Corals from the Carboniferous of the central Sahara (Algeria): the collection "Marie Legrand-Blain"

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ABSTRACT
The collection "Marie Legrand-Blain" contains a diverse fauna of Carboniferous corals from the marine strata of the Algerian Sahara. Among 96 specimens, there are 34 rugose coral taxa and four tabulate coral taxa. *Saharaphrentis tirechouminoidense* n. gen., n. sp., ?*Amplexizaphrentis illizidensis* n. sp. and *Haplolasma paraarciferum* n. sp. are new. The supposed high coral diversity of the Sahara basins is confirmed by the present study. The interspecific and intraspecific variabilities are hardly known, because the number of specimens is limited; commonly a single or few specimens. Thus populations could not be studied and in some cases only an assignment at generic level is possible. Two main coral associations can be distinguished. Undissepimented solitary rugose corals ("zaphrentids") and michelinid tabulate corals dominate the shaly environments. Larger and more complex solitary and colonial rugose corals occur mainly in carbonate environments. The Mid-Carboniferous Boundary is an important faunal break. It is characterized by the disappearance of typical Mississippian solitary and colonial taxa. "Colonial aulinid" corals have only been found below and above the boundary level. The new Bashkirian coral stock shows palaeobiogeographic connections to the western United States and the Donets Basin. The studied coral fauna does not support the assignment of a Bashkirian age for strata in the Iliizi Basin and the Ahnet and Reggane basins. The Marie Legrand-Blain collection is a good example of the utility of such old collections for the study of Carboniferous corals from the often remote and hardly accessible Algerian basins.

KEY WORDS
Carboniferous,
Mississippian,
Pennsylvanian,
Rugosa,
Tabulata,
Algeria,
Sahara,
Mid-Carboniferous
Boundary,
new genus,
new species.

RÉSUMÉ
Coraux du Carbonifère du Sahara central (Algérie) : La collection « Marie Legrand-Blain ».
La collection « Marie Legrand-Blain » renferme une faune diverse de coraux carbonifères en provenance des couches marines du Sahara algérien. Sur les 96 spécimens, 34 taxa de tétracoralliaires et quatre taxa de tabulés ont été reconnus. *Saharaphrentis tirechouminoidense* n. gen., n. sp., ?*Amplexizaphrentis illizidensis* n. sp. et *Haplolasma paraarciferum* n. sp. sont nouveaux. La diversité élevée des coraux dans les bassins sahariens est confirmée par notre étude. Cependant les variabilités interspécifiques et intraspécifiques restent mal connues, car le nombre de spécimens est limité : un seul ou quelques-uns seulement par taxon. Il est donc impossible d'étudier des populations et parfois, la détermination est seulement possible au niveau générique. Deux associations principales de coraux peuvent être différenciées. Des tétracoralliaires sans dissépiments (« zaphrentidé ») et des tabulés michelinides dominent des environnements argileux. Des tétracoralliaires solitaires plus larges et complexes et des formes coloniales sont préférentiellement trouvés dans des environnements carbonatés. La limite médio-Carbonifère est une rupture importante. Elle est caractérisée par la disparition de formes solitaires et coloniales typiques du Mississippien. Les coloniaux avec un aulos sont seulement présents autour de cette limite. La nouvelle faune du Bashkirien indique des relations paléobiogéographiques avec l'ouest des États-Unis et le Bassin du Donets. La faune étudiée ne permet pas de confirmer l'attribution au Bashkirien pour des couches dans les régions d'Iliizi, Ahnet et Reggane. La collection « Marie Legrand-Blain » est un bon exemple de l'utilité des anciennes collections pour l'étude des coraux carbonifères en provenance des bassins sahariens isolés et difficilement accessibles aujourd'hui.

MOTS CLÉS
Carbonifère,
Mississippien,
Pennsylvanien,
Tétracoralliaires,
Tabulés,
Algérie,
Sahara,
Limite médio-Carbonifère,
genre nouveau,
espèces nouvelles.

INTRODUCTION

The coral record from the marine Carboniferous strata of the Algerian Sahara is relatively poorly known. In his summary, Semenoff-Tian-Chansky (1985) mentioned corals from various regions based on material he collected in the Béchar Basin *sensu lato* or obtained from geologists working in other parts of the Sahara. Most of his material is housed in the Muséum national d'Histoire naturelle, Paris. However, Semenoff-Tian-Chansky (1985) illustrated only specimens from the Béchar Basin *sensu lato*, which has the best Carboniferous coral record in the Sahara. This is partly due to the fact that only in this basin were corals a prime target of field campaigns (Semenoff-Tian-Chansky 1974, 1985; Semenoff-Tian-Chansky *et al*. 1975), whereas in all other areas coral collections have been more or less a by-product (e.g., Conrad 1984). Thus coral occurrences outside the Béchar Basin *sensu lato* have to be considered to be fairly biased. Nevertheless, it has to be mentioned that only the dissepimented solitary rugose corals of the Béchar Basin are adequately described and illustrated (Semenoff-Tian-Chansky 1974).

This paper presents the corals collected by Marie Legrand-Blain in various parts of the Algerian Sahara in the last 40 years. Brachiopods were the prime target during field campaigns (e.g., Legrand-Blain 1968, 1971, 1974, 1985a, b, 1986; Conrad & Legrand-Blain 1971; Legrand-Blain & Poncet 1991; Mottequin & Legrand-Blain 2010), and their preferred facies might exclude the presence of corals or limit their abundances and diversity in some cases.

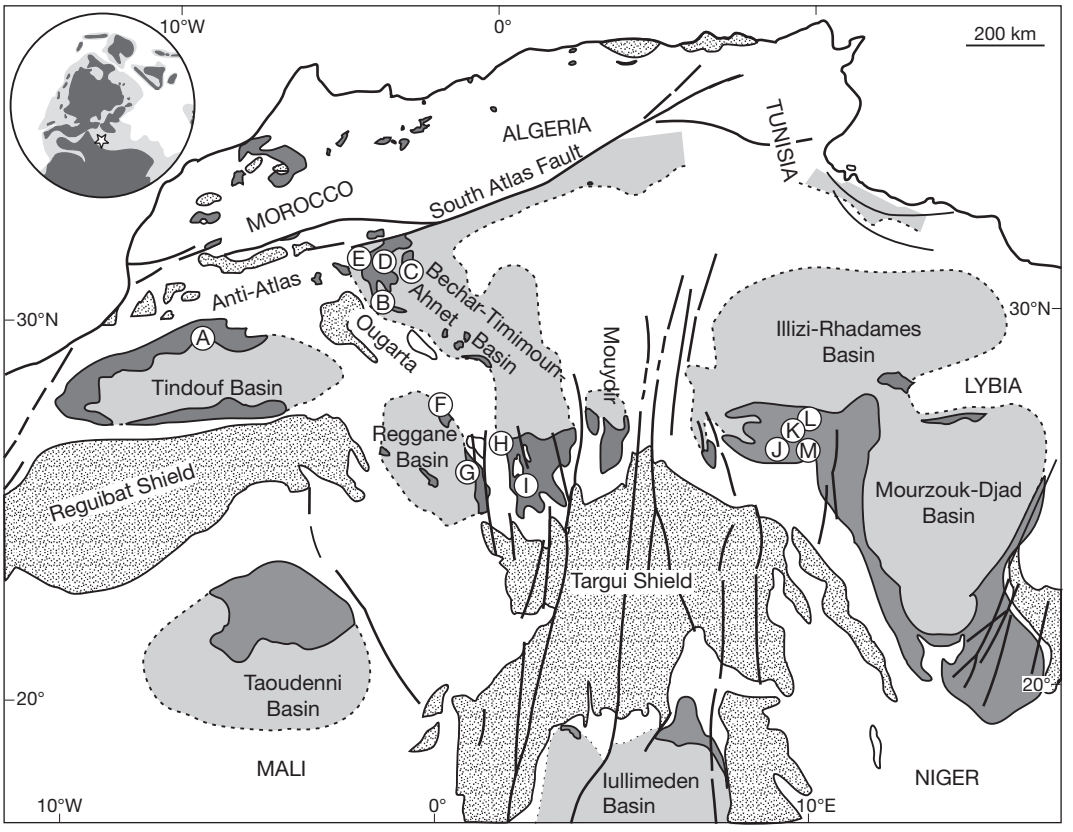


FIG. 1. — Overview on the distribution of the Carboniferous strata in North Africa and the studied outcrops (modified from Conrad [1985]). Localities: **A**, Foum Defili; **B**, Djorf el Morhabar Nord, El Hariga, S. Oglat Hamia; **C**, Goumirats; **D**, El Aouedj, Djenien; **E**, Chebket Mennouna; **F**, El Ahmar; **G**, South of Taïbine; **H**, Djebel Berga; **I**, Tirechoumine; **J**, Assekaifaf; **K**, South of Oued Oubarakat; **L**, Dôme à Collenias; **M**, Ikebrane.

Although the collection represents only a fraction of the expected diversity, the paper aims to 1) describe and illustrate the Carboniferous corals, especially specimens from regions previously not illustrated by Semenoff-Tian-Chansky (1985); and 2) to elucidate the potential and implications for further studies.

GEOLOGICAL SETTINGS

Carboniferous rocks are widely distributed in Northern Africa (Fig. 1). The Carboniferous strata south of the South Atlas Fault were mainly deposited on the African Craton. Their position is controlled by structural features. Structural basins are separated by older cratonised units, but they barely outline the original depositional setting. Their present disposition reflects younger Variscan and Alpine tectonical activities (Conrad 1985). With important temporal and spatial variations, a simplified palaeogeographical model shows an epicontinental sea in large parts of the entire Sahara. The marine successions are most complete towards the margin of the African Craton (e.g., Béchar Basin *sensu lato*), where the Carboniferous transgression started in latest Devonian times (Strunian). Its climax was reached around the Viséan/Serpukhovian boundary, before the final regression subsequently gradually established continental

conditions from the South (early Serpukhovian) to the North (late Moscovian). This large simplified picture is locally more complicated and important variations in facies and thickness occur over short distances (e.g., Béchar Basin *sensu lato*; Pareyn 1961; Malti *et al.* 2008).

SAMPLE LOCATIONS

The corals described in this study cover a stratigraphical interval from Viséan to Bashkirian time and represent almost all Saharan basins (Fig. 1; Appendix 1). It is important to note that in the Algerian Sahara the Viséan is only two-fold; the Algerian early Viséan comprises also the time-equivalents of the European Middle Viséan. The abbreviation "ML" followed by a three or four-digit number indicates the exact horizon Marie Legrand-Blain took the sample from. These accurate locations are indicated in her publications (Legrand-Blain 1978, 1985, 1986) and will be used herein (Fig. 2; Appendix 1).

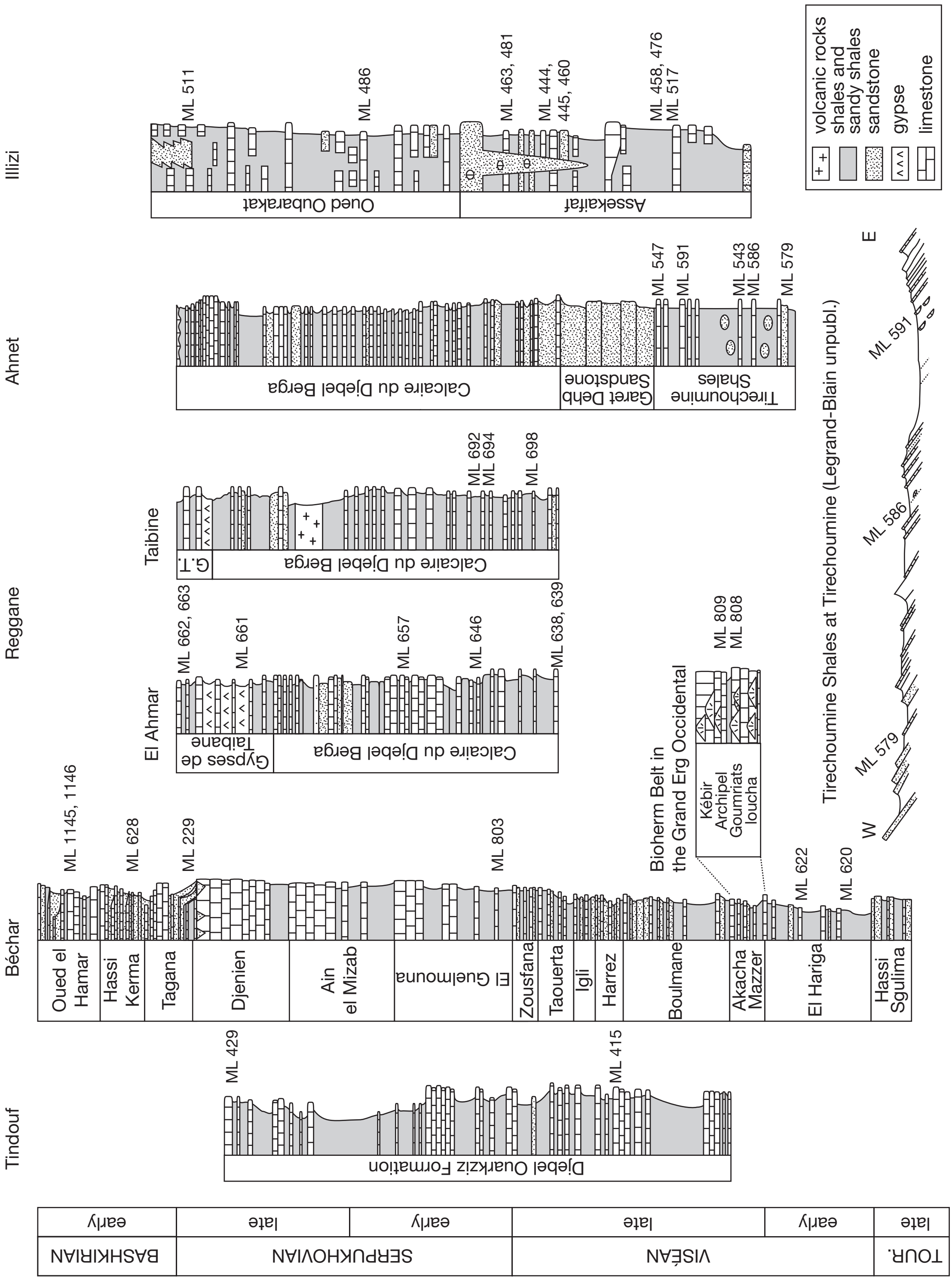
The names of lithostratigraphical units and attributed ages are taken from the existing literature. Properly defined formation names are not available in all regions. The controversial attribution of a Bashkirian age to the Djebel Berga Formation (Wendt *et al.* 2009, 2010) is not followed herein based on the arguments of Legrand-Blain *et al.* (2010).

Samples from the northern flank of the Tindouf Basin are from the Foum Defli section (Fig. 1[A]). Corals are from two limestone horizons of the mixed siliciclastic-carbonate succession of the Djebel Ouarkziz Formation. In the Béchar Basin *sensu lato* Marie Legrand-Blain collected corals from various outcrops. The oldest corals are from lower Viséan rocks in the southern part of the Saoura Valley (Fig. 1[B]). The coral fauna of the late Viséan reefal environments in the Grand Erg Oriental (Fig. 1[C]) is poorly documented with only three specimens. Serpukhovian to lower Bashkirian strata in the central, northern (Fig. 1[D]) and northwestern parts (Fig. 1[E]) of the basin yielded a diversified fauna. In the Reggane Basin corals were collected from the northern section El Ahmar (Fig. 1[F]) and a section in its central part 20 km south of Taïbine (Fig. 1[G]). Both sections represent late Viséan-Serpukhovian calcareous platform sequences. Coral samples from the Ahnet Basin are from thin calcareous levels within the early – late Viséan Tirechoumine Shales at the Djebel Berga and Tirechoumine sections (Fig. 1[H, I]), both situated in the northeastern part of the basin. The Illizi Basin is the eastern-most basin of the Algerian Sahara. It is separated from the western and central basins by the Amguid-El Biod structure. Its isolation may explain some sedimentological and biostratigraphical peculiarities (Legrand-Blain 1985). Late Viséan-Serpukhovian rugose corals from this poorly accessible region are from the sections Assekaifaf (Fig. 1[J]), "South of Oued Oubarakat" (Fig. 1[K]), Dôme à Collenias (Fig. 1[L]), and Ikebrane (Fig. 1[M]) described by Legrand-Blain (1978). Contrary to Lys in Legrand-Blain (1983), horizon ML 511 is Serpukhovian and not Bashkirian in age based on brachiopod (Legrand-Blain 1985) and coral data (herein).

INSTITUTIONAL ABBREVIATIONS

BGS	British Geological Survey, Keyworth;
BM	British Museum (Natural History), London;
DPM	Departamento de Paleontología, Universidad Complutense de Madrid;
GM SAD	Geological Museum, Academy of Science, Donetz;
MNHN	Muséum national d'Histoire naturelle, Paris;
KM	Kelvingrove Museum, Glasgow;
SM	Sedgwick Museum, University of Cambridge;
UMO	University Museum Oxford.

FIG. 2. — Overview of the stratigraphical intervals containing corals in the studied basins. The ML numbers give the approximate position of the sampled horizons. The successions are simplified and there is no precise correlation between the basins. See Appendices for more detailed information. The sketch of the Tirechoumine section is not to scale. Modified from Legrand-Blain 1978, 1985a, 1986. Abbreviation: **Tour.**, Tournaisian.


Tindouf
Béchar
Reggane
El Ahmar
Taibine
Ahnet
Illizi
Djebel Ouarkziz Formation
ML 429
ML 415
Oued el Hamar
Hassi Kerma
Tagana
Djenien
Ain el Mizab
El Guelmouna
Zousfana
Taouerta
Igli
Harrez
Boulmane
Akacha Mazzer
El Hariga
Hassi Sgulima
ML 1145, 1146
ML 628
ML 229
ML 803
ML 622
ML 620
Bioherm Belt in the Grand Erg Occidental
Kébir
Archipel
Goumriats
Ioucha
ML 809
ML 808
Gypses de Taibane
Calcaire du Djebel Berga
ML 662, 663
ML 661
ML 657
ML 646
ML 638, 639
G.T.
ML 692
ML 694
ML 698
Garet Dehb Sandstone
Tirechoumine Shales
ML 547
ML 591
ML 543
ML 586
ML 579
Tirechoumine Shales at Tirechoumine (Legrand-Blain unpubl.)
W
E
Oued Oubarakat
Assekaifaf
ML 511
ML 486
ML 463, 481
ML 444, 445, 460
ML 458, 476
ML 517
volcanic rocks
shales and sandy shales
sandstone
gypse
limestone
TOUR.
VISÉAN
SERPUKHOVIAN
BASHKIRIAN
late
early
late
early
late
early

SYSTEMATIC PALAEONTOLOGY

Although sample numbers are small, which hampers the evaluation of intra-specific variations, systematic descriptions are presented for most taxa. As in many North African coral faunas (Semenoff-Tian-Chansky 1974; Aretz 2010a), well-preserved specimens are rare, and thus external characters are commonly difficult to determine. Samples from the Saoura Valley are in some cases too badly preserved or incomplete for a detailed study and determination.

