

MESOZOIC AND CENOZOIC CALCAREOUS ALGAE, PRAECURSOR OF FAMILY CODIACEAE

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Abstract. It is amazing how long time was the using of the marine green – algae, Family *Codiaceae* and the genus *Codium*, as suffix of many fossil genera (*Carpathocodium*, *Arabicodium*, *Calabricodium*, *Madonicodium*), without any relation with the real morphology of the Recent genus *Codium*. The genus *Codium* is well represented on warm – cool transitional marine coasts or in the inner shelf environments of carbonate platform. The genus *Codium* has an unique structural plan with thallus multibranching, noncalcareous, vesiculous crossed by medullary siphons and only one layer of cortical utricles. The utricles show a great anatomical diversity with diagnostic value in separating the approximately 100 Recent species. Until now, a real representative of the Recent Family *Codiaceae* in the fossil state was not found. Also, the same situation is with Recent genus *Pseudocodium* (Family *Pseudocodiaceae*).

Contrary, the fossils praecursors of the Recent *Codiaceae* were recorded, described and included now, for the first time in the Family *Praecodiaceae* nov. fam.

This family only with fossil representatives contains calcareous thalli composed by cylindrical branches crossed by medullary siphons, few in number (4 to 6, rarely 8) and only one utricles layer. The utricles layer is variable in morphology from species to species.

Beside the late Triassic *Hydracara kubeae* Dragastan et al.2000 are introduced the following taxa: *Lupertosinnium bariensis* nov.gen.nov.sp. (early Barremian), *L. banatensis* n.sp. (late Barremian – early Aptian), *Alpinium tragelehni* nov.gen.nov.sp. (Thanetian) and *Atlasium* nov.gen. (Type species *Halimeda erikfluegeli* Dragastan & Herbig 2007, late Thanetian).

Three taxa of early, middle and late Devonian, *Botrys compacta* Schrischova, *Uva suspecta* Maslov and *Botryella spinosa* Shuysky & Schrischova are considered Paleozoic taxa belonging to the Family *Praecodiaceae*.

Keywords: Green siphonous calcareous algae, Family *Praecodiaceae* nov.fam., *Chlorophycota*, Paleozoic, Mesozoic and Cenozoic.

INTRODUCTION.

During the time, many fossils calcareous algal genera were assigned to the different families. It is also, the case of the Family *Codiaceae*.

Reis (1923) described genus *Dimorphostroma* as a new codiacean from the freshwater Miocene (See sinterkalke) of Rheinpfalz (Germany), which is now considered a synonym with cyanophycean genus *Rivularia* (Roth) Agardh 1824 (Dragastan 1985).

Pia (1927) introduced the Section „ Porostromata” for „ filamentous” calcareous algae with thalli crossed by tubes, simple or multi- branched.

Frollo (1938) described genus *Cayeuxia* with two new species, *C. pia* and *C. moldavica* considered also, *Codiaceae* from marine Tithonian of the Bicaz Gorges, East Carpathians. Dragastan (1985) transfered the genus to cyanophycean as synonym of the genus *Rivularia*.

Tappan (1980) in his important treatise considered correctly that, in the Class *Bryopsidophyceae*, Order *Codiales* Setchel 1929 and Family *Codiaceae* (Trevisan) Zanardini 1843 contains only one Recent genus *Codium* and no fossil representatives.

The others genera, like *Bevocastris*, *Garwoodia*, *Hedstroemia*, *Ortonella* were assigned to Order *Caulerpales*, Family *Garwoodiaceae* (author of this rank not clearly designated). Also, the genera *Arabicodium*,

Boueina, *Bacinella*, *Halimeda*, *Palaeoporella*, *Udotea* or *Uva* are included by Tappan to the Family *Udoteaceae*. If for genus *Codium* of Family *Codiaceae* the statement is correct, for others genera assigned to Order *Caulerpales* (Family *Garwoodiaceae* and Family *Udoteaceae*) is not correct and cannot be follow.

In the same manner, different authors included genera *Garwoodia* Wood 1941, *Hedstroemia* Rothpletz 1913, *Carpathocodium* Dragastan 1985, *Scotlandella* Dragastan 1985, *Johnsonicodium* Dragastan 1985, *Arabicodium* Elliott 1957, *Tethysicodium* Dragastan 1985 or *Bevocastris* Garwood 1931 to the Family *Codiaceae* without to take into consideration, the real structure of the thallus of the genus *Codium*.

Roux (1985) and Mamet et al (1987) considered the genera *Bevocastris*, *Garwoodia*, *Hedstroemia*, *Malakhovella*, *Nansenella*, *Ellesmerella* as representatives of Family *Codiaceae*.

Luchinina (1987) and Shuysky in Chiuwashov et al. (1987) introduced another classification as follow: Phylum *Cyanophyta*, Family *Garwoodiaceae* (genera *Mitcheldeania*, *Botomaella*, *Ortonella*, *Garwoodia*, *Hedstroemia*, *Cayeuxia*, *Bevocastris*) and in the Class *Siphonophyceae*, Order *Siphonales* (genera *Arabicodium*, *Uva*, *Botrys*, *Funiculus*).

The classifications of calcareous siphonous green algae suggested by different authors are summarized by Dragastan et al. (1997).

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It is amazing, how long time was the using of rank (Family) *Codiaceae* for different marine, green algae or non- marine and the genus *Codium* as suffix for many fossils genera : *Arabicodium*, *Carpathocodium*, *Calabricodium*, *Madonicodium* etc. , without any relation with the real morphology and inner structure of the Recent genus *Codium*.

