from Martín-Closas and Schudack *in* Riveline *et al.* [1996]. Mojon [1996] proposes changing the Cantaperdius Formation lower boundary at a level about 60 m below the basal laterite (fig. 1b). Such a modification, seems once again to be based on an erroneous equivalence of biostratigraphic and lithostratigraphic units. The lateritic level which bounds basinwide the base of the Cantaperdius Formation is somewhat arbitrarily located by Mojon as lying at the upper limit of this unit. Unfortunately, this limit is no visible along the Els Mangraners section due to a fault cutting across its upper part, as was noted by Combes *et al.* [1966]. However the whole succession is visible five kilometres further north, along the road to Fredes village and Cantaperdius hill, where Salas [1987] established the type locality of the formation.

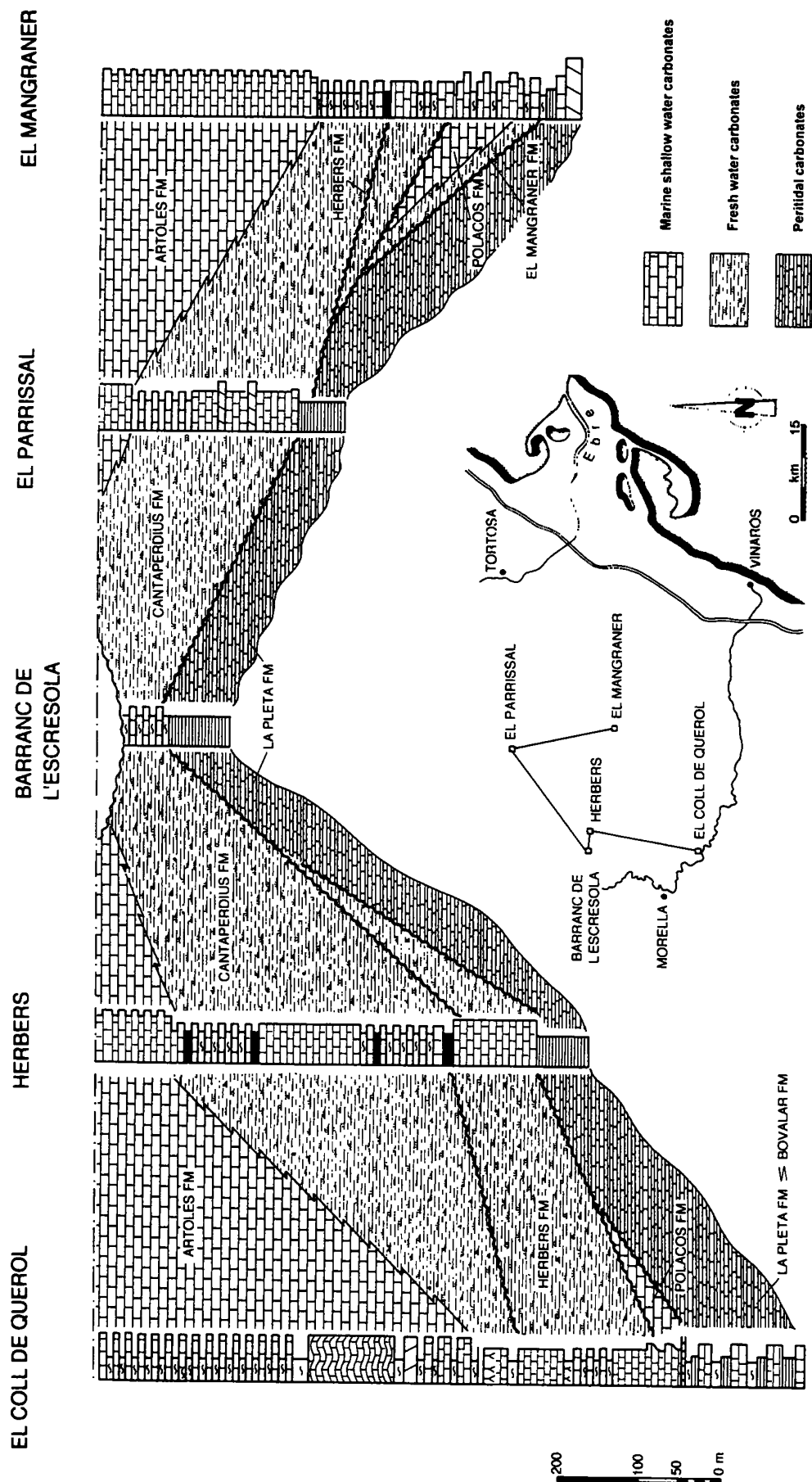


FIG. 2. - Correlation of Neocomian freshwater carbonates in the northern margin of the Maestrat Basin (from Salas *et al.*, 1995).

FIG. 2. - Corrélation des carbonates d'eau douce dans la marge septentrionale du Bassin de Maestrat (d'après Salas *et al.*, 1995).

Finally, Mojon [1996, p. 70-71] would seem to confuse some slightly marine intervals of the Cantaperdius Fm with those of the Artoles Fm. Although both units were deposited during the same time interval (the whole Barremian up to the Lowermost Aptian), they are lithologically distinct. The Artoles Fm is a neatly carbonatic and shallow marine unit, whereas Cantaperdius Fm is overwhelmingly continental and lithologically diverse, with a significant influence of siliciclastics. As discussed above, Mojon [1996] would have us believe that there are distinct biozones within each formation but this would appear to be quite impossible in the case of the Cantaperdius and Artoles Fms, which are laterally equivalent and interfingering throughout the whole Barremian and Lowermost Aptian (fig. 2).

These conceptual confusions as to the definition and boundaries of lithostratigraphic units in the section of Els Mangraners have also led Mojon [1996] to draw certain erroneous biostratigraphic conclusions, which will be discussed below.

3. – TAXONOMY AND SYSTEMATICS