This study relies on 1) material from the Muséum national d'Histoire naturelle, Paris, studied and partly thin sectioned by P. Semenoff-Tian-Chansky (no additional thin sections have been made); and 2) new material, made available by Marie Legrand-Blain. In some cases no remaining specimen could be located for existing thin sections of Semenoff-Tian-Chansky (Appendix 2). The number of thin sections for each specimen is listed in Appendix 2.

The terminology of morphological characters follows Hill (1981), Poty (1981) and Fedorowski *et al.* (2007) (Fig. 3). The attribution of genera to higher taxonomical levels of Hill (1981) is largely followed in this work. All material is stored in the Muséum national d'Histoire naturelle, Paris, under the numbers MNHN.F.A32948-A33040.

To reduce the lengths of the synonymy lists, only those references have been added, which were not included in recent synonymy list the author agrees with [cum. syn.].

Class ANTHOZOA Ehrenberg, 1834
Subclass RUGOSA
Milne Edwards & Haime, 1850
Order STAURIIDA Verrill, 1865
Suborder STEREOLASMATINA Hill, 1981
Family HAPSIPHYLLIDAE Grabau, 1928
Genus *Amplexizaphrentis* Vaughan, 1906

?*Amplexizaphrentis illizidensis* n. sp.
(Fig. 4A-C)

HOLOTYPE. — Specimen MNHN.F.A32948, Illizi Basin, Assekaifaf Fm, late Viséan (ML 517).

ETYMOLOGY. — For the region were the specimen was found.

TYPE LOCALITY AND TYPE LEVEL. — Assekaifaf section, sample point ML 517, Illizi Basin, East Algeria. Approximate coordinates: 26°58'N, 8°50'E. Assekaifaf Formation, Assekaifaf section, Illizi Basin; late Viséan.

AGE AND OCCURRENCE. — Single specimen from the upper part of the Assekaifaf Formation (late Viséan) in the Assekaifaf section, Illizi Basin.

DIAGNOSIS. — 10 cm long, cylindrical, slightly curved solitary coral with cardinal fossula on its convex side. Maximum diameter 3.4 cm. As many as 53 major septa. No minor septa. Major septa in young stages thick, laterally contiguous and fused axially, short cardinal septum in fossula. In mature stage septa are individualized, cardinal and alar fossulae formed, counter septum long.

DESCRIPTION

External characters

10 cm long cylindrical slightly curved solitary coral. Apex and calice are not preserved. The upper part of the corallite (6 cm) is crushed. The wall is eroded. The cardinal fossula is on the convex side.

Internal characters

The maximal diameter is 3.4 cm. There are as many as 53 major septa, minor septa are lacking. In the smallest section, 3.2 cm in diameter, all septa are thick and laterally contiguous and fused at their axial ends, only the cardinal septum is short. Thus a very compact section appears, with only some open space in the counter quadrants where tabulae become visible. In more distal sections, the thickness of the septa decreased, and they individualize, only in the cardinal quadrants are septa still laterally contiguous and fused at the axis. The septa are slightly sinuous to curved. A marked cardinal fossula around a very short cardinal septum and two alar fossulae occur. The counter septum is long and extends towards the open centre of the corallite. A short polished longitudinal section in the upper part of the corallite does not allow precise observations on the shape of the tabulae.

DISCUSSION

The missing longitudinal section is a shortcoming for the description of the specimen. It shows

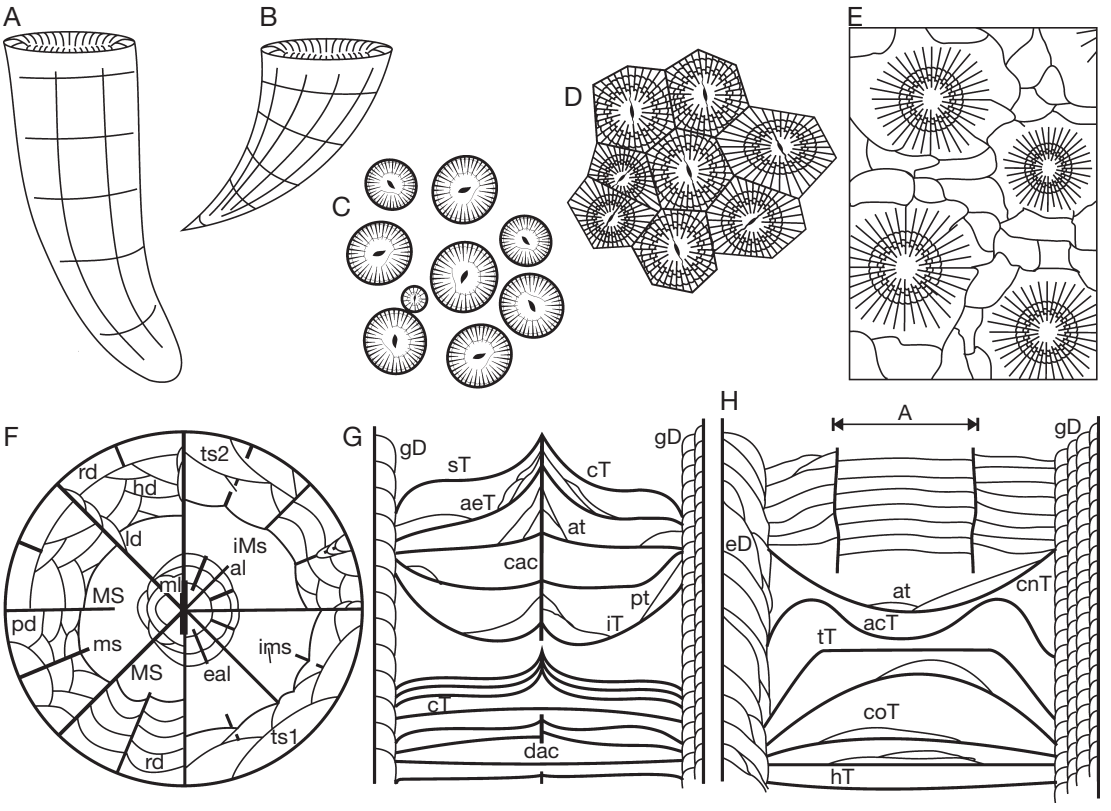


FIG. 3. — Overview of the main descriptive morphological terms for the corals studied herein: **A**-**E**, outer shape; **A**, **B**, solitary corals; **A**, cylindrical; **B**, ceratoid; **C**-**E**, colonial corals; **C**, fasciculate; **D**, cerioid; **E**, aphroid; **F**-**G**, internal characters (colonial and solitary); **F**, transverse section; **G**, longitudinal section with axial structure; **H**, longitudinal sections without axial structure. Abbreviations: Septa: **MS**, major septum; **iMS**, interrupted major septum; **ms**, minor septum; **ims**, interrupted minor septum. Dissepiments: in transverse section: **rd**, regular or concentric; **pd**, pseudoherringbone pattern; **hd**, herringbone pattern; **ld**, lateral; **ts1**, transeptal 1st order; **ts2**, transeptal 2nd order. In longitudinal section: **gD**, globous; **eD**, elongate. Tabulae: **cT**, complete; **iT**, incomplete; **acT**, axial concave; **aeT**, adaxially elevated; **sT**, sigmoidal; **hT**, horizontal; **cnT**, concave; **coT**, convex; **tT**, trapezoid. Tabellae: **pt**, peripheral; **at**, axial. Axial structure: **ml**, median lamella; **al**, axial lamella; **eal**, extraaxial lamella; **cac**, continuous axial column; **dac**, discontinuous axial column. **A**, Aulos. **A**-**E** modified from and inspired by Hill (1981); **F**-**H**, modified from Fedorowski *et al*. (2007).

a good overlap with the specimens assigned to *Saharaphrentis tirechouminoidense* n. gen., n. sp., but it differs from this species by its considerably larger size, the cylindrical corallite shape, and a counter septum not crossing over the centre. In this respect its septal arrangement more resembles mature stages of *Amplexizaphrentis*, but the fossula is not closed and on the convex side. Also the thick septa are unusual for the later genus. The specimen falls into the group of undescribed Hapsiphyllidae from the Illizi Basin of Semenoff-Tian-Chansky (1985).

?*Amplexizaphrentis* sp.
(Fig. 4D, E)

MATERIAL EXAMINED. — 15 specimens MNHN.F.A32949-A32963, the Ahnet Basin, Tirechoumine Shales, late Viséan? (ML 547).

DESCRIPTION

External characters

Up to 5 cm long cylindrical, towards the apex slightly curved solitary corals, preservation is moderate. Calyx commonly abraded, but the better preserved corallites show a depth of at least 6 mm.

Fossula deep and closed on concave side. Growth lines and septal furrows are visible. The maximum diameter is 2.7 cm.

Internal characters
There are a maximum of 41 major septa; minor septa are missing. The cardinal septum is short and in some cases only recognized as a wave in the wall. The cardinal fossula is closed in the centre. The slightly sinuous septa are axially fused. Overall they are thick, but peripherally thinner than axially. In sections near to the base of the calice, many septa are withdrawn from the axis. There are few tabulae in interseptal spaces.

DISCUSSION
There is no section in a stage of less than 1.7 cm diameter. Up to this stage the counter septum is always short, thus the long counter septum in young stages of *Amplexizaphrentis* cannot be demonstrated in this material. Main differences to ?*Amplexizaphrentis illizidensis* n. sp. are the size of the specimens (not more than only one-half), the position of the cardinal fossula on the concave side and less thick septa.

Genus *Zaphrentites* Hudson, 1941

Zaphrentites sp.
(Fig. 4F, G)

MATERIAL EXAMINED. — Specimen MNHN.F.A32964 from ML 458, and two specimens (MNHN.F.A32965, A32966) from ML 476, Illizi Basin, lower Assekaifaf Fm (lower part), late Viséan.

DESCRIPTION
External characters
Up to 4 cm long ceratoid solitary coral. Apex abraded. U-shaped calice *c.* 1 cm deep. Fossula on concave side. Growth lines visible. The maximum diameter is 1.9 cm, for a specimen lacking the wall.

Internal characters
The wall is thick and lamellar. There are 31-35 major septa, minor septa are absent. The cardinal septum is short and lies within a fossula that is closed in the centre of the corallite through fusion of the ends of the other major septa. The septa are relatively thick, but in MNHN.F.A32964 two short and thin septa might be the alar septa, there forming inconspicuous alar fossulae. There are few tabulae.

DISCUSSION
Species determination within the commonly closely related species of *Zaphrentites*, like *Z. delanouei* Milne Edwards & Haime, 1851 or *Z. parallelus* Carruthers, 1910, requires more than one transverse section per specimen. However, the available sections much resemble sections in the upper part of *Zaphrentites delanouei*, and thus the studied specimens are believed to tend to this or a closely related species.

Family ZAPHRENTOIDIDAE Schindewolf, 1938
Genus *Zaphrentoides* Stuckenberg, 1895

Zaphrentoides sp.
(Fig. 4H)

MATERIAL EXAMINED. — Seven specimens MNHN.F.A32967-A32973, Ahnet Basin, lower part of Tirechoumine Shales, early Viséan? (ML 579).

DESCRIPTION
External characters
Up to 5 cm long ceratoid to trochoid solitary coral. Calice not reported. Fossula on convex side. Growth lines visible. The maximum diameter is 1.8 cm.

Internal characters
The wall is thick. There are as many as 38 major septa, minor septa are absent. In young stages, all septa are thick, laterally contiguous and fused; the cardinal septum is slightly shorter than the other septa. Higher in the corallite the septa of the counter quadrants become thinner and start to individualize from the zone around the counter septum onward. In mature stages the cardinal septum is short and lies within a fossula that is closed in the centre of the corallite through fusion of the ends of the major septa of the cardinal

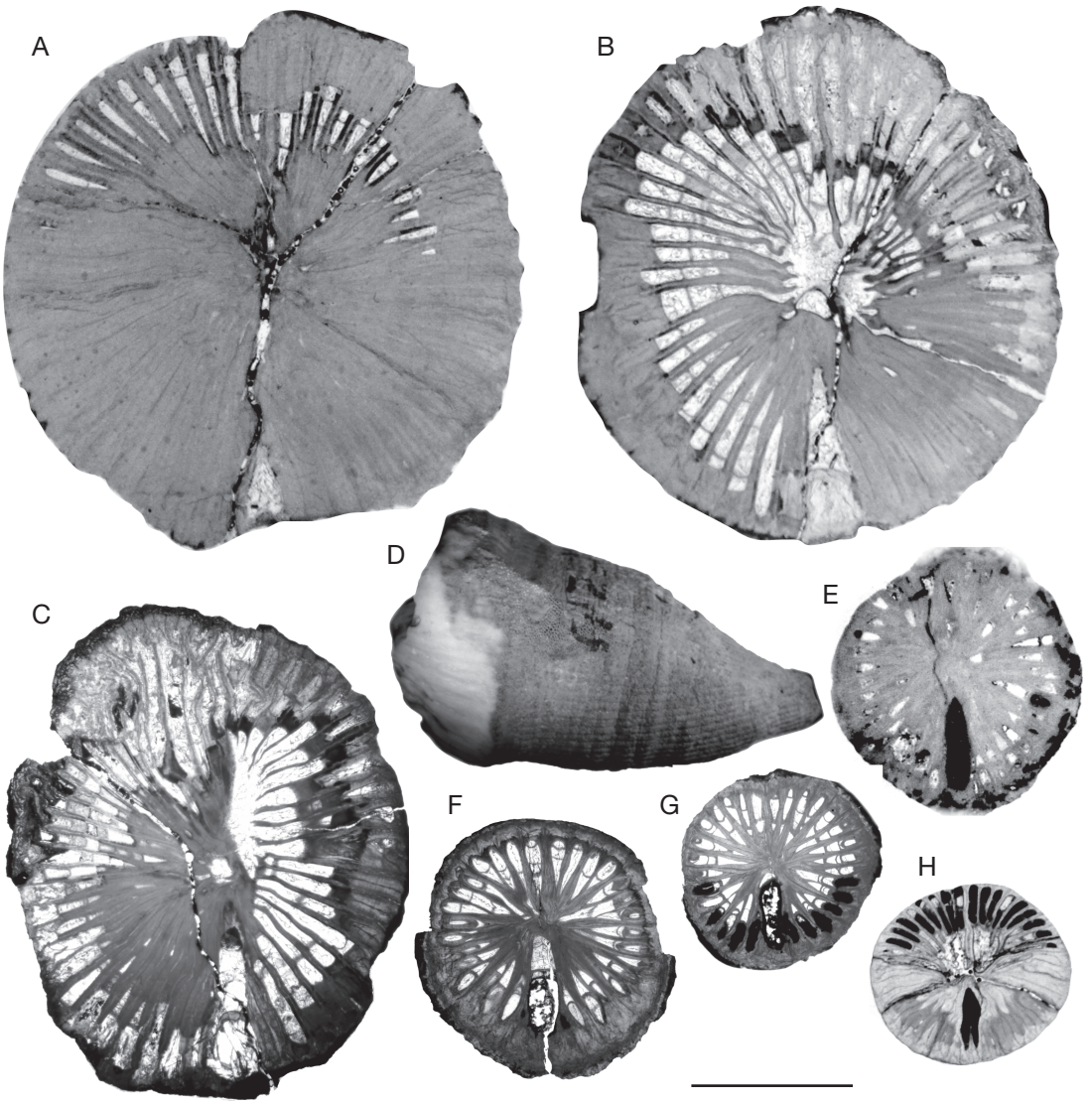


FIG. 4. — **A**-**C**, ?*Amplexizaphrentis illizidensis* n. sp., holotype (MNHN.F.A32948), 3 transverse sections; **D**, **E**, ?*Amplexizaphrentis* sp.; **D**, whole specimen (MNHN.F.A32956); **E**, transverse section (MNHN.F.A32958); **F**, **G**, *Zaphrentites* sp., transverse sections (MNHN.F.A32964 and A32965); **H**, *Zaphrentoides* sp., transverse section (MNHN.F.A32967). Scale bar: 10 mm.

quadrants. Septa of the counter quadrants are rarely attached. Septa in the cardinal quadrants are thick and laterally contiguous. Septa in the counter quadrants are thinner and individualized. The counter septum is long. There are few tabulae.

DISCUSSION

The studied specimens show clearly the characteristics of the genus, but have not been assigned to a species. The variability observed in the thin sections advocates for more material from this locality to identify and test inter- and intra-specific variabilities.

?Family ZAPHRENTOIDIDAE Schindewolf, 1938

Genus *Saharaphrentis* n. gen.

TYPE SPECIES. — *Saharaphrentis tirechouminoidense* n. gen., n. sp. by present designation.

ETYMOLOGY. — The genus name refers to the Sahara, and *-phrentis* for zaphrentoid coral.

DISTRIBUTION AND AGE. — Tirechoumines Shales, Ahnet Basin; late Viséan.

DIAGNOSIS. — Medium-sized, ceratoid solitary coral of up to 2.4 cm in diameter. Deep fossula on convex side. There are as many as 49 major septa. Minor septa visible only in late mature stage in the stereoplasm zone. In young stages, major septa thick and laterally contiguous, fused at their axial ends. Septa of variable length and commonly curved. Cardinal septum short in closed fossula. In the later stages, major septa individualized, sinuous and thicker in the cardinal quadrants. Cardinal fossula closed within the cardinal quadrants. The complexity and number of fused septa vary but generally decrease towards the calice. Counter septum is long and commonly fused with the axial ends of the other major septa. Incomplete tabulae, which rise towards the center.