Shuysky (1996) in a paper about the evolution and phylogeny of green siphonous calcareous algae (Fig.1) supposed that, genera *Botrys* , *Botryella* and *Uva* from Devonian deposits have some characters close to the Family *Codiaceae* and possible evolved from the genus *Abacella* Maslov.

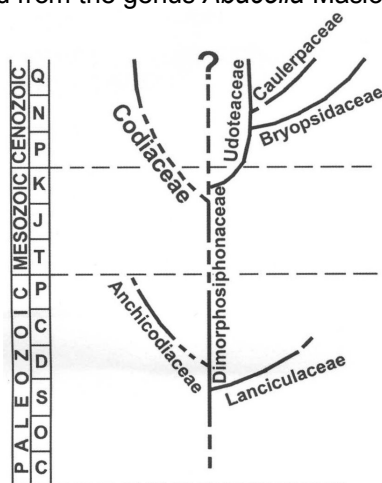


Figure 1. Schematic phylogeny of the families belonging to Order *Siphonales* (from Shuysky 1996).

The author considered that, the Family *Codiaceae* has an evolutive ancestor in the Family *Dimorphosiphonaceae* and appeared (?) at the Jurassic – Cretaceous boundary and some „ genera „ are „ sure” present during the late Neogene and Quaternary time.

Due to many data achieved recently, the systematic of green siphonous algae has now, more stability, but without to be accepted by all paleoalgalogists (See classification of Paul C. Silva in Dragastan & Schlagintweit 2005).

A new scheme for this group of algae was adopted using the followings ranks: Phylum *Chlorophycota* ENGLER 1903, Class *Siphonophyceae* HAECKEL 1894, Order *Siphonales* KIRCHNER 1878, Suborder *Halimedineae* HILLIS- COLINVAUX 1984.

In the Suborder *Bryopsidineae* HILLIS – COLINVAUX 1984 will be included and described the new fossil group of green – siphonous calcareous algae, which was compared with the Recent genera of the Family *Codiaceae* KÜTZING 1843 and Family *Pseudocodiaceae* HILLIS – COLINVAUX 1984.

THALLUS MORPHOLOGY OF THE RECENT CODIACEAE AND PSEUDOCODIACEAE.

Genus *Codium* Stockhouse 1797

The genus *Codium* (Family *Codiaceae*) is well represented by over 100 species, on warm – cool transitional shores and produce a vesiculous, non- calcareous bushy thallus, hemisphaerical, like a „ball”, erect or prostrate (creeping mats).The thallus is composed by cylindrical or flattened branches. The branches are spongy, 2 up to 6 mm in diameter, mainly dichotomously branched (Fig. 2 / 1, 3).

The genus *Codium* is rich in species with an „ intrageneric morphological diversity, which presumably reflects intrageneric, genetic diversity „. (Silva 1992).

The inner structure of the cylindrical, dichotomously branches displayed, more or less, large, central, medullar zone crossed by medullar siphons disposed like in a network, in transverse section. (Fig.2 / 2, 5).

In the longitudinal section, the medullar siphons are disposed vertically, more or less paralell, being dichotomously branched. (Fig. 2 / 4 – 6).

The important characters used for the discrimination of species are the shape (morphology) of utricles layer, only primary, mode of connexion between utricles and the medullary siphons and the position and shape of gametangia.

The genus *Codium* represents a benthic, marine, green algae, which reach their peak of species diversity on the transitional warm – cool temperate shores. In the Atlantic, the cold – water flora is richest in the east, while the warm – water flora is richest in the west (Silva 1992). In the vastly broader Pacific, the cold – water flora is equally rich on both sides, but also, the warm – water flora is richest in the west area.

Genus *Pseudocodium* Weber van Bosse 1896.

The Recent genus *Pseudocodium* (Family *Pseudocodiaceae*) also is represented on the marine, warm – cool transitional coasts. The thallus vesiculous, non – calcareous is bushy, erect, more or less hemisphaerical composed by large in diameter, cylindrical, slightly, flattened branches.

The branches predominantly dichotomic, less tricho – or polytomic (Fig. 3 / 1). The inner structure of cylindrical branches presents a central, medullar zone crossed by large in diameter, medullar siphons, short, dichotomously branched (Fig. 3 / 2).

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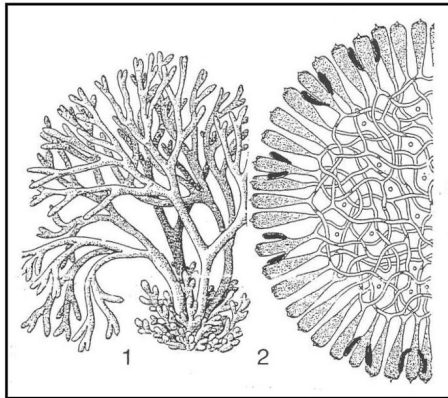


Figure 2. 1 – 6 . *Codium fragile* (Suringar 1867) Hariot 1889, 1.Thallus habit, 2. Transverse section in the thallus branch showing medullary siphons and cortical utricles bearing gametangia, 3. Thallus habit, 4, 6. Longitudinal axial section in the thallus branch, 5. Transverse section in the thallus branch., Figs. 2,4, 6 x 25 and Fig.5, x 15 (Figs 3 – 6 after K.L.Vinogradova 1979).