Concepts in systematics are the source of long-standing controversy in palaeontology. Clark [1992, 1994] identifies two diametrically opposed epistemological schools of thought among systematic palaeontologists. On the one hand there are the empiricists, inductive scientists, who approach the study of species from the point of view of biospecies, even if this concept is not testable in palaeontology (the reproductive isolation of populations and their genetic flow cannot be proved using fossil evidence). On the other hand there are the positivist and post-positivist palaeontologists, objectivist scientists, who approach the study of species from the point of view of evolutionary species, which are defined by lineage continuity as shown by continuous morphological change. This concept can be tested in the fossil record. Charophyte specialists have been faced with the same dilemma resulting in the confrontation between the “traditional systematists”, who promote the use of biospecies and the methods of evolutionary taxonomy [Feist and Wang, 1995] and “cladists”, who defend evolutionary species and the methods of phylogenetic systematics or cladism [Martín-Closas and Schudack, 1997]. Mojon takes a clearly inductive approach.

The use of biospecies in palaeontology, as applied by Mojon [1996], would seem however to lead to inevitable errors. Mojon [1996, p. 75, point 3] asserts that two Lower Cretaceous charophyte subspecies “share the

same genotype and are genetically homogenous”, which is impossible to demonstrate with calcareous fossils such as clavatoracean utricles.

Since Grambast’s [1974] study we have known that the lineage *Globator* constitutes a gradualistic succession of forms. Whether these forms should be termed species, subspecies or varieties is, as discussed above, an epistemological question. In such a gradualistic lineage, infinite intermediary taxa may be created between two previously described forms. However, this leads to a heavily inflated taxonomy, which only hinders communication between specialists. Two of Mojon’s [1996] taxa, *Globator fallax* MOJON, 1996 and *G. trochiliscoides* subsp. *mutabilis* MOJON, 1996 belong to such superfluous taxa.