DISCUSSION
The genus is ranged with doubts in the Zaphrentoididae. It shows many characters of the family, but its long counter septum and the cardinal fossula not reaching the centre are unusual.

Saharaphrentis tirechouminoidense n. sp.
(Fig. 5A-F)

HOLOTYPE. — Specimen MNHN.F.A32974.

PARATYPES. — Specimen MNHN.F.A32975, uncut specimens MNHN.F.A32976-A32978.

ETYMOLOGY. — For the Tirechoumine section where Marie Legrand-Blain collected the specimens.

TYPE LOCALITY AND TYPE STRATUM. — Tirechoumine section (ML 586) north of the Oued Tirechoumine, limestone bed in the upper Tirechoumine Shales, Ahnet Basin, Algeria. Approximate coordinates: 26°13'58"N, 1°55'52"E. Tirechoumine Shales, late Viséan.

DIAGNOSIS. — As for the genus.

DESCRIPTION
External characters
Up to 4.5 cm long, ceratoid solitary coral. Growth lines well visible. Apex not preserved, calice strongly abraded. Deep fossula on convex side.

Internal characters
The maximal diameter is 2.4 cm. There are a maximum of 49 major septa, minor septa only visible in the wall of late mature stages. In young stages, 1.2 and 1.4 cm in diameter, septa are thick and laterally contiguous and fused at their ends. The septa are of variable length and commonly curved. The cardinal septum is short in a fossula. In mature sections, the septa start to individualize, leaving few open interseptal spaces. The wall is thick and corresponds to a stereoplasm zone, which contains minor septa. The septa are sinuous and thicker in the cardinal quadrants. A cardinal fossula is closed in the cardinal quadrants. The number of fused septa varies but generally decreases towards the calice. The counter septum is long and commonly extends over the centre of the corallite to fuse with the other major septa. In sections near to the calice it is individualized. In the longitudinal section there are incomplete tabulae, which rise with 20-45° towards the centre where they become flat. Near to the thick wall in few cases the tabulae are depressed.

DISCUSSION
Semenoff-Tian-Chansky (1985) mentioned the dominance of *Zaphrentoides* from the Timimoun Shale in the Gourara area. These specimens have not been located, and may also correspond to this new species.

Saharaphrentis cf. ***tirechouminoidense***
(Fig. 5G)

MATERIAL EXAMINED. — Specimen MNHN.F.A32979, Illizi Basin, middle Oued Oubarakat Fm, late Serpukhovian (ML 486).

DESCRIPTION
External characters
4 cm long, ceratoid solitary coral. Specimen completely embedded in glue. Growth lines visible. Apex and calice not preserved. Fossula on convex side.

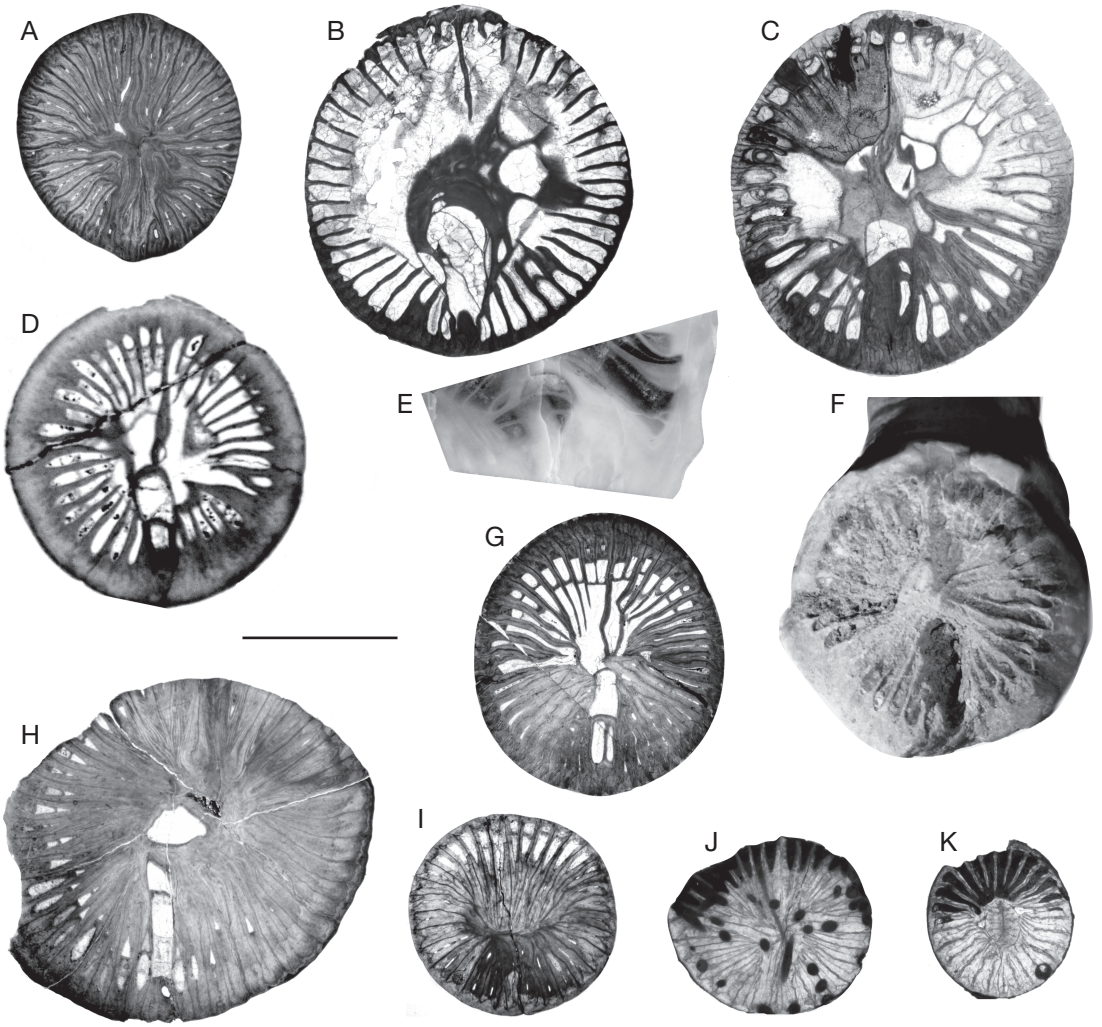


FIG. 5. — **A**-**F**, *Saharaphrentis tirechouminoidense* n. gen., n. sp.; **A**-**C**, holotype (MNHN.F.A32974), transverse sections; **D**, paratype (MNHN.F.A32975), transverse section; **E**, paratype (MNHN.F.A32975), longitudinal section; **F**, uncut specimen (MNHN.F.A32976); **G**, *Saharaphrentis* cf. *tirechouminoidense*, transverse section (MNHN.F.A32979); **H**, Stereolasmatina gen. indet. 1 sp. indet. 1, transverse section (MNHN.F.A32980); **I**, Stereolasmatina gen. indet. 2 sp. indet. 1, transverse section (MNHN.F.A32981); **J**, Stereolasmatina gen. 2 indet sp. 1 indet, transverse section (MNHN.F.A32982); **K**, *Lophophyllidium* sp., transverse section (MNHN.F.A32984). Scale bar: 10 mm.

Internal characters

The maximal diameter is 1.9 cm. There are a maximum of 41 major septa, minor septa are visible in the wall. Major septa are thick and laterally contiguous in the cardinal quadrants, and thin and individualized in the counter quadrants. The axial ends are fused in the corallite centre. The cardinal septum is short and lies in a closed fossula. The counter septum is long and fused to the other major septa. Few tabulae appear in interseptal spaces of the abraded calice.

DISCUSSION

The section strongly resembles intermediate stages of *Saharaphrentis tirechouminoidense* n. gen., n. sp. before all septa are individualized. Due to the absence of a section in the younger stages, showing the fusion of all septa, the specimen is attributed with cf.

Stereolasmatina gen. indet. 1 sp. indet. 1
(Fig. 5H)

MATERIAL EXAMINED. — Specimen MNHN.F.A32980, Illizi Basin, lower Assekaifaf Fm (lower part), late Viséan (ML 517), transverse section just below calice.

DESCRIPTION
External characters
4.5 cm long, ceratoid solitary coral. Apex is not preserved, calice largely eroded and at least 0.8 cm deep. Fossula on concave side.

Internal characters
The maximal diameter is 2.7 cm. There are a maximum of 45 major septa and no minor septa. The major septa are all thick and laterally contiguous. The cardinal septum is very short. The fused ends of the 4-6 septa left and right of the cardinal septum close the fossula, but a further central open space (3 mm in diameter) is present above the closed fossula due to the fusion of the other septa. In the right half of the corallite, septa are less thick in their lower part and few tabulae become visible in the interseptal spaces.

DISCUSSION
The very compact organization of this coral in a presumably mature stage may point towards *Sochkineophyllum.* It also resembles genus and species indet. from southern Spain figured by Rodriguez & Falces (1992: pl. 15, figs 3, 4). There is also some resemblance to young stages of *?Amplexizaphrentis illizidensis* n. sp. from the same horizon, but that specimen does not show the second open central space. The second open central space could indicate the tendency of the septa to withdraw from the axial structure.

Stereolasmatina gen. indet. 2 sp. indet. 1
(Fig. 5I, J)

MATERIAL EXAMINED. — Specimens MNHN.F.A32981 and A32982, Ahnet Basin, Tirechoumine Shales (lower part), early Viséan? (ML 579).

DESCRIPTION
External characters
Small-sized ceratoid solitary corals (2.5 cm long). Calice not preserved. Wall absent in both specimens, MNHN.F.A32982 strongly eroded. Fossula on convex side.

Internal characters
The maximal diameter is 1.5 cm. There are a maximum of 34 major septa and no minor septa. The septa are all thick and mostly laterally contiguous, interseptal space occurs only in the counter quadrants. The cardinal septum is short. In MNHN.F.A32981 the fused ends of the 4-6 septa left and right the cardinal septum close the fossula well within the cardinal quadrants, the other septa are twice as long and also attached to that structure. Thus a semicircular arrangement of the fused axial ends of the septa is observed. In MNHN.F.A32982 the septa are more equal and no circular arrangement is seen.

DISCUSSION
It is unclear if these specimens are juveniles or represent mature stages. Thus they are kept in open nomenclature. The septal arrangement in MNHN.F.A32981 has not been documented in MNHN.F.A32982.

Suborder PLEROPHYLLINA Sokolov, 1960
Family LOPHOPHYLLIDA Grabau, 1928
Genus *Lophophyllidium* Grabau, 1928

Lophophyllidium sp.
(Fig. 5K)

MATERIAL EXAMINED. — Two transverse thin sections from MNHN.F.A32983 and A32984, Ahnet Basin, lower part of Tirechoumine Shales, early Viséan? (ML 579).

DESCRIPTION
The corallites are 1.0 and 1.2 cm in diameter. The smooth wall is 0.3-0.5 mm thick. There are 27-32 major septa. There are no minor septa or dissepiments. The septa are sinuous and fused in the cardinal quadrants. In MNHN.F.A32983 all septa are thick, whereas in MNHN.F.A32984 they are only thickened in the cardinal quadrants, where they form a single compact unit. The septa are variable in length, and some may be attached to the axial structure. The cardinal septum is shorter than the

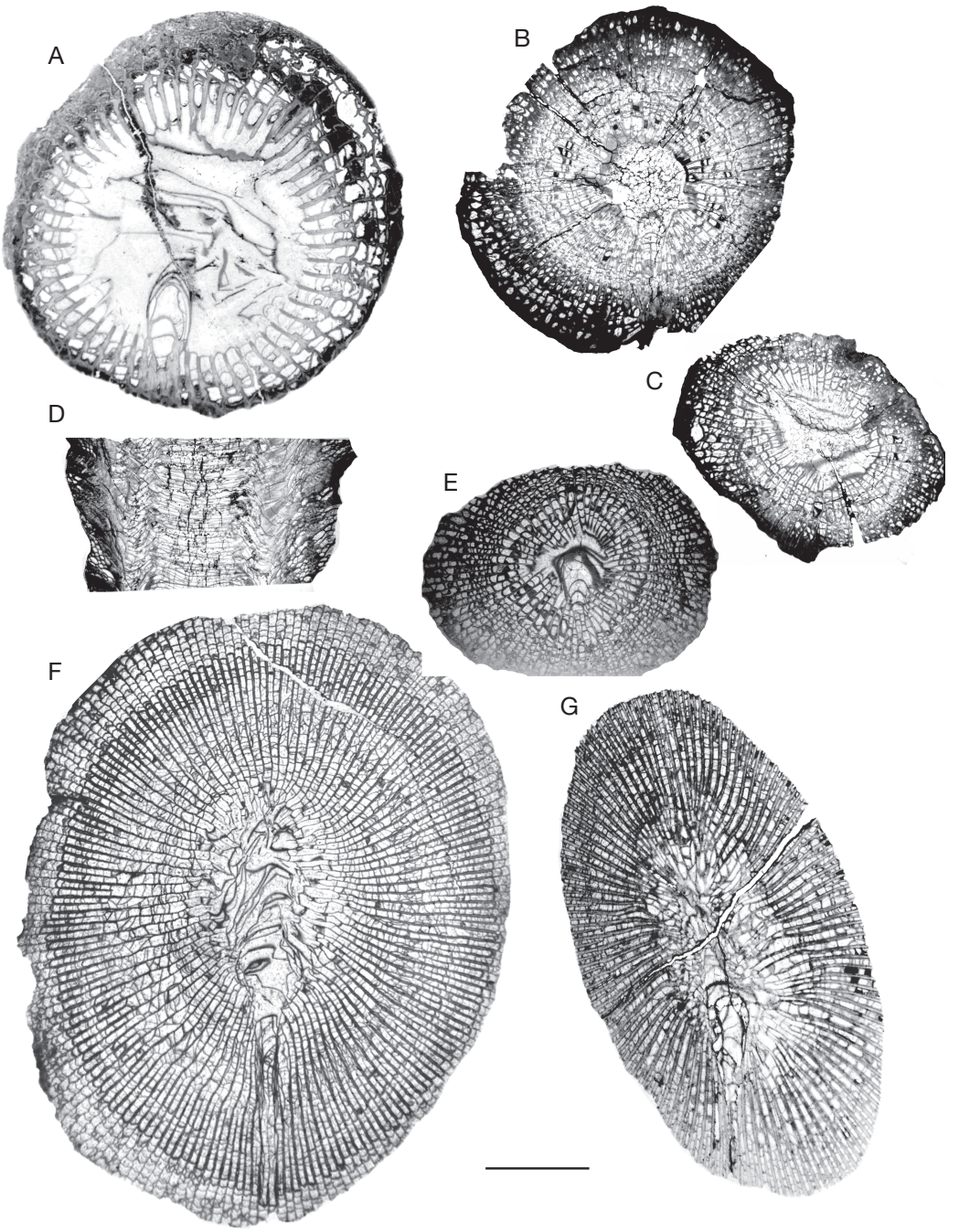


FIG. 6. — **A**, *Siphonophyllia samsonensis* (Salée, 1913), transverse section (MNHN.F.A32985); **B**-**D**, *Haplolasma paraarciferum* n. sp.; **B**, holotype (MNHN.F.A32986); **B**, **C**, 2 transverse sections; **D**, longitudinal section; **E**, *Haplolasma* aff. *paraarciferum*, transverse section (MNHN.F.A32987); **F**, *Palaeosmilia murchisoni* Milne Edwards & Haime, 1848, transverse section (MNHN.F.A32988); **G**, *Palaeosmilia* sp., transverse section (MNHN.F.A32990). Scale bar: 10 mm.

other septa. In MNHN.F.A32983 a fossula developed around a shorter counter septum. This is the only place, where tabulae may be intersected. The axial structure is 3 mm in diameter and consists of a thickened (?) median lamella and 6-10 septal lamellae on each side. The elements of the axial structure are contiguous and form a single compact unit.

Discussion

Due to the absence of the specimens, and thus the uncertainty about the ontogeny the specimens are not attributed to a species. The overall structure of the specimens is similar, although some differences exist in respect to the thickening of septa and the development of a counter fossula.

Suborder CANINIINA Wang, 1950
Family Cyathopsidae Dybowski, 1873
Genus *Siphonophyllia* Scouler *in* McCoy, 1844

Siphonophyllia samsonensis (Salée, 1913)
(Fig. 6A)

Caninia samsonensis Salée, 1913: 48, pl. D, fig. 1.

Siphonophyllia samsonensis – Aretz 2010a: 326, fig. 4A-F. [cum. syn.].

Holotype. — The specimen figured by Salée (1913: pl. D-1) has been recently found by Poty and is now housed in the collection at Liège.

Type locality and type level. — Thon-Samson, Belgium; lower upper Viséan.

Age and occurrence. — Although a well known species in the late Viséan of Europe and North Africa, the record from the Illizi Basin is the first in the Serpukhovian.

Diagnosis. — See Poty (1981).

Material examined. — 5 thin sections from specimen MNHN.F.A32985, Illizi Basin, lower Assekaifaf Fm (upper part), early Serpukhovian, (ML 463).

Description

Internal characters

Solitary coral of large diameter. Only one thin section shows a small part of the wall, the dissepimentarium is in all thin section at least partly eroded. The maximal diameter is 5.0 cm. The undulating wall is relatively thick (0.5 mm). There are as many as 60 major septa of variable lengths (1-1.5 cm). They invariably leave a large open central space (max. 2.7 cm). The major septa are straight and stereoplasmatic thickenings are common. Two trends can be seen. First, the thickness is significantly higher in the tabularium than in the dissepimentarium. Second, the thickness decreases towards the calice. In the smallest sections the thick septa are touching each other in the tabularium, whereas in the largest sections there are five times thinner and large open spaces exist between them.

Minor septa are short and discontinuous, and mostly reduced to spines on dissepiments. A cardinal fossula is invariably present; in two of four transverse sections the shortening of an alar septum may indicate an alar fossula. The counter septum is inconspicuous. The dissepimentarium consists of an inner regular part and an outer part with transeptal dissepiments of both orders. Its width in the longitudinal section is 8 mm. There are several rows of elongate (2-6 mm) and steeply inclined dissepiments. Tabulae are complete. In the axial part they are flat and continue into a peripheral depression. Within this depression stereoplasm may be observed.