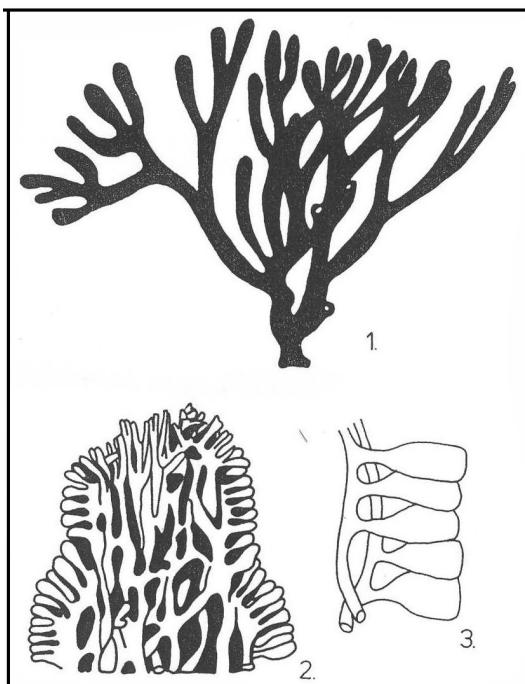
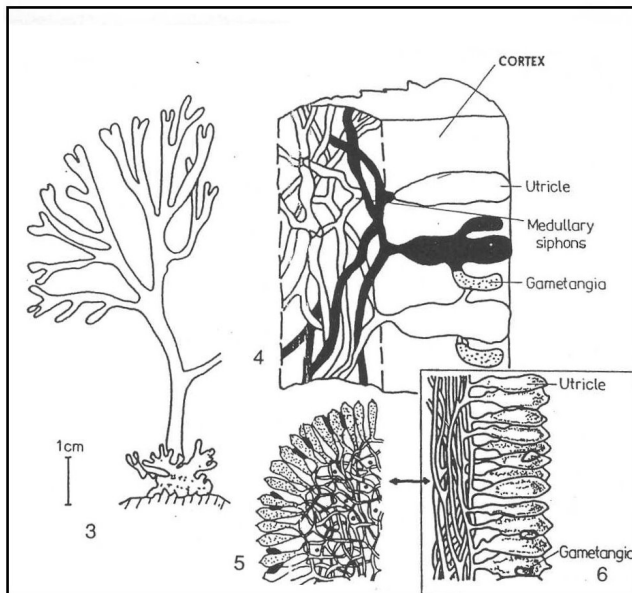


Figure 3. 1 - 3 . *Pseudocodium devriesi* Weber van Bosse , 1. Thallus habit, 2. Longitudinal section of thallus branch showing the large, medullary zone and utricles, 3. Morphology of the utricles layer (after original of Weber van Bosse 1896, in Glinowskaja 1972)., Figs.1 x 1, 2 x 200 , 3 x 300.

The medullary siphons continued by clear, tubular connexion with only primary utricles

layer (Fig. 3 / 3). The primary utricles layer have specific morphology, proximal short,

tubular increasing in diameter, from the proximal part to the distal, like a „spoon – bill”. At genus *Pseudocodium* the disposition of medullary siphons and the morphology of the utricles layer are species specific characters.

The praecursors of the Family Codiaceae. Paleozoic praecodiaceans.

The Paleozoic praecodiaceans are described by Maslov (1956), Schirshova (1987) and Shuysky & Schirshova (1987) under the generic names: *Uva* Maslov, *Botrys* Schirshova and *Botryella* Shuysky & Schirshova from Devonian limestone deposits. (Fig. 4 / 1 – 3).

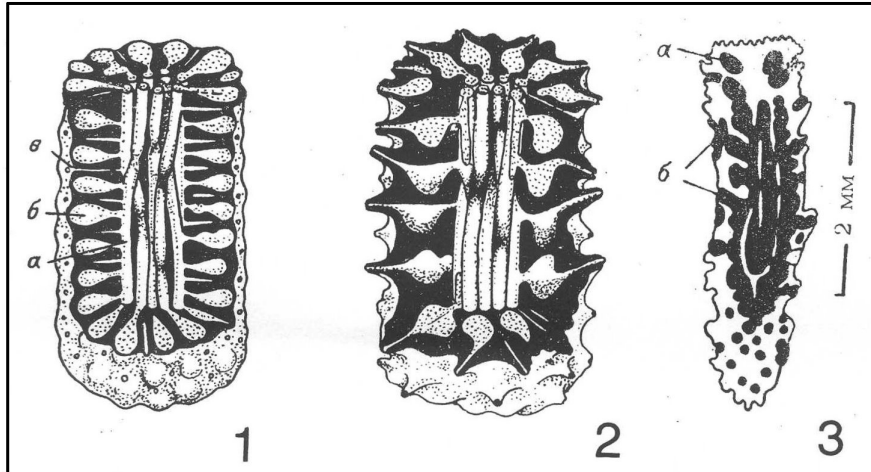


Figure 4. 1 – 3 .The Paleozoic praecodiaceans : 1. *Botrys compacta* Schirshova , 2. *Botryella spinosa* Shuysky & Schirshova, 3. *Uva suspecta* Maslov, Devonian limestones. (from authors original reconstruction).

The Devonian genera presents morphology close to *Codiaceae* or *Pseudocodiaceae*, but differs, by small in diameter medullary zone, few number rows of medullary siphons and a characteristic shape of the utricles layer, being typical for the Paleozoic *Praecodiaceae* nov.fam. Although, the inner structure of Devonian algal thalli is comparable with the morphology of the Recent genera *Codium* and *Pseudocodium*. Shuysky assigned this group of genera to Order *Siphonales*, Family *Dimorphosiphonaceae* and to the Tribe *Botryelleae* Shuysky 1987.