According to Mojon [1996] *Globator fallax* MOJON, 1996 appears to include fructifications which morphologically are intermediate to *Globator maillardii* var. *incrassatus* (MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986) MARTÍN-CLOSAS, 1996 and *Globator maillardii* var. *nurrensis* PECORINI, 1969 though younger in age. Yet it seems extremely difficult to separate *Globator fallax* MOJON, 1996 objectively from populations of the former two taxa. This would appear evident from the diagnosis given by Mojon [1996, p. 74], which to all intents and purposes differs little from that given by Grambast [1966] for the whole genus *Globator*. The same might be said for *Globator trochiliscoides* subsp. *mutabilis* MOJON, 1996. This morphotype is usually associated in the same populations with what has been known as *Globator maillardii* var. *steinhauseri* (MOJON in Détraz and Mojon, 1996) MARTÍN-CLOSAS 1996 and both morphotypes are often impossible to distinguish objectively. Clearly the new subspecies is also found associated with its anagenetic descendant, *Globator trochiliscoides* subsp. *trochiliscoides* GRAMBAST, 1966.

Furthermore, the new species *Globator fallax* is considered by Mojon [1996 p. 75, point 3] to include the type material of *Globator incrassatus* MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986. While the creation of a new intermediary taxon depends on one’s understanding of species the synonymisation of a legitimate species with a younger, new taxon surely contravenes articles 11 and 14.5 of the International Code of Botanical Nomenclature (ICBN). Mojon [1996 p. 76] goes on to claim priority for his description of *Globator incrassatus* in Détraz and Mojon [1989] over the original description of *Globator incrassatus* MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986. However, according to the rules of the ICBN (article 48), a specific name shall have priority over any species subsequently described bearing the same name on the basis of another type material. Thus, *Globator incrassatus* MOJON, 1989 should be considered as a more recent homonym of *Globator incrassatus* MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986; whereas *Globator fallax* MOJON, 1996 is – in

consequence – a more recent synonym of the former species.

Mojon [1996, p. 75] also questions Martín-Closas and Grambast-Fessard's description of the type material of *Globator incrassatus* "à la suite d'importantes erreurs dans les mensurations effectués en microscopie optique". He believes the size of the type material to have been exaggerated. We include a holotype photograph taken in a SEM Jeol 840 with the corresponding graphic scale (fig. 3) as evidence that *Globator incrassatus* is indeed a very large fructification, which in many cases exceeds one millimetre in length.

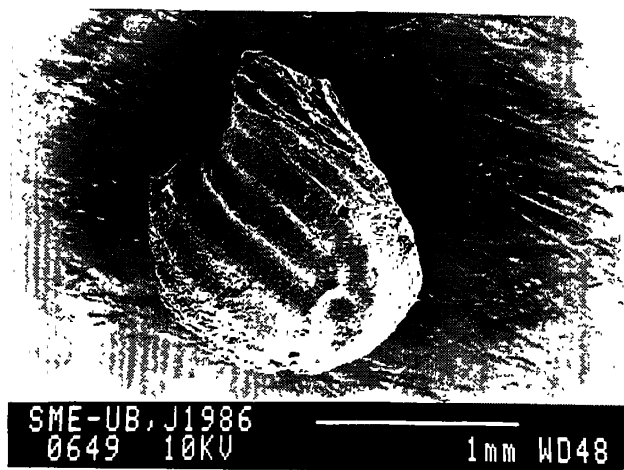


FIG. 3. – *Globator maillardii* var. *nurrensis* (MARTÍN-CLOSAS and GRAMBAST-FESSARD 1986). Original photograph of holotype in lateral view taken in 1986 on a S.E.M. Jeol 840. The automatically incorporated graphic scale is included as a evidence of the real size of this fructification.

FIG. 3. – *Globator maillardii* var. *nurrensis* (MARTÍN-CLOSAS & GRAMBAST-FESSARD 1986). Photographie originale de l'holotype en vue latérale, prise en 1986 avec un microscope à balayage Jéol 840. L'échelle graphique incorporée automatiquement est présentée comme une preuve de la grande taille de cette fructification.