Discussion

This specimen fits well into the variability of the species (see Dixon 1970; Aretz 2010a). The age of the sample is problematical, because this species has so far not been found in the Serpukhovian in Europe and North Africa, as already stated by Semenoff-Tian-Chansky (1985). However, the discrepancy of ages based on macrofossils and microfossils can be highlighted in other parts of the Sahara as well (e.g., Legrand-Blain 1978; Wendt *et al.* 2009).

?Genus *Haplolasma*
Semenoff-Tian-Chansky, 1974

Remark

Semenoff-Tian-Chansky (1974) placed the genus into the Cyathopsidae whereas Hill (1981) placed it with a question mark into the Aulophyllidae subfamily Dibunophyllinae. In the latter case *Haplolasma* could be interpreted as a *Koninckophyllum* without any trace of an axial structure. However,

the attribution of Hill (1981) is not followed herein, because important characters for the attribution to the Aulophyllidae, like the presence of at least rudimentary and discontinuous axial structure, are not found in *Haplolasma*. Note that Boland (2001) and Rodriguez *et al*. (2001) used the original attribution of Semenoff-Tian-Chansky.

Haplolasma paraarciferum n. sp.
(Fig. 6B-D)

HOLOTYPE. — Specimen MNHN.F.A32986 (ML 444bis).

MATERIAL EXAMINED. — Specimen MNHN.F.A32986, Illizi Basin, Assekaifaf Fm, early Serpukhovian (ML 444bis).

TYPE LOCALITY AND TYPE STRATUM. — Section "South of Oued Oubarakat", circular structure 2 of Megartsi (1972), sample point ML 444bis, Illizi Basin, East Algeria, Approximate coordinates: 27°00'19"N, 9°16'23"E. Upper part of the Assekaifaf Formation, early Serpukhovian.

AGE AND OCCURRENCE. — The single specimen is from early Serpukhovian strata of the Illizi Basin; "South of Oued Oubarakat" section, upper part of the Assekaifaf Formation.

ETYMOLOGY. — For the resemblance to the species *H. arciferum* Semenoff-Tian-Chansky, 1974.

DIAGNOSIS. — *Haplolasma* with relatively long straight to sinuous minor and major septa. The minor septa are about ½ as long as major septa. Septa are strongly dilated in the tabularium. A cardinal fossula is developed. The outer dissepimentarium is irregular and contains pseudoherringbone and transeptal dissepiments. In this part the septa are strongly sinuous. The inner dissepimentarium is more regular. At the base of the tabularium all skeletal elements are thickened by stereoplasm. Dissepiments are globose to elongate. They reach their maximal inclination towards the tabularium (max. 45°). Tabulae are complete and incomplete, flat to slightly concave in the axial zone, downturned at the periphery. A peripheral depression is formed by tabulae and peripheral tabellae. Spacing of the tabulae is dense (19/cm). The tabulae are thickened by stereoplasm.

DESCRIPTION

External characters

3.5 cm long cylindrical fragment of solitary coral, slightly curved. Apex and calice are not preserved. The corallite is partly enclosed in limestone matrix, other parts are eroded and show septa and dissepiments. The overall shape of the corallite is oval, but some important irregularities are observed. The maximum diameter is 3.5 cm.

Internal characters

The wall is relatively thick (0.5 mm) and smoothly undulates. Several irregularities (notches) affect the wall and dissepimentarium. There are as many as 60 major septa. The major septa are slightly sinuous, and do not reach the centre, thus leaving an open central space of 6-7 mm in diameter, in the younger stage the open space is somewhat larger. The cardinal septum is shorter than the other major septa and occurs in a fossula. Major septa are twice as thick in the tabularium as in the dissepimentarium. Minor septa are thin and end within the dissepimentarium. They are about one-half as long as the major septa, although some are slightly longer. The irregular outer dissepimentarium is up to 5 mm wide and contains dissepiments in pseudoherringbone patterns as well as some transeptal dissepiments. The septa become very curved in this part of the dissepimentarium. The inner dissepimentarium is more regular. At the base of the tabularium all skeletal elements are thickened by stereoplasm. In the longitudinal section the dissepimentarium is composed of numerous rows of globose to elongate dissepiments. Their inclination increases towards the tabularium (max. 45°). The tabularium contains complete and incomplete tabulae. In the axial zone they are flat to slightly concave. In the peripheral zones, tabulae are downturned. With a series of peripheral tabellae they form a peripheral depression. There are 19 tabulae per 1 cm. The tabulae are considerably thickened by stereoplasm, which also occurs on dissepiments at the inner edge of the dissepimentarium.

DISCUSSION

The evaluation of the inter-specific variability of Northern African species grouped in the genus *Haplolasma* is strongly hampered by the low number of specimens, and thus they may present only extreme or intermediate morphotypes of the same or another *Haplolasma* species.

Because this problem cannot be solved with the available specimens, the concept of Semenoff-Tian-Chansky (1974) for differentiating species is used herein and thus the new species is erected. The specimen from the Illizi Basin shares many similarities with the single specimen from the upper Viséan of Ioucha (eastern Béchar Basin) described by Semenoff-Tian-Chansky (1974) under the name *H. arciferum*. Main differences are a less complicate and irregular dissepimentarium, somewhat shorter minor and major septa, a wider dissepimentarium, less steeply inclined dissepiments, and the wide spread stereoplasmatic thickenings. As for *H. arciferum*, the complexity of the dissepimentarium is also for *H. paraarciferum* n. sp. an important criterion to differentiate from *H. parvicarinatum* Semenoff-Tian-Chansky, 1974. However, the presence of an aulos in younger stages as in the latter species could not be determined due to the absence of a section in the younger stages of the corallite.

Haplolasma aff. ***paraarciferum*** n. sp.
(Fig. 6E)

MATERIAL EXAMINED. — Specimen MNHN.F.A32987, Illizi Basin, Assekaifaf Fm, early Serpukhovian (ML 445).

DESCRIPTION

Internal characters

No wall preserved, outer dissepimentarium largely eroded. The maximum preserved diameter is 3 cm. There are 53 slightly sinuous major septa that are dilated in the tabularium. They leave an open central space, 5 mm in diameter. A cardinal fossula is developed. Minor septa end at the base of the tabularium. The dissepimentarium consists of numerous rows of dissepiments, which become more irregular towards the periphery. However, no transeptal dissepiments were found. In the longitudinal section the dissepimentarium is composed of numerous rows of globose to elongate dissepiments. Their inclination increases towards the tabularium (max. 80°). The tabularium contains complete and incomplete tabulae. In the axial zone they are flat to slightly concave. In the peripheral zones, tabulae are downturned. With few peripheral tabellae they locally form peripheral depressions.

DISCUSSION

The specimen shares similarities with *H. arciferum* and *H. paraarciferum* n. sp. The lack of the outer dissepimentarium makes a definitive attribution impossible, but the observed wide dissepimentarium makes an "*arciferum*-styled" dissepimentarium very unlikely for this specimen. The supposed ratio number of septa/diameter is also slightly smaller. The specimen differs from *H. paraarciferum* n. sp. by the significantly steeper declined dissepiments, the wider dissepimentarium, the less abundant stereoplasmatic thickenings and less marked peripheral depressions of the tabulae.

Suborder AULOPHYLLINA Hill, 1981
Family PALAEOSMILIIDAE Hill, 1940
Genus *Palaeosmilia*
Milne Edwards & Haime, 1848

Palaeosmilia murchisoni
Milne Edwards & Haime, 1848
(Fig. 6F)

Palaeosmilia murchisoni Milne Edwards & Haime, 1848: 261. — Conrad 1984: pl. 10, fig. 2. — Aretz 2010a: 327, fig. 4h [cum. syn.]. — Legrand-Blain *et al.* 2010: fig. 1c. — Poty 2010: fig. 4c, d.

HOLOTYPE. — Specimen BM 48398, Bowerbank Collection.

TYPE LOCALITY AND TYPE LEVEL. — Frome, Somerset, UK; Viséan. Doubts about the age and locality were summarized by Hill (1940).

AGE AND OCCURRENCE. — This species is known from the early Viséan to Serpukhovian in Europe and North Africa (see e.g., Aretz 2010a; Mitchell 1989; Semenoff-Tian-Chansky 1974).

MATERIAL EXAMINED. — Specimens MNHN.F.A32988 and MNHN.F.A32989, Reggane Basin, Hassi Taïbine Gypsum (lower part), late Serpukhovian (ML 661).

DIAGNOSIS. — See Semenoff-Tian-Chansky (1974).

DESCRIPTION

External characters

Fragments of mature stages of large-sized cylindrical, in some cases slightly curved solitary corals

(max. 7.5 cm high); apexes and calices are not preserved; the wall and outer dissepimentarium are eroded.

Internal characters

The maximal diameter is 6.0 cm. In the mature stages there are 74-92 major septa. Major septa are straight to slightly sinuous and reach towards the open central space. Most septa are thickened in the tabularium. Towards the axis their thin ends are commonly strongly curved and septa may touch each other. Minor septa penetrate into the tabularium. Their lengths can only be estimated and seems to be in the order of ½ to ⅔ as long as the major septa. A marked deep cardinal fossula is developed. The dissepimentarium is regular and consists of numerous rows of globose dissepiments. Their sizes vary.

DISCUSSION

All specimens fall into the intra-specific variability of this well-known species described by Semenoff-Tian-Chansky (1974).

Palaeosmilia sp. (Fig. 6G)

MATERIAL EXAMINED. — Specimens MNHN.F.A32990-A32994, Illizi Basin, upper Oued Oubarakat Fm, late Serpukhovian (ML 511).

DESCRIPTION

External characters

Fragments of mature stages of large-sized cylindrical, in some cases slightly curved solitary corals (max. 7.5 cm high); apexes and calices are not preserved; the wall and most parts of the dissepimentarium are eroded. The maximal diameter is 5.5 cm.

Internal characters

There are 75-98 major septa. Major septa are straight to slightly sinuous and reach towards the open central space. Towards the axis their thin ends are commonly strongly curved and septa may touch each other. Minor septa penetrate into the tabularium. A deep cardinal fossula and a counter fossula are developed. The innermost dissepimentarium is regular, but most parts of the dissepimentarium lack.

DISCUSSION

Semenoff-Tian-Chansky (1985) highlighted the counter fossula and the large number of septa and differentiated these specimens from *P. murchisoni* Milne Edwards & Haime. In doing this, the stratigraphical value of the latter species for the Serpukhovian in the Sahara basins could be maintained and the youngest palaeosmilids in the supposedly Bashkirian strata of the Illizi Basin belong to a different species (Semenoff-Tian-Chansky 1985).

This approach is only partly followed here. A separation from *P. murchisoni* based on the larger number of septa cannot be upheld, because the numbers are not different from typical *P. murchisoni*. More important is the presence of a counter fossula. This could be a criterion to differentiate a new species, but Semenoff-Tian-Chansky (1974) already noted that in some specimens of *P. murchisoni* the counter septum and neighbouring minor septa may show important variations in lengths and arrangement. Thus the formation of a counter fossula could be an end point of this trend and the other end point would be a long counter septum. However, its evaluation requires more and better preserved material.

In any case, the poor preservation makes an adequate description of the specimens difficult and thus also hampers its species affiliation.

Family AULOPHYLLIDAE, Dybowski, 1873
Subfamily AMYGDALOPHYLLINAE
Grabau *in* Chi, 1935
Genus *Amygdalophyllum* Dun & Benson, 1920

Amygdalophyllum sp.
(Fig. 7A)

MATERIAL EXAMINED. — Specimen MNHN.F.A32995, Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 694).

DESCRIPTION

External characters

Partly eroded 4 cm long fragment of cylindrical solitary coral. Apex and calice are missing. Smooth wall, growth bands are visible. The maximum diameter is 3.0 cm.

Internal characters
The wall is thin. There are as many as 55 major septa. They are slightly sinuous, and they do or do not reach the axial structure. The central space is occupied by an axial structure with a thick median lamella surrounded by numerous axial lamellae and axial tabellae. The cardinal septum is shorter than the other major septa. Major septa are much thicker in the tabularium than in the dissepimentarium. Minor septa are thin and slightly sinuous. They either end at the base of the tabularium or persist as short septal spines. The dissepimentarium contains mostly regular dissepiments. A thin outer dissepimentarium consists of narrow transeptal dissepiments of both orders.

There are several rows of globose dissepiments, which are steeply declined. Tabulae are incomplete, generally inclined and convex. The axial tabellae are numerous, domed or steeply inclined. The thick median lamella is well developed.

Discussion
The axial structure much resembles the "fibrous columella" typical for this genus (Benson & Smith 1923). The specimen shows a septa/diameter ratio in the variability of *A. turbophylloides* Semenoff-Tian-Chansky, 1974, but differs by the connection of major septa to the axial structure and by the presence of transeptal dissepiments. Although the latter are common in the genus (Poty 2007), they had not been described for the Sahara species (Semenoff-Tian-Chansky 1974). This may partly result from the poorly preserved specimens not showing the wall and outer dissepimentarium.

Genus *Espielia* Rodríguez & Hernando, 2005

Espielia columellata Rodríguez & Hernando, 2005 (Figs 9H; 10)

Espielia columellata Rodríguez & Hernando, 2005: 555, figs 2-9, table 1.

?*Lithostrotion* cf. *irregulare* – Aretz 2002a: 193, figs 6.1, 2; 2002b: 113, figs 11.5, 6.

Holotype. — Specimen COL/8-1, DPM.

Type locality and type level. — Sierra del Castillo section, Córdoba province, SW Spain; lower Brigantian (Late Viséan).

Age and occurrence. — In Southern Spain it is described from the lower Brigantian of the Sierra del Castillo Unit (Rodríguez & Hernando 2005). In the Montagne Noire (France) the specimens are from the lowermost Brigantian of Castelsec (Aretz 2002a,b). The genus is for the first time found in North Africa.

Material examined. — Colony fragment MNHN.F.A32996 (7 × 8 × 4 cm), Béchar Basin, Archipel Fm, Niveau Ioucha 14, late Viséan (ML 809).

Diagnosis. — See Rodríguez & Hernando (2005).

Description
External characters
Preservation is bad. The corallum is phaceloid.

Internal characters
The corallite diameter is on average 4-5.5 mm. The thickness of the corallite wall is moderate. There are 20-22 major septa. They are long and mostly reach the amygdallophyllid axial structure, which consists of a prominent median lamella, numerous axial lamellae and stereoplasm. The orientation of the median lamella indicates the cardinal-counter plane. The minor septa are relatively short. Major and minor septa are slightly sinuous. There are 1-2 rows of regular globose dissepiments declined towards the tabularium. Tabulae are incomplete and sigmodial to concave. Scattered peripheral tabellae are developed.

Discussion
The specimen much resembles the two specimens from the Montagne Noire (France), illustrated by Aretz (2002a, b). All three specimens are somewhat smaller than the corals described by Rodríguez & Hernando (2005) and their axial structure seems to be less complex. It is possible that these three specimens represent a separate species, but currently the intraspecific variability is based on only few specimens and thus these three specimens are kept as a small morphotype in the species defined by Rodríguez & Hernando (2005). The axial structure and overall thicker skeletal elements have been used to differentiate *Espielia* and *Siphonodendron* (Rodríguez & Hernando, 2005).

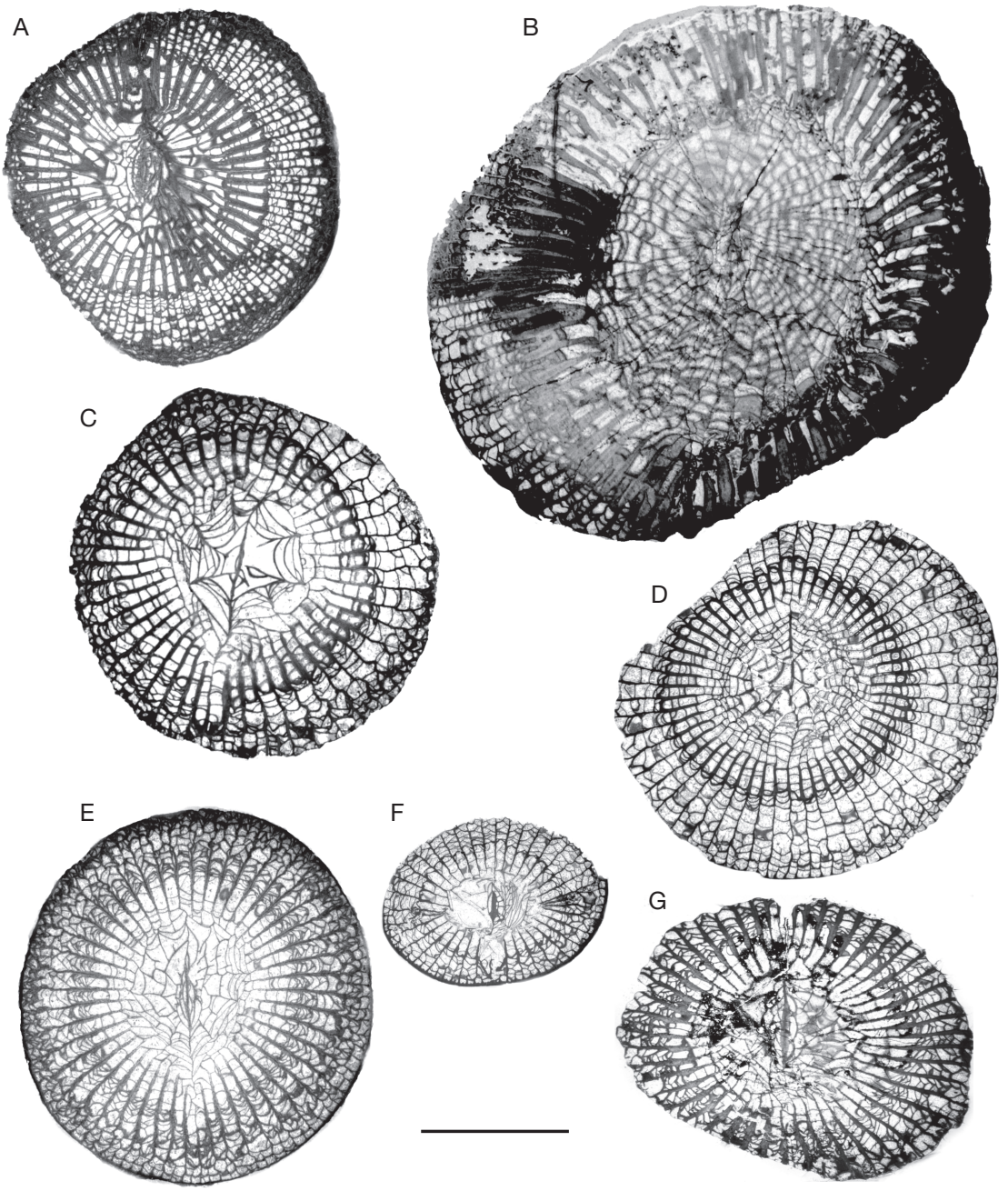


FIG. 7. — **A**, *Amygdalophyllum* sp., transverse section (MNHN.F.A32995); **B**, *Clisiophyllum keyserlingi* McCoy, 1849, transverse section (MNHN.F.A32997); **C**-**E**, *Dibunophyllum bipartitum* (McCoy, 1849); **C**, transverse section (MNHN.F.A33000); **D**, transverse section (MNHN.F.A33002); **E**, transverse section (MNHN.F.A33003); **F**, *Dibunophyllum arachnoforme* Vassiljuk, 1960, transverse section (MNHN.F.A33007); **G**, *Arachnolasma* sp., transverse section (MNHN.F.A33008). Scale bar: 10 mm.