The diagnosis of Tribe Botryelleae is: „calcareous thalli cylindrical in shape crossed by medullary zone and continued with utricles”. To this diagnosis we add : „ the medullary zone is narrow and has not so many siphons, 2 up to 4, possible dichotomously branched disposed in the longitudinal rows and utricles only with primary layer. The utricles are different in shape, ovoidal (*Uva*), claviform (*Botrys*) and tear – shaped (*Botryella*).

In Shuysky (1996) scheme the genera *Botrys*, *Botryella* and *Botrys* from Devonian are considered the ancestors of the Family *Codiaceae* without to present the relative connexion with Meso – Cenozoic or some algal genera.

In spite of similarities regarding the construction and inner structure of the thalli, Shuyski (1987) included these Devonian

green – siphonous algae with close codiaceans characters to Family *Dimorphosiphonaceae* Shuysky 1987.

We consider that, the Family *Dimorphosiphonaceae* is a distinctive group of algae with a stratigraphical range covered the Cambrian – Ordovician time. (Dragastan & Schlagintweit 2005).

In the Shuysky (1996) evolution scheme, this family has a long stratigraphic range from Ordovician till the early Permian with a breaking off to the Permian / Triassic boundary, to come out, again during the Jurassic and possible the evolution continued till de Recent. The scheme, in some circumstances is based only on supposition, that some taxa of *Dimorphosiphonaceae* are present during the Mesozoic and Cenozoic time.

Mesozoic and Cenozoic praecodiaceans.

Dragastan et al (2000) described and introduced a new calcareous green siphonous algal taxon *Hydracara kubeae* from Rhaetian, reefal environment of Hydra Island, Greece. At the time Dragastan et al. (2000) assigned this taxon to the Family *Halimedaceae* with the mention that „ the new taxon is close to the Recent genus *Codium*, in its simple utricular system „.

New data and discoveries regarding the presence of calcareous praecodiaceans,

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green siphonous algae during the Mesozoic and Cenozoic, allowed to introduce a new family name for the genera with relative, close morphological „traits” with the Recent Family *Codiaceae*, respectively Family *Praecodiaceae* nov. fam.

The Mesozoic and Cenozoic praecodiaceans are represented by green siphonous algae with calcareous hemispherical thalli, in majority of the cases as broken parts. The broken thalli delivered cylindrical branches crossed by medullary zone and the cortex with only one, primary utricles layer. The medullary zone crossed by four to six (up to eight) cylindrical siphons, dichotomously branched disposed parallel, in longitudinal rows. The utricles only, primary, different in shape is characteristic for each species.

SYSTMEATICS PALAEONTOLOGY

Phylum CHLOROPHYCOTA Engler 1903
Class *Siphonophyceae* Haeckel 1894
Order *Siphonales* Kirchner 1878
Family *Praecodiaceae* nov.fam.

Derivatio nominis: from the latin „prae” before and the suffix „codiaceae”.

Diagnosis : Calcareous, green siphonous algae composed by hemispherical thalli (?)with cylindrical or slightly flattened branches. The branches, simple or dichotomously branched. The branches crossed by a narrow medullary zone. The medullary siphons, small in diameter, variable as number (4 – 6 or rarely 8, dichotomously branched disposed in longitudinal rows. The transition from medullary zone to the cortex is clearly marked. The cortex variable in thickness, equal or unequal with medullary zone. The cortex formed only by primary utricles layer. The utricles, variable in morphology: ampuliform, lanceolate, oval – ellipsoidale, eared – shaped (auriculate) and subclaviform.

Remarks : The taxa of Family *Praecodiaceae* nov.fam. are comparable with taxa of Family *Codiaceae* by the inner morphology of thalli, in the case of broken parts as cylindrical branches, by its medullary zone and the cortex with only one, primary utricles layer. Differs from some Recent taxa of Family *Codiaceae* by narrow medullary zone, by the reduce number of medullary

Hydracara kubeae n.gen.n.sp.- Dragastan, Kube & Richter 2000, p. 147, Pl.3, Fig.7 – 8, Text- Fig.8.

siphons rows and by the characteristic shape of the primary utricles layer for each species.

It is time and recommend now, do not use the suffix „ Codium” in describing the genera, which do not belongs or do not corresponds in construction and morphology with taxa of Family Codiaceae or Family Pseudocodiaceae.

There are many described genera, *Arabicodium*, *Carpathocodium*, *Tethysicodium*, *Alpinocodium*, *Calabricodium*, *Collarecodium*, *Egericodium*, *Madonicodium*, which are not comparable with the inner morphology of thalli, and genera from the Families *Codiaceae* and *Pseudocodiaceae*.

Systematic, some taxa belongs to the Family *Udoteaceae* (some species of *Arabicodium*), to the Family *Halimedaceae* (*Alpinocodium*, *Madonicodium* , Senowbari – Daryan & Zamparelli 2005)) and to the Family *Protohalimedaceae* (*Carpathocodium*, *Tethysicodium*, *Banatocodium*, in Dragastan & Schlagintweit 2005).

In the same time, the nomenclature for the taxa of Family *Praecodiaceae* nov.fam is better to be use, in case of genus, the ending „ium” from the Recent genus *Codium*. For example for fossil genus *Lupertosinium* nov.gen.

I don' t agree, with the commentaries of Senowbari- Daryan & Zamparelli (2005), that: „ all species mentioned from Hydra are poorly documented and their determination is almost impossible „.

Colleagially, I was also, not convinced that, new taxa introduced by the authors (Senowbari- Daryan & Zamparelli 2005), like *Collarecodium cornuiformis* has a clearly, diagnostic inner structure and the taxa *Calabricodium irregularum*, *Bradneria calabrica* and *Madonicodium noricum*, all taxa have the same „ missing” inner structure, being strongly recrystallized and their determination, only from the outer morphology of thalli is almost impossible. Unfortunately, the Triassic reefal limestones, are diagenetically changed and the real, inner structure of the fossils suffered a strongly obliteration.