Mojon [1996, p. 75] creates the new genus *Favargerella* to include two taxa which have already been described : *Ascidiella stellata* var. *stellata* (MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986) MARTÍN-CLOSAS ex SCHUDACK, 1993 and *Ascidiella stellata* var. *lata* MARTÍN-CLOSAS, 1996. These taxa were formerly classified within genus *Embergerella* which is now considered as being paraphyletic [Martín-Closas, 1996]. According to Mojon [1996, p. 78] *Embergerella* may be distinguished from *Favargerella* by the absence of an inner nodular layer. He also believes that the structure of the outer layer of *Favargerella* differs from that of *Embergerella*, as the rosettes of the former genus are not supported by a bract-cell. However, the presence of a nodular layer in *Embergerella* was demonstrated in thin sections

published by Grambast [1969, fig. 12 and 13] while bract-cells supporting the rosettes of *Ascidiella stellata* are visible in section at the centre of the rosettes in figures 14 (6) and 14 (7) of Martín-Closas [1996]. By examining Mojon's [1996] plate 3, figure 2 it would seem he confuses sterile fragments of thalli of *Ascidiella stellata*, believing them to be fructifications. What Mojon calls "still immature" utricles are in fact sterile nodes carrying a whorl of six short branchlets with a whorl of petal-like branchlets on top of each. Were Mojon to prepare a thin section along the longitudinal axis of the remains pictured in plate 3, figure 2, we believe he would find a succession of nodes separated by short internodes rather than a single fructification. The following emendation of genus *Favargerella* should therefore be made.

Genus *Favargerella* (MOJON, 1996) emend. MARTÍN-CLOSAS

Emended diagnosis : Infertile charophyte thalli formed by swollen nodes separated by short internodes. Nodes bear a whorl of 5 short branchlets, which have a rosette, formed by about 6 petal-like branchlets on top. Branchlets bearing rosettes may be seen in transversal section (as a hole) from the surface. These vegetative remains are usually associated with utricles of *Ascidiella stellata*.

Type species : *Favargerella aquavivae* nov. sp.

Holotype : specimen illustrated by Mojon [1996] on plate 3, fig. 2 A.

Paratype : specimen illustrated by Mojon [1996] on plate 3, fig. 2 B and 2D.

Type horizon and locality : level 2 of Les Rases section (Lower Barremian) described by Mojon [1996] and located at km 36 of the road from Sorita del Maestrat to Aiguaviva, close to this village (province of Castelló, Pais Valencià, Spain).

Derivation of name : from the Latin name of the type locality, Aiguaviva.

Repository : Mojon collection.

Diagnosis of type species : Coincides so far with the generic diagnosis and may not differ from it in the future since the remains named after this form-genus are supposed to belong exclusively to *Ascidiella stellata*.

As equally confusing as the definition of *Favargerella* given by Mojon [1996] is his analysis of its phylogenetic relationships. Initially (p. 77) genus *Favargerella* (= thalli of *Ascidiella stellata*) is classified within Clavatoroidae, in accordance with most charophyte specialists. Nevertheless on page 78 he proposes that from the utricle symmetry the new genus should be related to Atopocharoidae. This hypothesis, however, is abandoned by the same author two paragraphs later when he notes "a certain (phylogenetic) relation" of *Favargerella* with particular genera of Clavatoroi-

dae such as *Clavator*, *Clypeator*, *Flabellochara*, *Nodosoclavator*, *Hemiclavator*, *Pseudoglobator* and *Asciidiella*. This phylogenetic relation seems not to be straightforward since “(*Favargerella*) utricles are formed by characters convergent with lineage *Clypeator* – *Flabellochara*”, which means that both lineages arise from different ancestors. By the end of the discussion, the phylogenetic relationships of *Favargerella* with Clavatoroidae are even more confused as it is stated that the utricle of *Favargerella* originated from a utricle similar to those of *Hemiclavator adnatus* or certain populations of *Flabellochara*. By mentioning almost all the groups known within Clavatoraceae Mojon [1996] is sure to hit on the phylogenetic relatives of his new genus eventually. However, it is necessary to be explicit about the phylogenetic status of characters in order to propose a testable hypothesis regarding phylogeny and systematics, this unfortunately is not the approach taken by Mojon.

4. – BIOSTRATIGRAPHY

Mojon [1996, p. 78] criticises the biozonation proposed by Martín-Closas and Schudack *in Riveline et al.* [1996] on the basis of concurrent ranges of taxa (Oppelzones). In contrast he proposes a biozonation which is exclusively based on total range zones (or cenozones) of the gradualistic lineage *Globator*. However it is not clear how Mojon is able to fix the upper limit of a cenozone on the basis of a taxon, that coexisted with its anagenetic descendant during long time spans and in thick carbonatic series. Even charophyte specialists who share Mojon's approach recognise that the definition of such boundaries is an arbitrary practice [e.g. Feist and Wang, 1995].