Subfamily CLISIOPHYLLINAE Nicholson, 1889
Genus *Clisiophyllum* Dana, 1846

Clisiophyllum keyserlingi McCoy, 1849
(Fig. 7B)

Clisiophyllum keyserlingi McCoy, 1849: 2. — Poty 1981: 40, fig. 39, pl. 17, figs 6, 7. [cum. syn.]. — Conrad 1984: pl. 10, fig. 4. — Said & Rodríguez 2008: 21, figs 3, 4c, d.

?*Clisiophyllum keyserlingi crassiseptatum* Semenoff-Tian-Chansky, 1974: 70, fig. 24; pl. 10, figs 3, 4; pl. 11, figs 2-5. — Said & Rodríguez 2008: 22, figs 3, 4e-g.

HOLOTYPE. — Specimen SM A2353.

TYPE LOCALITY AND TYPE LEVEL. — Derbyshire, UK; Carboniferous Limestone, late Viséan.

AGE AND OCCURRENCE. — In Europe *Clisiophyllum keyserlingi* is known from the upper Asbian and Brigantian of Ireland and south-western Spain (Rodríguez & Somerville 2007), the upper lower Warnantian = upper Asbian of Belgium (Poty *et al.* 2006), Coral Zone 8 = latest Viséan = Brigantian of Russia (Hecker 2001). In Africa, Semenoff-Tian-Chansky (1974) described the species and subspecies from the Serpukhovian of the Béchar Basin, Said & Rodríguez (2008) added the record from the Brigantien of Adarouch, Morocco for the subspecies.

MATERIAL EXAMINED. — Transverse and longitudinal thin sections from specimens MNHN.F.A32997 and A32998, Illizi Basin, lower Assekaifaf Fm (upper part), early Serpukhovian (ML 481), and specimen MNHN.F.A32999 enclosed in limestone block, Béchar Basin, Oued Amouche 2, Serpukhovian (ML 803).

DIAGNOSIS. — See Hill (1938) and Semenoff-Tian-Chansky (1974)

DESCRIPTION

External characters

Large ceratoid solitary coral. 6.5 cm of the corallite of MNHN.F.A32999 are visible, but no apex and calice. The thin wall is only partly preserved. The maximum diameter is 4.5 cm.

Internal characters

There are up to 70 major septa. A cardinal fossula is developed. The major septa are sinuous and may reach the axial structure. The major septa are thickened, especially in the cardinal quadrants; they are also thicker in the tabularium than in the dissepimentarium. In the smallest specimen (MNHN.F.A32997) the thickening of the septa is lost in the mature stages of the corallite. The minor septa persist into the tabularium. The axial structure is up to 2.5 cm in diameter. It consists of a median lamella surrounded by many axial lamellae and axial tabellae. Regular dissepiments form a narrow zone, max. 0.5 cm width. There are several rows of small, commonly elongate, steeply declined (70-85°) dissepiments. Tabulae are incomplete, slightly inclined (10-20°) and convex or concave. The axial tabellae are numerous (19 per cm), domed or steeply inclined.

DISCUSSION

Semenoff-Tian-Chansky (1974) erected the subspecies *crassiseptatum* for species of *Clisiophyllum keyserlingi* with a wide axial structure and narrow dissepimentarium and thickened major septa. The three studied specimens have these two characters, but the variability within the species is high (Hill 1938). Hill's illustrations (1938: pl. 1) include specimens with thickened septa, especially in early stages and also very different width of the axial structure, and with some respect her figure 6 shows the tendency to *crassiseptatum*. The less inclined tabellae are a difference between the Algerian specimens and those from Morocco figured by Said & Rodríguez (2008). The studied specimens may be attributed to the subspecies, but it is preferred to keep only the species until more detailed comparisons on the variability of the species is known. This cautious attempt is especially necessary, because Said & Rodríguez (2008) attribute to the subspecies a palaeogeographical value for the western Palaeotethys.

Subfamily DIBUNOPHYLLINAE Wang, 1950
Genus *Dibunophyllum*
Thomson & Nicholson, 1876

Dibunophyllum bipartitum (McCoy, 1849)
(Fig. 7C-E)

Clisiophyllum bipartitum McCoy, 1849: 2.

Dibunophyllum bipartitum – Conrad 1984: pl. 10, fig. 3. — Aretz 2010a: 329, fig. 4l. [cum. syn.]. — Legrand-Blain *et al.* 2010: fig. 1g.

LECTOTYPE. — Specimen SM A 1971, W. Hopkins Collection, chosen by Hill (1938).

TYPE LOCALITY AND TYPE LEVEL. — Derbyshire, UK; Lower Carboniferous.

AGE AND OCCURRENCE. — The species is abundant in many late Viséan shallow water carbonate platforms of Europe and locally known in the Serpukhovian. Records for NW Africa are from the Béchar and Adarouch areas (Semenoff-Tian-Chansky 1974; Said *et al.* 2007).

MATERIAL EXAMINED. — MNHN.F.A33000, Tindouf Basin, Ouarkziz Fm (upper part), late Serpukhovian (ML 429), MNHN.F.A33002, Reggane Basin, Hassi Taïbine Gypsum (upper part), late Serpukhovian (ML 662), MNHN.F.A33004 and A33005, Reggane Basin, Hassi Taïbine Gypsum (upper part), late Serpukhovian, (ML 663) and MNHN.F.A33003, A33006, Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 692), MNHN.F.A33001, Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 694) and MNHN.F.A33552, A33553, Reggane Basin, Djebel Berga Limestone, late Viséan (ML 698).

DIAGNOSIS. — See Hill (1938) and Poty (1981).

DESCRIPTION

External characters

Medium-sized ceratoid to cylindrical solitary corals. All specimens are at least partly eroded, thus the outer dissepimentarium is generally lacking and the thin smooth corallite wall only exceptionally preserved. Some growth lines are visible. The maximum diameter of these eroded specimens is 2.7 cm and specimens are 3.5-6.0 cm. The tip is preserved only once. This tip is deformed (Specimen MNHN.F.A33000) and thus shows the attachment of this specimen to a bioclast or grain.

Internal characters

There are 43-62 major septa. They are long and reach towards the axial structure. An open cardinal fossula is developed. Minor septa are very short, and persist only into the outer rows of the dissepimentarium. In some specimens the major septa are thicker in the inner dissepimentarium and the tabularium where minor septa are absent. There are 3-8 rows of mainly irregular elongate to globose dissepiments, which are declined (~45-60°). The oval axial structure comprises about one third of the corallite diameter and is somewhat variable. The basic type consists of a long median lamella, 3-7 axial lamellae on each side, and numerous axial tabellae. This typically dibunophyllid axial structure can be somewhat twisted and the median lamella loses its prominent character; then sections show the transition to a gangamophyllid axial structure.

DISCUSSION

The specimen fits well into the characteristic variability of this well-known species.

Dibunophyllum arachnoforme Vassiljuk, 1960 (Fig. 7F)

Dibunophyllum arachnoforme Vassiljuk, 1960: 142, pl. 37, figs 2, 2a. — Semenoff-Tian-Chansky 1974: 89, fig. 31, pl. 17, figs 3-6, pl. 18, fig. 9.

HOLOTYPE. — Specimen 1405/30, GM SAD.

TYPE LOCALITY AND TYPE LEVEL. — River Kal'mius, Adaman-Tchalgan, Donetz Basin, Ukraine; Zone C_1^nd.

AGE AND OCCURRENCE. — The holotype is from the lower Namurian of the Donetz Basin. Semenoff-Tian-Chansky (1974) reported it from the late Viséan of the Béchar Basin. The Reggane specimen is from latest Viséan-early Serpukhovian strata.

DIAGNOSIS. — See Semenoff-Tian-Chansky (1974).

MATERIAL EXAMINED. — Specimen MNHN.F.A33007, Reggane Basin, Hassi Taïbine Gypsum (upper part), late Serpukhovian, (ML 663).

DESCRIPTION

External characters

5.5 cm long fragment of a cylindrical solitary coral, which lacks apex and calice. The wall and outer dissepimentarium are mostly lacking. Growth lines are visible. The maximum diameter is 2.2 cm, although due to the erosion transverse sections are elliptical. The wall is smooth, but thicker in comparison to other specimens of this genus (0.3 mm).

Internal characters

There are 38 major septa. They are slightly sinuous and reach the axial structure. A marked cardinal fossula is developed. The minor septa are reduced to short septal spines. The axial structure is up to

7 mm in diameter. It consists of a thick median lamella surrounded by few axial lamellae and some axial tabellae. The dissepimentarium is wide and consists of dissepiments in herringbone arrangement. The dissepiments are elongate. There are 3 to 7 rows of dissepiments, steeply declined (45-60°). Tabulae are incomplete, generally slightly inclined (10-20°) and convex. The axial tabellae are numerous, domed or steeply inclined, at the edge they might be sacked.

Discussion

The broad inter-specific variability of *D. bipartitum* makes the separation of further species somewhat difficult and arbitrary. However, a number of species have been described that differ by characters like size and complexity of the axial structure. The proximity to genera evolving from the same phylogenetic branches as *Dibunophyllum* can help or complicate the separation (see references in Aretz & Nudds 2005). The studied specimen differs from the specimens assigned to *D. bipartitum* in this study by the two times ticker median lamella, a much thicker corallite wall, and a slightly lower septa/diameter ratio. In this respect it points toward the genus *Arachnolasma*. The Reggane specimen has a slightly larger axial structure than those specimens attributed to *D. arachnoforme* by Semenoff-Tian-Chansky (1974), but the dibunophyllid axial structure with a very thick median lamella and the organisation of the dissepimentarium enables the attribution to this species.

Genus *Arachnolasma* Grabau, 1922

Arachnolasma sp.
(Fig. 7G)

Material examined. — Specimen MNHN.F.A33008, Illizi Basin, lower Assekaifaf Fm (upper part), early Serpukhovian (ML 481).

Description

External characters

Fragment of 6 cm large cylindrical solitary coral. Apex and calice are not preserved. External parts strongly eroded. Maximum diameter 2.6 cm.

Internal characters

Most of the dissepimentarium is missing. There are 50 major septa. Due to the erosion of the dissepimentarium, only the ends of few minor septa are seen. The major septa are thick and reach towards an axial structure. An open cardinal fossula is developed. The axial structure consists of a thick median lamella, which is surrounded by few septal lamellae and axial tabellae. The innermost dissepimentarium is organised in pseudoherringbone patterns. In a longitudinal section rows of declined globose to elongate dissepiments are visible. The tabulae are incomplete. A peripheral zone of slightly upward orientated tabellae is followed by an axial zone of steeply inclined tabellae (12/0.5 cm). The thick axial column is continuous.

Discussion

Semenoff-Tian-Chansky (1974) described a series of *Arachnolasma* species from the Sahara. In respect to corallite size and number of septa only *A. lapparenti* Semenoff-Tian-Chansky (1974) might correspond to the studied specimen. However, it differs by the much thicker septa and a less complex axial structure and also by the form of the axial tabellae. Having in mind the bad preservation of the specimen and these differences, the specimen is kept in open nomenclature.

Genus *Koninckophyllum* Thomson & Nicholson, 1876

Koninckophyllum magnificum Thomson & Nicholson, 1876
(Fig. 8A)

Koninckophyllum magnificum Thomson & Nicholson, 1876: 121, pl. 12, fig. 2, 2a. — Thomson 1883: 419, pl. 11, fig. 1, 1a. —Vaughan *in* Smith 1910: 622, 627, pl. 16, fig. 4, 4a. — Hill 1939: 89, pl. 3, figs 11-17, pl. 4, figs 1-7. — Fedorowski 1971: 79, text-figs 29A-E, 32; pl. 7, figs 5-9; pl. 18, fig. 4. — Semenoff-Tian-Chansky 1974: 109, figs 36, 37, 44, 52, pl. 20, figs 2-5. — Conrad 1984: pl. 9, fig. 2.

Lophophyllum (*Koninckophyllum*) *magnificum* – Garwood & Goodyear 1924: 262, pl. 17, fig. 3a, b, c.

Lophophyllum (*Koninckophyllum*) *postscarlattense* – Gorsky 1951: 49, pl. 12, fig. 4a, b.

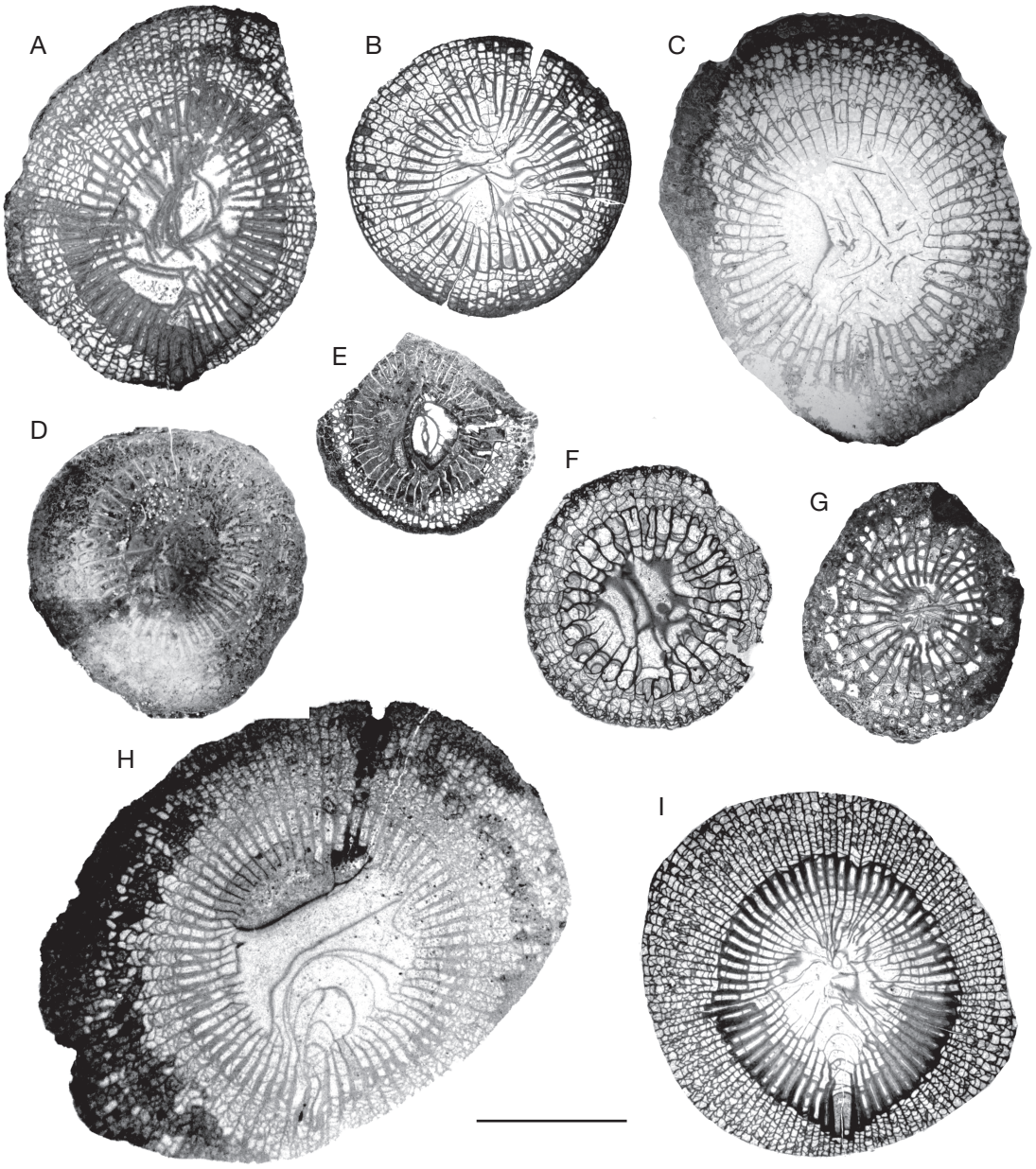


FIG. 8. — **A**, *Koninckophyllum magnificum* Thomson & Nicholson, 1876, transverse section (MNHN.F.A33009); **B**, *Koninckophyllum interruptum* Thomson & Nicholson, 1876, transverse section (MNHN.F.A33012); **C**, *Koninckophyllum* cf. *interruptum*, transverse section (MNHN.F.A33013); **D**, *Koninckophyllum* aff. *variabile* Semenoff-Tian-Chansky, 1974, transverse section (MNHN.F.A33014); **E**, *Koninckophyllum* sp., transverse section (MNHN.F.A33015); **F**, *Turbinatocaninia* sp., transverse section (MNHN.F.A33016); **G**, *Bothrophyllum proteum* Semenoff-Tian-Chansky, 1974, transverse section (MNHN.F.A33017); **H**, *Caninophyllum archiaci* (Milne Edwards & Haime, 1852), transverse section (MNHN.F.A33022); **I**, *Caninophyllum* sp., transverse section (MNHN.F.A33023). Scale bar: 10 mm.

LECTOTYPE. — Specimen KM.T 1037, which was illustrated by Thomson & Nicholson (1876) and later by Thomson (1879, 1883) and Hill (1939), chosen by Hill (1939).

TYPE LOCALITY AND TYPE LEVEL. — Charlestown, Scotland, D3 Zone = Brigantian, late Viséan.