Taxa examined

Genus *Hydracara* DRAGASTAN, KUBE & RICHTER 2000

Hydracara kubeae DRAGASTAN et al . 2000

Pl.1 , Fig. 1- 3

Description : Thallus composed of long, broken, cylindrical branches crossed by a narrow, axial, medullary zone. The medullary zone contains six up to eight (?) rows of

tubular, medullary siphons, small in diameter and dichotomously branched (Pl.1, Fig.3). The cortex is thick, in comparison with medullar area. It is pierced by simple, only one primary, ampuliform utricles layer. In transverse section, the thallus branch is round in shape and in some areas of the cortex, show the ampuliform utricles layer.

The utricles are large in proximal part and became acuminate towards the distal end.

Dimensions in mm : Length of thallus branch (L) = 2.70 – 3.30, Diameter of branch (D) = 0.55 – 0.90, Diameter of medulla (dm) = 0.25 – 0.30, Diameter of medullary siphons (dms) = 0.020 – 0.070, Thickness of the cortex (thc) = 0.020 – 0.30, Diameter of the utricles in the proximal part (dup) = 0.10 – 0.12, Diameter of the utricles in the distal part (dud) = 0.060 – 0.075, length of the utricles (lu) = 0.20 – 0.30.

Remarks : Initially this taxon was assigned to the Family Halimedaceae, although Dragastan et al. (2000) have written that „ **the new taxon is close to the Recent genus *Codium*, in its simple utricular system**”.

It is sure, a praecodiacean alga, not segmented with broken parts of thalli, as branches and the cortex only with one, primary utricles layer, characteristic for the new family.

Stratigraphic range: Rhaetian (Sample Lo 29 and additional material), Hydra, Greece.

Genus *Lupertosinnium* nov.gen.

Derivatio nominis : Dedicated to Dr. Elena Luperto Sinni (University of Bari), a homage for her scientific activities and the contributions to geology and paleontology of the alpine carbonate platforms.

Diagnosis : Calcareous broken, cylindrical branches thalli, crossed by narrow, axial, medullar zone and cortex with only primary utricles layer, cylindrical to claviform, in shape and slightly recurvent upwards.

Type species : *Lupertosinnium bariensis* nov.sp.

Lupertosinnium bariensis nov.sp.

Pl.1, Fig. 4 – 5

Organisme indetermine - Luperto Sinni & Masse 1984, Pl.39, Fig. 1, 5, non Fig.3, which corresponds to *Juraella bifurcata* Bernier.

Derivatio nominis : from Calcari di Bari, Murges region.

six mm in diameter are crossed by a large, medullar zone and the cortex composed by utricles cylindrical, club – shaped or pear –

Holotype : Pl.1, Fig.4, longitudinal section, from Luperto Sinni & Masse, 1984, pl.39, fig.1, Sample L186

Paratype : Pl.1, Fig.5, transverse section, Collection Luperto Sinni, Sample L. 186.

Locus typicus : Montericco Limestones, Murges region, Southern Italy.

Stratum typicum : early Barremian, *Salpingoporella biokovensis* Biozone, Montericco Member, Bari Formation.

Description : Long, calcareous cylindrical branches delivered from hemispherical broken thalli. In the longitudinal section, the thallus branch is cylindrical. The branch crossed by narrow, medullar, axial zone. The medullar zone composed by, two up to four, not so small, in diameter medullary siphons, dichotomously branched. The medullary siphons are short, tubular and vertically, disposed along the axis of thallus branch (Pl.1, Fig.4).

The cortex is thick, crossed by cylindrical to claviform primary utricles, slightly recurvent, upwards to the distal end (Pl.1, Fig.4), irregularly disposed each- others.

Dimensions in mm : L = 6.0 – 7.50, D = 0.85 – 1.20, dm = 0.30 – 0.60, dms = 0.060 – 0.10, thc = 0.80 – 1.0, dup = 0.10 – 0.17, dud = 0.16 – 0.27, lu = 0.60 – 0.75.

Remarks : This alga was considered by Luperto Sinni & Masse (1984) as an „Organisme indetermine”, not accompanied by a description, and any discussion about a possible group of algae or others relationships. Looking carefully to the original pictures, was clearly the algal affinities of this broken branches thalli and with inner morphological structure, characteristic for a praecodiacean alga.

The Recent species of genus *Codium*, especially, the habit of *C. decortatum* (Woodward) Harris having bushy, hemispherical thallus composed by cylindrical branches, six up twentyfive mm, in diameter and the shape of utricles, cylindrical to club – shaped is comparable with the fossil species *Lupertosinnium bariensis* nov. sp.

Codium decortatum is a species widespread in the Caribbean area, preferring coral – reefs, rocky substratum, or sheltered zones up to 15 m deep.

Another Recent species *Codium isthmocladum* Vickers has also, hemispherical thallus and dichotomously branched. The branches cylindrical, two up to

shaped, being different by variable morphology of utricles, in comparison with fossil new species.

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Codium isthmocladum is also, recorded in the Caribbean area growing on the reef, rubble or hard surfaces up to 10 m deep.

Stratigraphic range : early Barremian, Bari Formation, Murges region, southern Italy.

Lupertosinnium banatensis nov. sp..

Pl.1, Fig.6

Halimeda ? sp.- Bucur 1994, p.17, Pl.3, Fig.6 – 7.

Derivatio nominis: from Banat a region where was found the alga.