Mojon [1996, p. 83-84] defines two new biozones (M6 and M7a) on the basis of the two new taxa of genus *Globator* that he proposes. These biozones are presented as splitting the Steinhauseri biozone, which is a long-lasting biozone (Uppermost Berriasian to Upper Hauterivian) according to Martín-Closas and Schudack *in Riveline et al.* [1996] (fig. 4). According to Mojon [1996], the first new biozone (M6, Valanginian) is characterised by the appearance of *Globator fallax* MOJON 1996 whereas the second new biozone (M7a, Hauterivian) is characterised by *Globator trochiliscoides* subsp. *mutabilis* MOJON 1996. The creation of species on the purpose of defining biozones is common practice among certain biostratigraphers but this practice does not help to solve real problems, such as the absence of morphological change in charophyte associations during Valanginian and Hauterivian. As noted by Martín-Closas and Salas [1988], continental levels interdigitated with marine layers containing the

Lower Valanginian foraminifer *Valdanchella miliani* (SCHROEDER, 1968) yield the first populations of *Globator maillardii* var. *steinhauseri* (MOJON *in* Détraz and Mojon, 1989) MARTÍN-CLOSAS, 1996 usually coexisting with intermediary morphotypes of its anagenetic ancestor *Globator maillardii* var. *nurrensis* PECORINI 1969 or even *Globator maillardii* var. *incrassatus* (MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986) MARTÍN-CLOSAS, 1996. These polymorph populations, which are called *Globator fallax* by Mojon [1996], changed progressively to other populations containing only *Globator maillardii* var. *steinhauseri* utricles. The *steinhauseri* populations already yield in the Lower Valanginian a number of utricles corresponding to what Mojon [1996] describes as *G. trochiliscoides* subsp. *mutabilis*, as shown by Martín-Closas and Salas [1988]. The association of *steinhauseri* and *mutabilis* morphotypes continues unchanged until the Lower Barremian [Martín-Closas and Grambast-Fessard, 1986]. This lack of change results unfortunately in a long-lasting Steinhauseri biozone, which only the discovery of new evolutionary changes will allow us to split in two or more shorter biozones.

By creating a Valanginian (M6 or Fallax) biozone, Mojon [1996] gives the impression that he is describing a new biostratigraphical event within the former Steinhauseri biozone, but what in fact occurs is that morphotypes which have already been described are given a different name. Similarly, Mojon's new Hauterivian biozone Mutabilis or M7a is based on a morphotype which already existed in the Lower Valanginian [Martín-Closas and Salas, 1988] and was previously called *G. steinhauseri* (or “primitive forms of *G. trochiliscoides*” by Grambast, 1974 and Martín-Closas and Grambast-Fessard, 1986). By changing its name however, it becomes impossible to distinguish Valanginian from Hauterivian, since no real morphological change has occurred. In addition, the new Hauterivian biozone M7a, is attributed by Mojon [1996] to levels where we found the orbitolinid *Valdanchella miliani* (SCHROEDER 1968) (fig. 1c), which is correlated with the Early Valanginian ammonite biozone Paramimouna [Azéma *et al.* 1976]. Mojon's [1996] proposals lead not only to a confused biozonation and a subsequent loss of credibility in charophyte biostratigraphy, but also to false datations being given to stratigraphic units.