AGE AND OCCURRENCE. — The species is known in North Africa and Europe in late Viséan and Serpukhovian strata.

MATERIAL EXAMINED. — Two specimens (MNHN.F.A33009 and A33010), Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 694).

DIAGNOSIS. — See Hill (1939) and Semenoff-Tian-Chansky (1974).

DESCRIPTION

External characters

Up to 9 cm long fragments of ceratoid solitary coral, one side is strongly eroded (wall and dissepimentarium). Apex is missing, the calice is preserved in parts. Growth bands are visible. The U-shaped calice is 1.5 cm deep, and surmounted by a few mm high simple axial structure (median lamella). The maximum diameter is 3.1 cm.

Internal characters

The wall is thin. There are as many as 58 major septa. They are slightly sinuous, and do not reach the centre, thus leaving an open central space (up to *c.* 1 cm in diameter). The cardinal septum is shorter than the other major septa. Major septa are much thicker in the tabularium than in the dissepimentarium, especially in the counter quadrants of the corallite. Minor septa are thin and end within the dissepimentarium. The dissepimentarium contains regular dissepiments, partly arranged in pseudoherringbone and herringbone patterns. A simple axial structure, commonly one median lamella eventually surrounded by few tabellae, is present.

There are several rows of globose and elongate dissepiments, which are steeply declined. The tabularium contains incomplete tabulae of variable shape (convex, flat, and concave). Tabulae are downturned in the peripheral zones. The simple axial structure, resulting from the doming of tent-shaped tabulae is developed.

DISCUSSION

The studied specimens are similar to the specimens described from Scotland (Hill 1939). Semenoff-Tian-Chansky (1974) illustrated small, mainly juvenile specimens from the Béchar Basin, but already mentioned the abundance of this species in the El Ahmar outcrop, where the studied specimens were collected.

Koninckophyllum interruptum
Thomson & Nicholson, 1876
(Fig. 8B)

Koninckophyllum interruptum Thomson & Nicholson, 1876: 121, pl. 12, fig. 3, 3a. — Semenoff-Tian-Chansky 1974: 112, figs 38, 45, 47, 49; pl. 20, figs 6, 7; pl. 21, figs 1-6. [cum. syn.]. — Niikawa 1981: 135, pl. 4, fig. 1a-c. — Herbig 1986: 198, Abb. 3, figs 1-3. — Rodríguez *et al.* 2001: 69, fig. 11; pl. 4, figs 1-5.

?*Koninckophyllum interruptum* – Khoa 1977: 360, pl. 14, fig. 5a-d.

HOLOTYPE. — Specimens from the Thomson collection are lost, no neotype has been assigned.

AGE AND OCCURRENCE. — The species is known in North Africa, Europe and Japan in late Viséan and Serpukhovian strata.

MATERIAL EXAMINED. — Specimen MNHN.F.A33011, Béchar Basin, Hassi Kerma Fm (upper part), early Bashkirian (ML 628), and MNHN.F.A33012, Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 692).

DIAGNOSIS. — See Semenoff-Tian-Chansky (1974).

DESCRIPTION

External characters

One 4 cm long cylindrical and one 7.5 cm long ceratoid fragment of solitary corals. The apexes are missing, calices are only partly preserved. The wall is rarely preserved. The maximum diameter is 2.2 and 2.4 cm. A *c.* 1 cm deep U-shaped calicular pit is surmounted by the gentle mounded axial structure.

Internal characters

The wall is thin. There are as many as 37 and 46 major septa. The major septa are slightly sinuous,

and do not reach the centre, thus leaving an open central space of 0.5 cm in diameter. The cardinal septum is shorter than the other major septa. Major septa are twice as thick in the tabularium as in the dissepimentarium. Minor septa are thin and end within the dissepimentarium. The outer dissepimentarium is regular and consists of mainly regular dissepiments. The inner dissepimentarium is more irregular and a herringbone pattern dominates. There are several rows of globose to elongate dissepiments, which are mostly steeply declined. The tabularium contains complete and incomplete tabulae of variable shape (convex, flat, and concave). Tabulae are downturned in the peripheral zones. A discontinuous simple axial structure, resulting from the doming of tent-shaped tabulae is developed.

Discussion

Hill (1939) concluded that this species was derived from *K. magnificum* by the loss of the axial structure. However, Semenoff-Tian-Chansky (1974) included specimens with a discontinuous axial structure. Thus, the studied specimen fits well into the variability of this species, although the cylindrical shape of one specimen is somewhat unusual for the species (Semenoff-Tian-Chansky 1974). The presence of the discontinuous axial structure is an important criterion to exclude these specimens from *Haplolasma* Semenoff-Tian-Chansky, 1974.

Koninckophyllum cf. ***interruptum*** Thomson & Nicholson, 1876 (Fig. 8C)

Material examined. — One specimen from MNHN.F.A33013, Illizi Basin, lower Assekaifaf Fm (upper part), early Serpukhovian (ML 463).

Description

External characters

Several cm long ceratoid fragment of solitary coral, the original length cannot be reconstructed based on the preserved parts. The specimen is crushed and was already eroded before deposition, thus the wall and parts of the dissepimentarium are mostly missing. The coral shows several phases of rejuvenesence. The apex is missing. Parts of a V-shaped calice are preserved. The maximum diameter is 3.5 cm.

Internal characters

There are as many as 53 major septa. The major septa are straight to slightly sinuous, and do not reach the centre, thus leaving an open axial space. A marked cardinal septum is found in juvenile stages; in mature stages it is less obvious. In mature stages, major septa are dilated in the tabularium in the cardinal quadrants. In more juvenile stages the dilatation is seen for all major septa. Minor septa are thin and end within the dissepimentarium. The dissepimentarium is commonly regular, but in some parts an irregular pattern, including few lateral dissepiments and pseudoherringbone, occur. These irregularities are randomly distributed. There are several rows of declined globose dissepiments. The tabularium contains complete and incomplete tabulae of variable shape. In the peripheral zones, tabulae are downturned. A simple axial structure, resulting from the doming of tent-shaped tabulae is developed; it becomes discontinuous in mature stages.

Discussion

The studied specimen has a more irregular dissepimentarium than many typical specimen of *K. interruptum*. The septa/diameter ratio is similar to 3 species described by Semenoff-Tian-Chansky (1974) from the Sahara; *K. interruptum*, *K. variabile* and *K. destitum*. The latter two differ by their more irregular dissepimentarium. The continuity of the axial structure resembles that observed in *K. magnificum* and is significantly more pronounced than in the studied specimens attributed to *K. interruptum*.

Koninckophyllum aff. ***variabile*** Semenoff-Tian-Chansky, 1974 (Fig. 8D)

Material examined. — Three thin sections from badly preserved specimen (MNHN.F.A33014), Illizi Basin, lower Assekaifaf Fm (upper part), early Serpukhovian (ML 463).

DESCRIPTION
Internal characters
The maximum diameter is 2.2 cm. A thin wall is preserved. There are as many as 48 major septa. They are slightly sinuous and dilated in the tabularium. They do not reach the axial structure, but the largest transverse section is in the calice and a second one is in a juvenile stage. The minor septa reach the edge of the tabularium. The dissepimentarium is formed by regular dissepiments, in some cases arranged in pseudoherringbone patterns, at the base of the dissepiments lateral or naotic dissepiments develop. The axial structure consists of a thick median lamella, surrounded by few axial tabellae. Axial lamellae are apparently absent. In the longitudinal section, there are several rows of globose to elongate dissepiments, steeply inclined. The tabulae are incomplete. They are peripheral elevated to sigmoidal. The axial column is continuous, although variable in thickness.

DISCUSSION
The studied specimen has many characters in common with specimens attributed by Semenoff-Tian-Chansky (1974) to his new species *K. variabile*. Although the intraspecific variability is high, the studied specimen does not contain an amygdallophylid axial structure. The single thick median lamella is a major difference.

Koninckophyllum sp.
(Fig. 8E)

MATERIAL EXAMINED. — Specimen MNHN.F.A33015, Illizi Basin, lower Assekaifaf Fm (upper part), early Serpukhovian (ML 481).

DESCRIPTION
Internal characters
Poorly preserved specimen. According to the sediment fill in the central space of the corallite, the section is near to the base of the calice. The wall and parts of the dissepimentarium are eroded. The diameter is 1.5 cm. There are two series of up to 30 septa. The major septa are sinuous, and do not reach the centre, thus leaving an open central space. A styliform columella is found in the 5 mm wide axial space. The minor septa end in the dissepimentarium. The dissepimentarium is irregular.

DISCUSSION
The single section does not allow for specific affiliation of this specimen.

Genus *Turbinatocaninia* Dobrolyubova, 1970

Turbinatocaninia sp.
(Fig. 8F)

MATERIAL EXAMINED. — Specimen MNHN.F.A33016, Béchar Basin, Hassi Kerma Fm (upper part), early Bashkirian (ML 628).

DESCRIPTION
External characters
5 cm eroded cylindrical solitary coral. Apex and calice are missing. The wall is not preserved. The maximum diameter is 1.8 cm.

Internal characters
There are as many as 30 major septa. They are sinuous, and do not reach the centre, thus leaving an open central space. The cardinal septum is significantly shorter than the other major septa. The minor septa are discontinuous in the dissepimentarium, but penetrate as short septal spines into the tabularium. All septa in the tabularium are at least twice as thick as in the dissepimentarium. The dissepimentarium is very irregular and contains few simple dissepiments, some lateral dissepiments, and many dissepiments in pseudoherringbone patterns. There are several rows of elongate dissepiments, which are steeply declined (45-90°). The tabularium contains complete and incomplete tabulae of variable shape (convex, flat, and concave). In the peripheral zones, tabulae are downturned and in some cases sacked.

DISCUSSION
This specimen shows many similarities with the specimen figured as *Turbinatocaninia dawsoni* (Lambe, 1889) by Poty (2002) from the Serpukhovian of Nova Scotia, but the septa are not thickened in the cardinal quadrants, which is

typical for the genus. It also shows similarities to the specimen of *Koninckophyllum interruptum* recovered from the same locality. They differ in the arrangement of the dissepimentarium, which is more similar to *Koninckophyllum variabile* in the studied specimen. The longitudinal section does not show any evidence of an axial structure and the studied specimen resembles in this respect the sections described as *Aulina* sp. (= *Aulokoninckophyllum* Sando, 1976) by Semenoff-Tian-Chansky (1974: pl. 27, figs 5, 6). However the formation of an aulos could not be clearly demonstrated in the studied specimen. It is provisionally kept in *Turbinatocaninia.*

Family BOTHROPHYLLIDAE Formichev, 1953
Genus *Bothrophyllum* Trautschold, 1879

Bothrophyllum proteum
Semenoff-Tian-Chansky, 1974
(Fig. 8G)

Bothrophyllum proteum Semenoff-Tian-Chansky, 1974: 140, fig. 55; pl. 29, figs 1-5; pl. 30, figs 1-5. — Guillaume & Semenoff-Tian-Chansky 1991: fig. 2A-F. — Semenoff-Tian-Chansky & Guillaume 1994 : 216, figs 2-5.

HOLOTYPE. — MNHN.F.A29911, Semenoff-Tian-Chansky Collection.

PARATYPES. — MNHN.F.A29912-A29920.

TYPE LOCALITY AND TYPE LEVEL. — Oued Tagana, Djebel Béchar, Algeria. Hassi Kerma Formation, Bashkirian.

AGE AND OCCURRENCE. — The species is endemic to the uppermost Mississippian and lowermost Pennsylvanian of the Béchar Basin.

DIAGNOSIS. — See Semenoff-Tian-Chansky (1974)

MATERIAL EXAMINED. — Five specimens (MNHN.F.A33017-A33020-A33021), Béchar Basin, Oued el Hamar Fm?, Bashkirian? (ML 1145).

DESCRIPTION

External characters

Fragments, max. 3.2 cm high, of small-sized cylindrical, slightly curved solitary corals, calice and apex lacking. Poor preservation, with significant erosion of the dissepimentarium. However, is the wall preserved, growth lines are visible. Diameters vary between 1.3 and 1.8 cm.

Internal characters

There are 29-31 major septa. Septa may be thickened in the counter quadrant. A cardinal fossula is developed. The length of major septa is variable, especially in sections near the supposed calice where they retreated from the centre of the corallite, thus leaving a larger central open space. Minor septa are discontinuous. A discontinuous bothrophyllid axial column is variably developed in the central part of the corallite (max. one-half of the corallite diameter), but there are a series of sections showing an open central space. The dissepimentarium consists of irregularly arranged dissepiments, which partly show herringbone arrangement. The thickness of septa, dissepiments and tabulae vary between the individual specimens. The thickest elements are found in the specimen with an axial structure (MNHN.F.A33017).

DISCUSSION

Specimens affiliated to this species can be highly variable in respect to the presence and complexity of the axial structure and the thickness of the skeletal elements as Semenoff-Tian-Chansky (1974) already described and illustrated. The original affiliation of *proteum* to *Bothrophyllum* is upheld herein based on the infrequent presence of a bothrophyllid axial structure and thickening of septa around the cardinal fossula.

These specimens are most likely from the same stratigraphical interval (Hassi Kerma Fm) as the specimens studied by Guillaume & Semenoff-Tian-Chansky (1991), Semenoff-Tian-Chansky & Guillaume (1994), and some localities described by Semenoff-Tian-Chansky (1974). Semenoff-Tian-Chansky & Guillaume (1994) discussed the affiliation of this species to *Bothrophyllum*. They kept it provisionally in the genus, because material from the Morrowan of Nevada (Sando 1985) with strong similarities to the upper Pennsylvanian *Crataniophyllum* is not adequately described, and thus, the concluded close resemblance to *B. proteum* is still under question.

Genus *Caninophyllum* Lewis, 1929

Caninophyllum archiaci
(Milne Edwards & Haime, 1852)
(Fig. 8H)

Cyathophyllum archiaci Milne Edwards & Haime, 1852: 183, pl. 34, fig. 7. — Aretz & Nudds 2005: 172, pl. 1, figs 4, 6. [cum syn.]

HOLOTYPE. — Specimen Geol. Soc. Coll. 5462, Murchinson Collection, BGS.

TYPE LOCALITY AND TYPE LEVEL. — Llanymynech, Shropshire, UK; upper *Dibunophyllum* Zone, upper Viséan.

AGE AND OCCURRENCE. — This well-known Western European species (middle-late Viséan; Lewis 1929; Poty 1981) is for the first time described from the Sahara.

DIAGNOSIS. — See Hill (1939).

MATERIAL EXAMINED. — Specimen MNHN.F.A33022, Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 692).

DESCRIPTION
External characters
5 cm high fragment of large-sized solitary coral. The fragment lacks the wall and parts of the dissepimentarium. The maximum observed diameter is 4 cm.

Internal characters
There are as many as 68 long major septa (up to 20 mm). They are slightly sinuous. They do not reach the centre and leave an open central area of 1.5 cm in diameter. Major septa are generally thin, but may be slightly thickened at the base of the tabularium in the cardinal quadrants. A cardinal fossula is present. The thin minor septa end in the dissepimentarium. The latter is irregularly organised. The dissepiments are very irregularly distributed, especially axial at ends of minor septa. Arrangements in pseudoherringbone and herringbone patterns occur.

In longitudinal section, the dissepimentarium consists of numerous rows of steeply declined globose to elongate dissepiments. The tabularium, 2.3 cm wide, contains complete to slightly divided incomplete tabulae. They are downturned at the periphery and horizontal to slightly concave in the centre of the tabularium.

DISCUSSION
The specimen fits well within the description of Lewis (1929).

Caninophyllum sp.
(Fig. 8I)

MATERIAL EXAMINED. — Specimen MNHN.F.A33023, Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 692).

DESCRIPTION
External characters
The fragment is 2 cm large and max. 2.8 cm wide. The calice is partly preserved. Wall and outer dissepimentarium are lacking. The calice is 0.7 cm deep.

Internal characters
There are two series of 62 septa. The long major septa are slightly sinuous to straight. They do not reach the centre, although some penetrate deeply into the tabularium, and leave an open central area of 0.7 cm in diameter. Major septa are thin within the dissepimentarium, but they strongly thicken at the base of the tabularium and thin towards the centre. The dilatation is significantly weaker in the counter than in the cardinal quadrants of the tabularium. A prominent cardinal fossula is present. The length of the minor septa varies and they end either in the dissepimentarium or reach the thickened zone at the base of the tabularium, but they do not cross this zone

The organisation of the dissepimentarium is highly variable. There are simple dissepiments, which may become very irregular, dissepiments arranged in pseudoherringbone or herringbone patterns, and dissepiments discontinuous.

In longitudinal section, the dissepimentarium consists of numerous rows of moderately to steeply declined, globose to elongate dissepiments. The tabularium and dissepimentarium are separated by a zone of stereoplasmatic thickening (2-4 mm thick), which corresponds in transverse sections to the thickening of the septa at the base of tabularium. The tabularium is 1.3 cm wide. Tabulae are incomplete; more or less horizontally arranged in the inner part and downturned at the periphery.