Holotype: Pl.1, Fig.6, Longitudinal axial section, from Bucur, 1994, pl.3, fig.6, Doman, Banat.

Additional material: possible.

Locus typicus: Doman, Banat, Southern Carpathians.

Stratum typicum: late Barremian – early Aptian, fide Bucur 1994.

Description: Long, cylindrical, broken thallus branch crossed by narrow, medullar zone. The medullar zone composed by four to six tubular siphons, medium long and dichotomously branched (Pl.1, Fig.6, arrow). The medullar siphons disposed parallel to the axis of branch thallus. The connexion between medullar siphons and the utricles of the cortex is strongly or acute, angular (Pl.1, Fig.6). The only, primary utricles have an oval up to ellipsoidal shape, disposed in a regular manner. Sometimes, the shape of utricles is round, function of the section plane. Possible, small, gametangia, oval, slender on the right side of the thallus branch, connected with utricles. The cortex not so thick is covered by microbolithic crusts.

Dimensions in mm : L = 6.35, D = 0.62, dm = 0.23, dms = 0.030 – 0.040, du = 0.060 – 0.080.

Remarks : Bucur (1994) assigned this alga to genus *Halimeda* ? sp. considering as long, cylindrical specimen with *Halimeda* type structure. Differs from *Lupertosinnium bariensis* n.sp. from early Barremian by four to six, medium long, medullar siphons and the utricles of oval up to ellipsoidal shape. The Recent *Codium taylori* Silva is comparable by the presence of cylindrical branches and oval, slender gametangia, having cylindrical to club – shaped utricles. This Recent species was recorded in the Caribbean area, living on the rubble reef, rocky substratum from 10 m up to 60 m deep. (Littler & Littler 1997).

Stratigraphic range : late Barremian – early Aptian, Doman, Banat, Southern Carpathians.

Genus *Alpinium* nov.gen.

Derivatio nominis : Name from Alps, respectively Northern Calcareous Alps, (NCA).

Diagnosis : Calcareous, broken cylindrical thallus branch crossed by narrow, medullar area. The medullar zone pierced by two up to four, short medullar siphons, intermingled each – others and continued with dichotomies in the cortex. Only primary utricles, ellipsoidal to pear – shaped.

Type species : *Alpinium tragelehni* nov.sp.

Alpinium tragelehni nov.sp.

Pl.2, Fig. 1

Halimeda cf. *praemonilis* Morellet – Tragelehn 1996, p.183, Pl.48, Fig.2, not Fig.3.

Derivatio nominis : Species dedicated to Dr. Harald Tragelehn, Germany for his very interesting and valuable thesis about Maastricht and Paleocene of Northern Calcareous Alps.

Holotype : Pl.2, Fig.1, Longitudinal section, Collection Dr. Harald Tragelehn.

Paratypes : Additional material, Collection Dr. Harald Tragelehn.

Locus typicus : Priggglitz, Lubina, Niederösterreich, Steiermark.

Stratum typicum : Thanetian, Northern Calcareous Alps.

Description : Cylindrical, medium long, thallus branch. Thallus branch crossed by narrow, medullar zone, which contains two up to four medullar siphons. The medullar siphons are not disposed parallel, but intermingled on short distance each – others. The tubular, medullar siphons, dichotomously branched, small, in diameter and continued, almost horizontal, into the cortex. (Pl.2, Fig.1). The utricles layer, only primary are ellipsoidal to pear – shaped (Pl.2, Fig.1). Small gametangia (?) on the right side of the thallus branch (Pl.2, Fig.1). The diameter of medullar zone is small, in comparison with the thickness of the cortex.

Remarks : The new taxon is different from the fossil species (*Lupertosinnium bariensis* n.sp. and *L. banatensis* n.sp.) and also, from some Recent species of the genus *Codium*, by its characteristic, intermingled disposition of medullar siphons and by some prolongations of the medullar dichotomies into the cortex. It is comparable with the Recent *Codium isthmocladum* Vickers, by the presence of pear – shaped utricles.

The new taxon was found in high energy environment of rudstones facies, in the open Carbonate platform (Tragelehn 1996).

Stratigraphic range : Thanetian.

Genus *Atlasinium* nov. gen.

Derivatio nominis : Name from Atlas Mts. (Morocco).

Diagnosis : Calcareous, broken, cylindrical thallus branch, crossed by large, medullar zone and the cortex very thin. The medullar zone pierced by up to eight, tubular, siphons, long, parallel disposed and dichotomously branched. The cortex with only, primary utricles, subconical in shape, distally inflated, club – shaped.

Type species : *Halimeda erikfluegeli* Dragastan & Herbig 2007

Atlasinium erikfluegeli (Dragastan & Herbig 2007) nov. comb.

Pl.2, Fig. 2 – 3

Halimeda erikfluegeli nov. sp. – Dragastan & Herbig 2007, p. 20, Pl.6, Fig. 6 / 7.

Locus typicus : Section SA – 12, Collection Herbig.

Stratum typicum : upper Jbel Guersif Formation, late Thanetian, High Atlas, (Morocco).

Description : Cylindrical, broken thallus branch, with large, medullar area, crossed by long, parallel siphons up to eight and dichotomously branched. In longitudinal section (Pl.2 , Fig.2), the medullar siphons have a small, diameter and are disposed in long, parallel, regular rows, along the axis, being dichotomously branched. The cortex is crossed by only, primary utricles, subconical in shape, distally inflated, club- shaped.

The transverse section (Pl.2, Fig.3), present a circular (round) shape of the cylindrical thallus branch. This section, exhibits six up to eight, medullar rows siphons and the cortex twenty up to twenty two, club- shaped primary utricles.