Hence, we believe the ages of the formations on the northern margin of the Maestrat Basin given by Mojon to be erroneous. The Herbers Fm as defined by Salas [1987] for instance, may not be exclusively Valanginian in age (biozone M6) as proposed by Mojon (1996). Indeed, Herbers Fm, including charophytes of the Steinhauseri biozone, may also be Hauterivian as demonstrated by its lateral change of facies towards the depocentre. As indicated by Salas *et al.* [1995, fig. 5],

M.A.	AGE	Correlation with marine biozones	Modified from Martín Closas & Schudack (1996) Biozonation	Mojon (1996) Biozonation
100 				

FIG. 4. – Comparison between biozonations of Martín-Closas & Schudack in Riveline *et al.* [1996] and Mojon [1996].FIG. 4. – Comparaison entre les biozonations de Martín-Closas & Schudack in Riveline *et al.* [1996] et Mojon [1996].

the Herbers Fm passes laterally to the shallow marine unit La Llacova Fm which passes laterally to the deep marine carbonates of La Gaita Fm. This formation yields Upper Hauterivian ammonites [Martínez *et al.*, 1994]. Further on, towards the top of the studied section Mojon [1996] believes that some levels of the Cantaperdius Fm (fig. 1d) are Lower Aptian in age (zone M8b). However this appears to be quite impossible since the Lowermost Aptian is marked in the Maestrat Basin by the development of the Morella and Cervera Fms [Salas *et al.* 1995]. These formations overlay the Cantaperdius and Artoles Fms (Barremian) and the Cervera Fm contains the palaeomagnetic anomaly M0 (Earliest Aptian) [Parés, 1997 ; pers. comm.].

5. – CONCLUSIONS

The changes to the Lower Cretaceous charophyte biostratigraphy proposed by Mojon [1996] constitute a criticism of previous studies on the same subject conducted in the Iberian Ranges by Salas [1987], Salas *et al.* [1995], Martín-Closas and Salas [1988, 1989 and 1994] and Martín-Closas [1989]. The new taxa he proposes are intended to replace taxa created by Martín-Closas and Grambast-Fessard [1986].

However, the modifications to the stratigraphic units of the Maestrat Basin proposed by Mojon appear with little foundation since this author mistakes lithostratigraphic units for biostratigraphic units. Also some of the units previously recognised along the section of Els Mangraners, studied by Mojon, are ignored or included arbitrarily within other units.

The new taxa proposed by Mojon [1996] can also be called into question for a variety of reasons. *Globator fallax* appears to include intermediate morphotypes between *Globator maillardii incrassatus* and *Globator maillardii nurrensis*, which constitute the variability of these anagenetic varieties. Taxonomically *Globator fallax* is a synonym of *Globator maillardii* var. *incrassatus* (MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986) MARTÍN-CLOSAS, 1996 whereas *Globator incrassatus* MOJON, 1989 is a homonym of *Globator incrassatus* MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986. The

creation of the new genus *Favargerella* MOJON 1996 is not acceptable for the inclusion of the fructifications of *Asciadiella stellata* (MARTÍN-CLOSAS & GRAMBAST-FESSARD, 1986) MARTÍN-CLOSAS ex SCHUDACK, 1993 since the description of the new genus corresponds simply to the vegetative remains of this species. Thus we propose an emendation to the diagnosis of *Favargerella* so as to include only vegetative remains. *Globator trochiliscoides* subsp. *mutabilis* MOJON, 1996 is another intermediate morphotype within the gradualistic lineage *Globator*. Though its definition is taxonomically correct and perfectly acceptable from the point of view of empiricists, it results in the further inflation of names without adding any new information.

Mojon's proposal for two new charophyte biozones (M6 zone for Valanginian and M7a zone for the Hauterivian) is intended to solve the lack of definition of the present day charophyte biozone Steinhauseri (Martín-Closas and Schudack *in* Riveline, 1996). However, the new biozones are based on taxa created on the purpose of defining these biozones, which do not add information to the already known biostratigraphical succession of *Globator* lineage. Thus, *Globator fallax*, proposed by Mojon as the type species of M6 zone, includes in fact some late morphotypes of *Globator maillardii nurrensis* and *Globator maillardii incrassatus*. Similarly, *Globator trochiliscoides mutabilis*, which is the type species for the Hauterivian biozone M7a has already been found in Lower Valanginian associations [Martín-Closas and Salas, 1988] and are late morphotypes of *Globator maillardii steinhauseri*. Given these apparent errors and conceptual confusions Mojon's biozonation fails to increase the definition of the previous biozonations and may in fact result in the erroneous datation of stratigraphic units. This is at least the case when applying Mojon's criteria to the datation of Herbers and Polacos Fms.

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