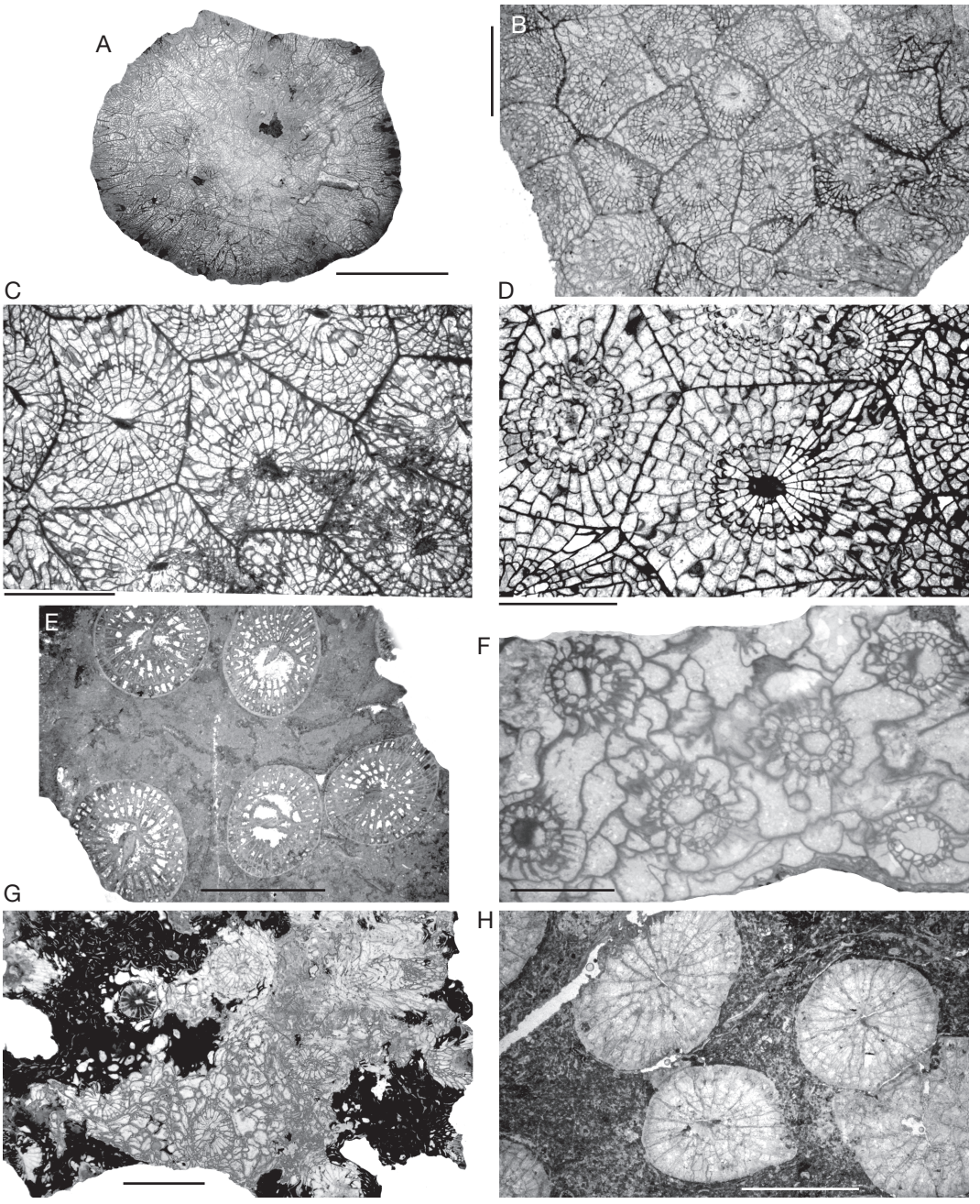


FIG. 9. — Colonial rugose corals: **A**, **B**, *Lithostrotion decipiens* (McCoy, 1849); **A**, transverse section through the base of a hemispherical colony, showing its radial growth (MNHN.F.A33026); **B**, transverse section (MNHN.F.A33025); **C**, **D**, *Lithostrotion vorticale* (Parkinson, 1808); **C**, transverse section (MNHN.F.A33027); **D**, transverse section (MNHN.F.A33030); **E**, *Siphonodendron martini* (Milne Edwards & Haime, 1851), transverse section (MNHN.F.A33031); **F**, *Aulina* (*Pseudoaulina*) *botanica,* Nudds, 1977, transverse section (MNHN.F.A33032); **G**, ?*Ivanovia* sp., transverse section (MNHN.F.A33033); **H**, *Espielia columellata* Rodríguez & Hernando, 2005, transverse section (MNHN.F.A32995). Scale bars: A, 2 cm; B-F, 5 mm; G, 1 mm; H, 3 mm.

Discussion

The studied specimen can be assigned to the genus *Caninophyllum*. Semenoff-Tian-Chansky (1974) erected the species *C. becharense* for small *Caninophyllum* specimens with a marked thickening at the base of the tabularium and a rudimentary pseudoaxial structure in young stages. The studied specimen shares with that species the important thickening of the major septa, the relatively small open axial space, and the irregular dissepimentarium, but it has a significantly greater septa/diameter ratio, which is univocally related to the erosion of the specimen. It differs from typical large-sized *C. archiaci* (e.g., Poty 1981; Aretz & Nudds 2005) by the small open axial size, the important thickening of the septa and the peripheral tabularium.

Family Lithostrotionidae d'Orbigny, 1852
Subfamily Lithostrotioninae d'Orbigny, 1852
Genus *Lithostrotion* Fleming, 1828

Lithostrotion decipiens (McCoy, 1849)
(Figs 9A-C; 10)

Nemaphyllum decipiens McCoy, 1849: 18.

Lithostrotion decipiens – Conrad 1984: pl. 9, figs 3, 4. — Aretz 2002b: 110, pl. 9 fig. 6; pl. 10, figs 1, 2. [cum syn.]. — Cózar *et al.* 2005: fig. 12/2.

Lectotype. — SM A2077a-d, chosen by Hill (1940).

Type locality and type stratum. — Derbyshire, UK; Lower Carboniferous.

Age and occurrence. — *Lithostrotion decipiens* is known in Western Europe and North Africa from the late Viséan (Poty 1981, 1985; Semenoff-Tian-Chansky 1985; Mitchell 1989).

Diagnosis. — See Poty (1981).

Material examined. — Colony fragments of various sizes (5-10 cm), MNHN.F.A33024, Illizi Basin, lower Assekaifaf Fm (upper part), early Serpukhovian (ML 481); MNHN.F.A33025 and A33026, Reggane Basin, Djebel Berga Limestone, late Viséan (ML 698).

Description

External characters

The corallum is cerioid. A thin section in the lower part of a partly preserved hemispherical colony (from MNHN.F.A33026) shows the peripheral, radial growth of the corallum (Fig. 9C). On the bottom surface of the corallum the corallites have the habit of *Siphonodendron* on their outward (open) side. Fragments with preserved calices show that the latter are a few mm deep and an elevated axial structure is well developed.

Internal characters

The corallites are polygonal in shape, preferentially pentagonal and hexagonal. There are 14-16, rarely 17, major septa. They are attached to the columella. Cardinal and counter septa are identified by the orientation of the columella. The columella is styliform. Minor septa extend shortly into the tabularium. The tabularium is 1.8-3.0 in width, and contains incomplete tabulae, which increase towards the axis. The dissepimentarium consists of 4-6 rows of globose to elongate dissepiments, which are slightly declined (20°). Lonsdaleiod (transeptal) dissepiments occur especially in corners and in offset structures of the larger corallites.

Discussion

The three specimens (Fig. 10) fit into the variability of this species (Poty 1981; Aretz 2002a, b). In small corallites the number of septa and the tabularium widths may partly attain values that are more characteristic for *Lithostrotion maccoyanum* Milne Edwards & Haime, 1851 (Poty 1981; Aretz 2010a). The opposite trend is observed in the largest specimens, when few corallites start to appear in *Lithostrotion vorticale* (Parkinson, 1808) habits. These observations are typical for the edges of the morphometrically defined species (Poty 1981).

Lithostrotion vorticale (Parkinson, 1808)
(Figs 9C, D; 10)

Madrepora vorticalis Parkinson, 1808: 45, pl. 5, figs 3, 6.

Lithostrotion vorticale – Aretz 2010a: 330, fig. 5b. [cum. syn.]. — Legrand-Blain *et al.* 2010: fig. 1a.

Types. — The Parkinson specimens are considered lost. A neotype has not been designated.

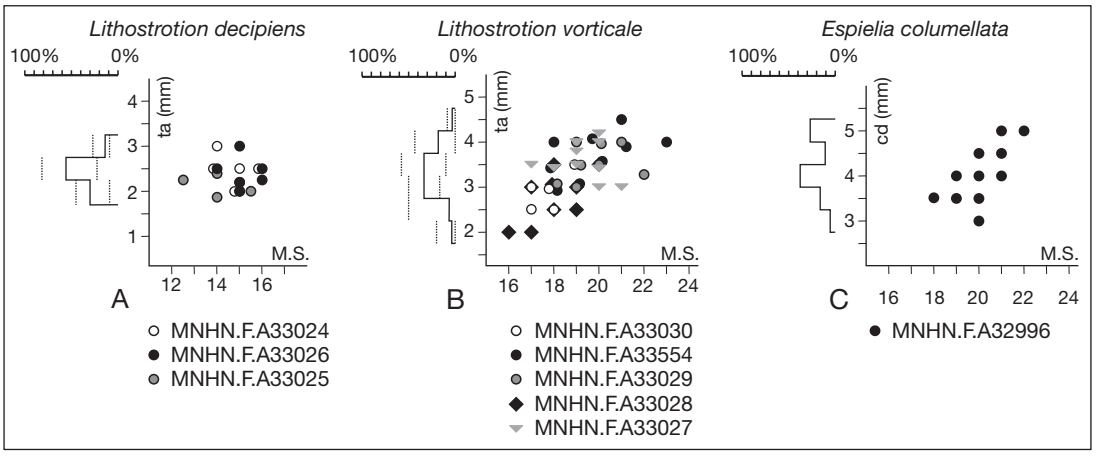


FIG. 10. — **A**, **B**, Intraspecific variabilities in *Lithostrotion decipiens* (McCoy, 1849) and *Lithostrotion vorticale* (Parkinson, 1808) expressed in the number of septa/tabularium width ratios and histograms for the abundance of the tabularium widths (**line**, average of all specimens; **dotted lines**, minimum and extreme values observed in individual specimens); **C**, variability of the specimen MNHN.F.A32995 (*Espielia columellata* Rodríguez & Hernando, 2005) expressed in the number of septa corallite/diameter ratios and a histogram for the abundance of the corallite diameter. Abbreviations: **cd**, corallite diameter; **ta**, width of tabularium.

AGE AND OCCURRENCE. — The species extends from the Holkerian/Livian to the Late Brigantian in Europe (Mitchell 1989; Rodriguez *et al.* 2002) and is known in North Africa from the late Viséan (Semenoff-Tian-Chansky 1985; Said *et al.* 2007; Aretz 2010a).

DIAGNOSIS. — See Poty (1981).

MATERIAL EXAMINED. — Colony fragments of various sizes (5-10 cm) from MNHN.F.A33027, Tindouf Basin, Ouarkziz Fm (lower part), late Viséan (ML 415), MNHN.F.A33028, Reggane Basin, Djebel Berga Limestone, late Viséan (ML 638), MNHN.F.A33029 and A33554, Reggane Basin, Djebel Berga Limestone, late Viséan (ML 639), MNHN.F.A33030, Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 646).

DESCRIPTION

Internal characters

The corallum is cerioid. Corallites are polygonal in shape, preferentially pentagonal and hexagonal. There are 18-23, average 19-21, major septa in mature stages (Fig. 10). Cardinal and counter septa are attached to a styliform columella. In most corallites the other major septa leave an open space around the columella. Minor septa extend shortly into the tabularium. The tabularium is 3.0-4.5 mm in width and consists of incomplete tabulae, which increase towards the axis. The dissepimentarium consists of 4-6 rows of globose to elongate dissepiments, which are almost horizontal. Lonsdaleiod (transeptal) dissepiments may occur in corallite corners and in offset structures.

DISCUSSION

All specimens fit well into the variability of this species (Hill 1940; Poty 1981). The smallest and largest corallites may show the trend towards a *Lithostrotion decipiens*, respectively *Lithostrotion araneum* habit (Fig. 10).

Genus *Siphonodendron* McCoy, 1849

Siphonodendron martini (Milne Edwards & Haime, 1851) (Fig. 9E)

Lithostrotion martini Milne Edwards & Haime, 1851: 436.

Siphonodendron martini – Conrad 1984: pl. 8, fig. 1. — Aretz 2010a: 334, fig. 5h. [cum. syn.].

LECTOTYPE. — Specimen E 1446, Phillips Collection, RMO, chosen by Semenoff-Tian-Chansky & Nudds (1979).

PARALECTOTYPE. — One specimen of Corwen, UK, MNHN.F.A29640 (collection Milne Edwards).

TYPE LOCALITY AND TYPE LEVEL. — Yorkshire, UK, possibly Teesdale or Ribblesdale; Dinantian.

AGE AND OCCURRENCE. — *Siphonodendron martini* is perhaps the most common species of *Siphonodendron* in the middle and late Viséan of the western Palaeotethys (Aretz 2010a).

MATERIAL EXAMINED. — Small colony fragment MNHN.F.A33031 with a dozen corallites, Béchar Basin, El Hariga Fm (upper part), early Viséan (ML 622).

DIAGNOSIS. — See Semenoff-Tian-Chansky & Nudds (1979).

DESCRIPTION

External characters

Slightly dolomitized phaceloid corallum with cylindrical corallites.

Internal characters

The corallite diameter is on average 6-7 mm. The corallite wall is thin (0.1-0.3 mm). There are 24-27 septa in two series. Major septa are long and can reach the styliform columella. The latter is a single axial plate thickened in its central part (up to 0.5 mm). The minor septa are up to one-half as long as the major septa. The septa are straight to slightly sinuous. There are 1-3, mean 2, rows of regular globose to elongate dissepiments, declined 30° in average towards the tabularium. There are about 20 tabulae per cm. They are tent-shaped, incomplete and in two series; the peripheral edges are rarely u-shaped.

DISCUSSION

Although poorly preserved, the El Hariga specimen fits well into the variability of this species (See Semenoff-Tian-Chansky & Nudds 1979; Poty 1981).

Subfamily AULININAE Hill, 1981
Genus *Aulina* Smith, 1917
Subgenus *Pseudoaulina* Minato & Rowett, 1967

Aulina* (*Pseudoaulina*) *botanica Nudds, 1977
(Fig. 9F)

Aulina botanica Nudds, 1977: 190, pl. 2, fig. 1.

Pseudoaulina botanica – Semenoff-Tian-Chansky 1985: pl. 15, fig. 2.

HOLOTYPE. — R49752, BM.

TYPE LOCALITY AND TYPE LEVEL. — How Gill, Botany, Teesdale, County Durham, UK; Botany Limestone, Serpukhovian (Arnsberian, E2).

AGE AND OCCURRENCE. — The species is known from the lower Namurian (Arnsbergian, E2) of Northern England (Nudds 1977) and from the upper Serpukhovian (Tagana Formation) of the Béchar Basin (Semenoff-Tian-Chansky 1985). Thus this species shows a narrow stratigraphical distribution, but it is very rare.

MATERIAL EXAMINED. — Small colony fragment MNHN.F.A33032 with *c.* 20 corallites (5 × 3.5 × 1 cm), Béchar Basin, Tagana 1 E, early Bashkirian (ML 229).

DIAGNOSIS. — See Nudds (1977).

DESCRIPTION

External characters

Massive colonial coral without any corallite walls. The centres of corallites are spaced 3-10 mm apart. The calices are elevated. They are U-shaped, few mm deep and 3-4 mm wide. Broken calices show the presence of an aulos.

Internal characters

The colony is aphroid. There are 11-14 septa in two series. Septa may be rarely carinate or zigzag. An aulos of ~1 mm diameter is formed at the axial ends of the major septa. The minor septa generally end within the dissepimentarium, but may reach the tabularium. The axial tabulae are horizontal, the periaxial tabulae are outward declined. Dissepiments are large and variable in shape. The outer dissepimentarium consists of large, irregular transeptal dissepiments and separate the corallites; there is no wall.

DISCUSSION

Although the corallite dimensions of this specimen are somewhat smaller than those mentioned by Nudds (1977), the morphological overlap with this rare British species is considerable. The aphroid corallum is typical for the subgenus *Pseudoaulina* Minato & Rowett, 1967 in the sense of Sando (1976).

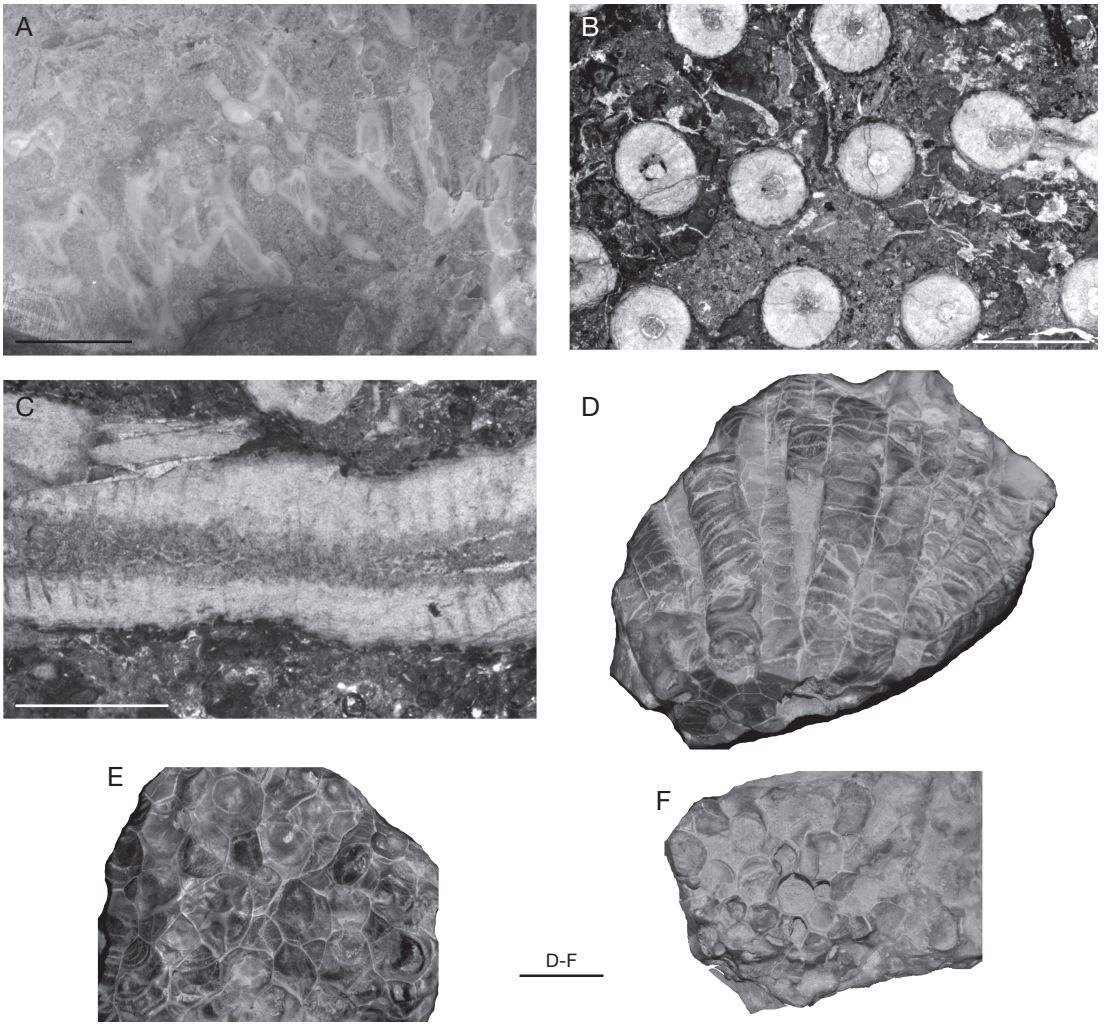


FIG. 11. — Tabulate corals: **A**, *Syringopora* sp., whole specimen (MNHN.F.A33034); **B**, **C**, *Multithecopora* sp. (MNHN.F.A33036); **B**, transverse section; **C**, longitudinal section showing spines; **D**, **E**, *Michelinia* sp., uncut specimen (MNHN.F.A33038); **D**, oblique view mainly showing longitudinal sections; **E**, view on top the side showing transverse sections; **F**, ?*Michelinia* sp., uncut specimen (MNHN.F.A33040). Scale bars: A, 5 mm; B, 3 mm; C, 2 mm; **D**-**F**, 10 mm.