Dimensions in mm : D = 0.58 – 0.60, dm = 0.36 – 0.42, dms = 0.032 – 0.040, thc = 0.090 – 0.10, dup = 0.024 – 0.026, dud = 0.036 – 0.042, lu = 0.076 – 0.090.

Remarks : Dragastan & Herbig (2007) assigned this alga to a new species of genus *Halimeda*. To our knowledges, all others fossil and Recent *Halimeda* species have a cortex with minimum two utricles layers and the

majority of taxa have multiple utricles layers from three up to seven.

The Recent *Codium taylori* Silva has a hemisphaerical thallus with cylindrical branches, dichotomously branched and the utricles, cylindrical to club – shaped comparable with the fossil species.

The Recent *Codium isthmocladum* Vickers could be compared also with the fossil new species, but differ by the shape of branches and the large dimensions of utricles layer.

Stratigraphic range : late Thanetian, Jbel Guersif Formation, High Atlas, Morocco.

CONCLUSIONS:

- The calcareous praecodiaceans are represented by two stocks of genera: one, Paleozoic (mainly Devonian with genera *Botrys*, *Botryella* and *Uva*) and second one, Mesozoic and Cenozoic (late Triassic with genus *Hydracara*, early Cretaceous – Barremian – early Aptian with genus *Lupertosinnium* and Paleogene – Thanetian with two genera *Alpinium* and *Atlasinium*).;

-The oldest regional distribution of praecodiaceans corresponds to Asian areas for the Paleozoic – Devonian taxa, respectively Ural, Salair and Pamir Mts., playing the role of origin and evolutive areas for this group of algae.;

-The Paleozoic representatives contains calcareous thalli composed by cylindrical branches from broken thalli, very small, crossed by narrow, medullary zone with 2 up to 4 siphons and the cortex with only, primary utricles, variables in shape from species to species.;

-The Mesozoic and Cenozoic praecodiaceans have another regional distribution European (Hydra Island, Greece, Appenines, Murges region, Italy, Southern Carpathians, Banat, Romania, Northern Calcareous Alps, Prigglitz, Austria) and African (Middle and High Atlas, Morocco), Fig. 5 .

-The praecodiaceans taxa were recorded in the Rhaetian reefal environment (*Hydracara*) and, in the inner carbonate platform and back – reef lagoon environments (*Lupertosinnium*, *Atlasinium* and *Alpinium*).;

- Mesozoic and Cenozoic praecodiaceans have also, cylindrical branches from the broken thalli, which are crossed by narrow, up to large, medullary zone with an increasing number of medullary siphons from 4 to 8 rows disposed axial – longitudinal, parallel or intermingled and dichotomously branched.;

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FAMILY CODIACEAE

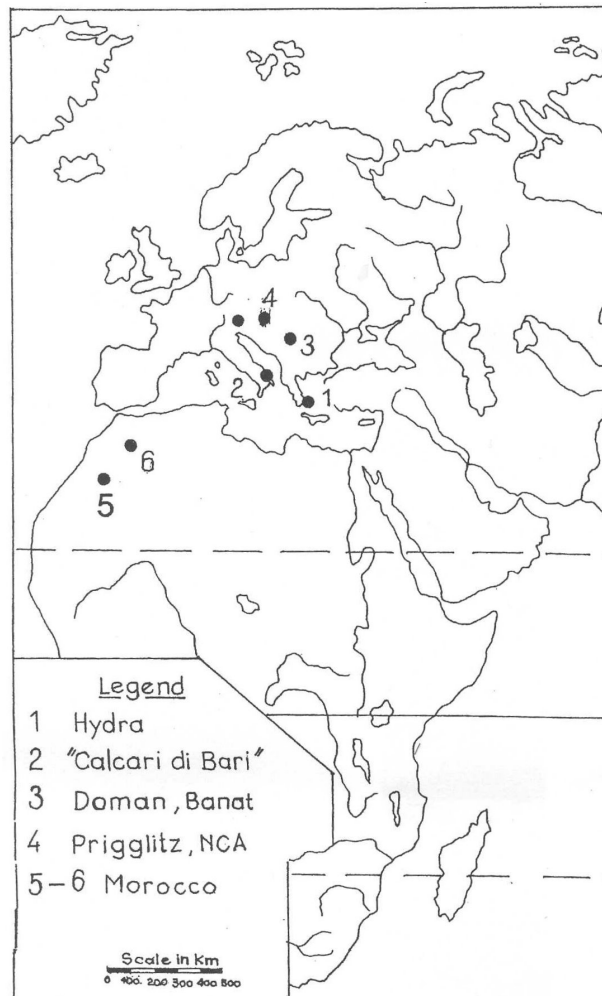


Figure 5 Euroafrican regional distribution of praecodiaceans calcareous algae (Family *Praecodiaceae* nov.fam.).

- The Mesozoic and Cenozoic new calcareous algae are represented in the cortex by only, one utricle layers with characteristic shape: ampuliform (*Hydracara*), claviform- recurbent, upwards to the distal end (*Lupertosinnium bariensis* n. sp.), oval – ellipsoidal (*L. banatensis* n. sp.), ellipsoidal to pear – shaped (*Alpinium* n.gen.) and subconical inflated club – shaped to the distal end (*Atlasinium* n. gen.);

- The evolution of praecodiaceans calcareous algae starts in Paleozoic during Devonian and after, a large gap, till the Jurassic continued during early Cretaceous and Paleogene (Thanetian). During the Thanetian followed another gap, till the Holocene, Fig.6.

- Comparing with Recent genera *Codium* and *Pseudocodium*, which have an unique structural plan of thalli, multibranching, non calcareous, vesiculous crossed by large, medullary zones, multisiphonatae, with an

intermingled or irregular disposition of the medullary siphons, the praecodiaceans differ by the small, diameter of medullary zone, crossed by few number of medullary siphons. The utricular system of the fossil counterpart is small, in dimensions, only primary, but with morphology close to some the Recent codiaceans.

ACKNOWLEDGEMENTS

My sincere thanks and gratitude are directed to Prof. Dr. Paul C. Silva from Berkeley University for many Recent personal papers and volume about the genus *Codium* and genus *Pseudocodium* and for the permanent useful commentaries, regarding the taxonomic and evolutionary lines suggestions. Also, my thanks to Mr. Radu Dumitrescu, technical designer (University of Bucharest, Laboratory of Paleontology).

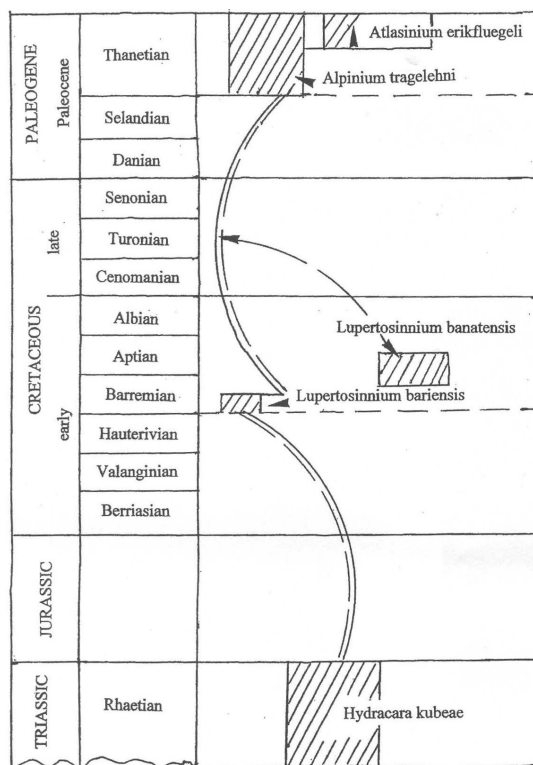


Figure 6. Evolution of taxa from Family *Praecodiaceae* nov. fam. during the Mesozoic and Cenozoic.

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EXPLANATIONS OF PLATES

PLATE 1

Figs.1 – 3. *Hydracara kubeae* DRAGASTAN, KUBE & RICHTER 1999,:1. longitudinal section in branch of thallus showing few medullary siphons and in the cortex, simple, ampuliform utricles; 2. transverse section in a cylindrical thallus branch and 3. reconstruction of thallus branch, Rhaetian, Hydra Island.

Figs.4 – 5. *Lupertosinnium bariensis* n.gen.n.sp. , 4. *Holotype*, from **Luperto Sinni & Masse**, 1984,pl.39, fig.1 Sample L 186, longitudinal section in a broken cylindrical thallus branch crossed by large medullary zone and the cortex with only primary cylindrical utricles and 4. *Paratype*, from **Luperto Sinni & Masse**, 1984, pl.39, fig.5, transverse section in a cylindrical thallus branch showing few medullary siphons and the shape of cortical utricles., Monterico Limestones, *Salpingoporella biokovensis* biozone, early Barremian, Italy.

Fig.6. *Lupertosinnium banatensis* n.gen.n.sp., 6. *Holotype*, from **Bucur**, 1994, pl.3, fig.6, longitudinal section in a cylindrical broken thallus branch crossed by long, medullary siphons and the cortex with ovoidal to ellipsoidal utricles, Sample 1242, Doman, Banat, Reșița- Moldova Nouă Zone, late Barremian – early Aptian.

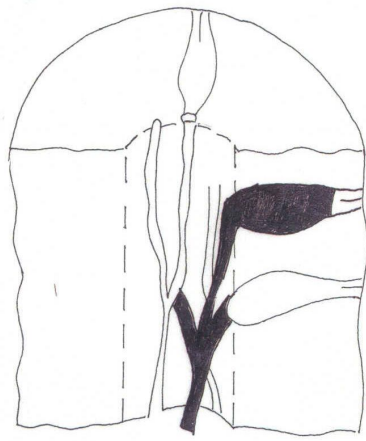
Scale bar : Figs.1 – 2 , 1 cm = 0.100 mm; Figs. 4- 5 – 1 cm = 0.500 mm ; Fig.6 1 cm =0.100 mm.

PLATE 2

Fig.1. *Alpinium tragelehni* n.gen.n.sp., *Holotype*, **Collection Tragelehn** , longitudinal section in a broken thallus branch crossed by narrow medullary zone and the cortex with linguiform utricles, Priggwitz, Thanetian, Northern Calcareous Alps, Sample Pr I 202 2.

Figs. 2 – 3. *Atlasinium erikfluegeli* (DRAGASTAN & HERBIG 2007) nov combination DRAGASTAN, 2. **Collection Herbig**, longitudinal section in a broken cylindrical thallus branch crossed by large medullary zone and the cortex with terete utricles, Upper Guersif Formation, late Thanetian, Sample 021085/ 7, Section SA- 12, High Atlas, Morocco, Fig. 3. Collection Herbig, transverse section in a cylindrical thallus branch with large medullary zone and the cortex with terete utricles., GIK 1894 a , late Thanetian, High Atlas.

Fig. 1 1cm = 0.200 mm , Figs. 2-3 1cm = 0.200 mm.



3



5