Family PETALAXIDAE Formichey, 1953
Genus *Ivanovia* Dobrolyubova, 1935

?***Ivanovia*** sp.
(Fig. 9G)

MATERIAL EXAMINED. — Colony fragment MNHN.F.A33033 (7.5 × 6 × 2.5 cm), Béchar Basin, Oued el Hamar Fm?, Bashkirian? (ML 1146).

DESCRIPTION

External characters

The massive corallum is badly preserved, partly dolomitized, partly recrystallized. The fragment has a discoidal shape and presumably represents the base of the colony. The increase is lateral. On the supposed bottom surface of the corallum the corallites have the habit of fasciculate corallites.

Internal characters
There are no walls between the corallites. Thick dissepimentaria of large transeptal dissepiments separate the individual corallites. Distances between the centres of corallites are 14-20 mm. There are two series of 20-24 septa. The septa are visible only in the inner dissepimentarium and tabularium. Major septa are straight to sinuous. Few septa reach the axial structure. Minor septa are variable in length, mostly ending in the dissepimentarium, but some reach the tabularium. Stereoplasmatic thickenings are observed in some corallites at the limit between the outer dissepimentarium of large irregular, transeptal dissepiments and inner, more regular dissepimentarium. A straight to sinuous thickened median lamella is developed in all corallites; in some it is surrounded by some axial tabellae. An oblique section through one corallite shows steeply inclined large elongate dissepiments.

Discussion
The axial structure of this specimen is only insufficiently known due to the absence of a longitudinal section. The presence of a relatively simple structure would favour the attribution to *Petalaxis*, but the presence of some axial tabellae and the absence of corallite walls exclude the specimen from this genus. It is ranged with doubts into *Ivanovia* due to the absence of corallite walls and the axial structure, although the latter is simpler than commonly observed in this genus. The specimen has also some resemblance to *Orionastrea*, but the septa are less confluent and the thickening at the base of the tabularium is not characteristic for the later genus.

Subclass TABULATA
Milne Edwards & Haime, 1850
Suborder AULOPORIDA Sokolov, 1947
Family Syringoporidae de Fromentel, 1861
Genus *Syringopora* Goldfuss, 1826

Syringopora sp.
(Fig. 11A)

Material examined. — Two small fragments MNHN.F.A33034 and A33035 from the "Dalle à *Syringopora*", Reggane Basin, Djebel Berga Limestone, early Serpukhovian (ML 657).

Description
Internal characters
Fragments of fasciculate corallum. The corallites are 1-2 mm in diameter. The intercorallite spacing is 1-4 mm. There are 7-12 corallites per cm². The increase is laterally. Offsets occur regularly. Tabulae infundibuliform, declined and irregular, in transverse sections concentric or subconcentric around small axial syrinx. The syrinx is in some cases in lateral position. Connecting tubes are very rare.

Discussion
The diameter of these *Syringopora* corallites are smaller than those of the two species described by Aretz & Herbig (2010) from the upper Viséan of the Western Moroccan Meseta. In corallite diameter it resembles morphotype 2 of Aretz & Nudds (2005), but there are more connecting tubules in the British specimen. The rareness of tubules excludes the specimens from *S. reticulata* Goldfuss, 1826. Conrad (1984) used *S. geniculata* Goldfuss, 1826 for the syringoporid corals from the "Dalle à *Syringopora*", but again the rarity of tubules and the corallite diameters make this affiliation questionable.

Family Multithecoporidae Sokolov, 1950
Genus *Multithecopora* Yoh, 1927

Multithecopora sp.
(Fig. 11B, C)

Material examined. — One colony fragment MNHN.F.A33036 (11 × 13 × 3.5 cm), Béchar Basin, Goumirats Fm, Niveau Ioucha 10, late Viséan (ML 808) and a highly fragmented and dolomitized specimen MNHN.F.A33037, Béchar Basin, El Hariga Fm (upper part), early Viséan (ML 622).

Description
Internal characters
Fragments of fasciculate corallum. The corallites are 2 mm in diameter. The intercorallite spacing is relatively regular 2-4 mm; smaller values are commonly in connection with offsets. Connecting tubules occur rarely. There are 6-10 corallites per cm². The increase is laterally and in the case of specimen MNHN.F.A33036 colony growth initiated on a

brachiopod shell. Offsets occur regularly, commonly after *c.* 1 cm of corallite growth. The corallite wall is thick. The central lumen is 0.4-0.6 mm in diameter. Very few tabulae occur. Septal spines occur irregularly and penetrate in some cases into the lumen.

Discussion
Specimen MNHN.F.A33036 clearly belongs to the genus *Multithecopora*, but a specific attribution is not possible as a consequence of the general poor knowledge of this genus in western Europe and North Africa. The affiliation of specimen MNHN.F.A33037 is more critical due to its bad preservation, but the single corallites share many common features with those of the almost intact specimen MNHN.F.A33036.

Suborder FAVOSITIDA Wedekind, 1937
Family Micheliniidae Waagen & Wentzel, 1886
Genus *Michelinia* de Koninck, 1841

Michelinia sp.
(Fig. 11D, E)

Material examined. — Wind-polished specimens MNHN.F.A33038 and A33039, Ahnet Basin, Tirechoumine Shales (middle part), late Viséan (ML 586). They are recrystallized and partly silicified; not thin-sectioned.

Description
External and internal characters
Several cm-sized fragments of massive coralla. No holotheca or calice preserved. Internal skeletal elements well visible on the weathered and polished surfaces. Corallites polygonal, slightly rounded, preferably tetragonal to hexagonal. Offsets by lateral increase throughout the corallum. Corallite diameters are 6-9 mm. The wall is 0.2-0.3 mm. Septal spines are visible in transverse sections. Tabulae are mostly complete, some lateral tabellae occur. The tabulae are flat to domal. Their thickness is not more than one-half of the corallite wall. There are 4-8 tabulae per cm in longitudinal section. Mural pores were not observed, but this might be difficult due to the preservation of the specimens.

Discussion
The specimens have not been attributed to a species, because of the preservation and the lack of thin sections.

?***Michelinia*** sp.
(Fig. 11F)

Material examined. — Specimen MNHN.F.A33040, Ahnet Basin, Tirechoumine Shales (middle part), late Viséan (ML 591); not thin-sectioned, polished on longitudinal side.

Description
External characters
Poorly preserved colony fragment of 2.5 × 2.5 × 1 cm in reddish ferruginous limestone. There are several polygonal, commonly hexagonal, corallites with diameters of 4-6 mm. Some weathered corallites are up to 5 mm deep. Longitudinal sections and deeply weathered calices do not show the presence of tabulae.

Discussion
This type of preservation is wide spread in somewhat shaly environments in the Sahara. The diagenetic signal and the recent weathering in the desert climate make the preservation of internal structures almost impossible; see also rugose corals of the lower Hariga Fm. Even apparently well preserved specimens are of no use for thin sectioning. It is doubtless a michelinid coral and strongly resembles the typical representatives of the genus *Michelinia*. The skeletal microstructure is one important taxonomical criterion (Lafuste & Plusquellec 1985), but it cannot be studied on this specimen. Thus it has not been sectioned to conserve at least the outer shape. Thus the colony is placed with some questions into the genus.

DISCUSSION AND IMPLICATIONS

The number of 38 taxa (rugose corals: 34, tabulate corals: 4) compared with the number of specimens (96) indicates that a high diversity can be expected for the Carboniferous corals of the Algerian Sahara. This supposed diversity is expected on the basis of the results for the dissepimented solitary rugose

corals of the Béchar Basin (Semenoff-Tian-Chansky 1974) and preliminary data for the colonial corals of the Béchar Basin (Semenoff-Tian-Chansky 1985; personal data). However, when using the diversity for comparisons with other Viséan-Bashkirian faunas, the longer temporal range of suitable facies, mainly platform carbonates up into the Bashkirian, has to be underlined for the Sahara basins. Thus, especially the comparison to the classical European faunas may be strongly biased. One problem with the Saharan faunas as represented by the studied collection is the number of samples; studies of populations for the evaluation of the intra- and interspecific variabilities are rarely possible. This is especially relevant for the larger solitary and colonial corals. Hence a relatively large number of taxa are represented only by a single or few specimens, which may result in biased data for the evaluation of biodiversity, palaeo(bio)geography and stratigraphy.

Two large Saharan coral associations can be distinguished. Shaly environments favour the presence of commonly smaller solitary corals of the *Zaphrentis*-type and massive tabulate corals (Micheliniidae). This assemblage can be placed among the "*Cyathoxonia*" faunas (Hill 1938), although the name-giving taxon has not been found, and it has to be highlighted that not only small taxa occur. The second coral association is found in the carbonate environments. They contain larger and more complex solitary and colonial corals, hence the common mixture (Aretz 2010b) of the two other faunal associations *sensu* Hill (1938). Here a broad range of different environments can be suspected, e.g., large biostromes formed by cerioid lithostrotionids ("Dalle à *Lithostrotion*" at the base of the "Calcaire de Djebel Berga") or capping-beds of reefs formed by fasciculate lithostrotionids in the Grand Erg Oriental (see also Pareyn 1961; Bourque 2007). For other mass occurrences, e.g., the "Dalle à *Syringopora*" (ML 657), only insufficient information on the number of corals and their spatial distribution is available. Thus, due to the absence of detailed sedimentological data for the coral horizons and the limited number of samples and information on their spatial distribution and abundance within the horizons, both coral associations cannot be further divided, but the full range of habitats typical for Carboniferous corals (Aretz 2010b) can be expected.

Rugose corals can be used to confirm and support the biostratigraphical framework of the marine Carboniferous strata in the Algerian Sahara. The easiest recognizable differences are between the Mississippian and Pennsylvanian colonial corals. The faunal turnover at the Mid-Carboniferous Boundary (MCB) was sharp and the typical genera of the Mississippian, *Lithostrotion* and *Siphonodendron*, did not cross the boundary. A new faunal stock arrived in the Sahara, probably immigrating from the Donets Basin. The presence of colonial aulinids can be used roughly to position the MCB. Among the solitary taxa, well-known taxa like *Palaeosmilia* and *Dibunophyllum bipartitum* do not cross the boundary. In the Illizi Basin, the ML 511 horizon has been correlated by Legrand-Blain (1985, 1986) with the *Titanaria* marker beds of the uppermost Serpukhovian in the western basins. The record of *Palaeosmilia* sp., close to *Palaeosmilia murchisoni*, as presumably exclusively Mississippian taxa, supports this interpretation. Thus the Bashkirian age of the horizon deduced from microfossils (Lys *in* Legrand-Blain 1983) is not supported by coral data. The corals described from the "section south of Taïbine" have also played a vital role in rejecting (Legrand-Blain *et al.* 2010) the Bashkirian age proposed for the "Calcaire de Djebel Berga" by Wendt *et al.* (2009, 2010).

The palaeobiogeographical relations of the studied specimens are still not fully established. The Western European coral province (Sando 1990) comprises North Africa, and thus the overlap to Western Europe is self-evident. However, especially in the younger strata, faunal connections to the western United States (see discussion for *Bothrophyllum proteum*) and the Donets Basin have to be envisaged. The later relation was advocated by Semenoff-Tian-Chansky (1974, 1985), but it needs to be corroborated by a detailed study of the unpublished material of the Semenoff-Tian-Chansky collection. It is interesting to note that within the West European coral province, the Algerian basins were a refuge during the Serpukhovian because they were not affected by strong, adverse facies change so typical for the northern part of the province. The inventory of the

Legrand-Blain collection further corroborates the existence of an independent faunal province on the southern side of the Armorican micro-plate (Western Mediterranean Variscan zones) (Aretz 2002a, 2010a; Aretz & Herbig 2010).

All discussed points advocate the need for more detailed studies of the Algerian basins, which should certainly include new field work for the collection of additional material with a better control on the sedimentary facies. However, today's access to the remote area is almost impossible. Thus our knowledge of the Carboniferous corals from the Algerian Sahara will largely depend on the collections housed in the Muséum national d'Histoire naturelle in Paris.

CONCLUSIONS

The 96 specimens from the Carboniferous strata of the Algerian Sahara basins of the collection "Marie Legrand-Blain" include 34 rugose coral taxa and four tabulate coral taxa; one genus and three species of rugose corals are knew.

Overall, these numbers support the previously suggested high diversity of corals in that region. However, data on populations are insufficiently documented and thus the interspecific and intraspecific variabilities are poorly known. This results in a series of specimens that can only be assigned at a generic level.

Although corals were collected from various facies, only two large coral associations can be separated. Undissepimented solitary rugose corals and michilinid tabulate corals dominate in shaly environments, whereas larger and complex solitary and colonial rugose corals dominate in carbonate environments.

The Mid-Carboniferous Boundary is well marked by the renewed colonial coral fauna. The typical Mississippian *Lithostrotion* and *Siphonodendron* became extinct and new genera possibly immigrating from the Donets Basin appeared. Aulinid colonial corals indicate the proximity of the boundary. Rugose corals play a critical role in rejecting the Bashkirian age of strata in the Illizi Basin and the "Calcaire de Djebel Berga" based on microfossils.

The studied fauna contains elements typical of the West European coral province, but at least in the Pennsylvanian, gets input from the western United States and the Donets Basin.

Considering the limited accessibility of the remote Algerian basins, old collection like the Marie Legrand-Blain collection seem to be the best source for the study of Algerian Carboniferous corals.

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APPENDIX 1

Overview on the geographic and stratigraphical positions of the sampled horizons and main references. **ML**, exact horizon Marie Legrand-Blain took the sample from.

TINDOUF BASIN

ML 415 Foum Defili, Ouarkziz Fm (lower part), late Viséan, Legrand-Blain 1985a;
ML 429 Foum Defili, Ouarkziz Fm (upper part), late Serpukhovian, Legrand-Blain 1985a.

BÉCHAR BASIN *SENSU LATO*

ML 229 Djenien, Tagana 1 E, lower Bashkirian, Legrand-Blain 1985a;
ML 620 Djorf el Morhabar Nord, El Hariga Fm (lower part), early Viséan, Pareyn 1961;
ML 622 El Hariga, El Hariga Fm (upper part), early Viséan, Pareyn 1961;
ML 628 Chebket Mennouna?, Hassi Kerma Fm (upper part), lower Bashkirian, Legrand-Blain 1985a;
ML 803 El Aouedj, Oued Amouche 2, Serpukhovian, Legrand-Blain 1985a;
ML 808 Goumirats, Goumirats Fm, Niveau Ioucha 10, late Viséan, Pareyn 1961;
ML 809 Djebel er Rneb, Archipel Fm, Niveau Ioucha 14, late Viséan, Pareyn 1961;
ML 1145 S. Oglat Hamia, Oued el Hamar Fm?, Bashkirian?, Deleau 1951;
ML 1146 S. Oglat Hamia, Oued el Hamar Fm?, Bashkirian?, Deleau 1951.

REGGANE BASIN

ML 638 South of Taïbine , Djebel Berga Limestone, late Viséan, Legrand-Blain 1985a;
ML 639 South of Taïbine , Djebel Berga Limestone, late Viséan, Legrand-Blain 1985a;
ML 646 South of Taïbine, Djebel Berga Limestone, early Serpukhovian, Legrand-Blain 1985a;
ML 657 South of Taïbine, Djebel Berga Limestone, early Serpukhovian, Legrand-Blain 1985a;
ML 661 South of Taïbine, Hassi Taïbine Gypsum (lower part), late Serpukhovian, Legrand-Blain 1985a;
ML 662 South of Taïbine, Hassi Taïbine Gypsum (upper part), late Serpukhovian, Legrand-Blain 1985a;
ML 663 South of Taïbine, Hassi Taïbine Gypsum (upper part), late Serpukhovian, Legrand-Blain 1985a;
ML 692 El Ahmar, Djebel Berga Limestone, early Serpukhovian, Legrand-Blain 1985a;
ML 694 El Ahmar, Djebel Berga Limestone, early Serpukhovian, Legrand-Blain 1985a;
ML 698 El Ahmar, Djebel Berga Limestone, late Viséan, Legrand-Blain 1985a.

AHNET BASIN

ML 547 Djebel Berga, Tirechoumine Shales, late Viséan?;
ML 579 Tirechoumine, Tirechoumine Shales (lower part), early Viséan?;
ML 586 Tirechoumine, Tirechoumine Shales (middle part), late Viséan, Legrand-Blain 1986;
ML 591 Tirechoumine, Tirechoumine Shales (middle part), late Viséan, Legrand-Blain 1986.

ILLIZI BASIN

ML 444bis S. of Oued Oubarakat, Assekaifaf Fm, early Serpukhovian, Legrand-Blain 1978;
ML 445 S. of Oued Oubarakat, Assekaifaf Fm, early Serpukhovian, Legrand-Blain 1978;
ML 458 Dôme à Collenias, lower Assekaifaf Fm (lower part), late Viséan, Legrand-Blain 1978;
ML 460 Dôme à Collenias, lower Assekaifaf Fm (lower part), late Viséan, Legrand-Blain 1978;
ML 476 Dôme à Collenias, lower Assekaifaf Fm (lower part), late Viséan, Legrand-Blain 1978;
ML 463 Dôme à Collenias, lower Assekaifaf Fm (upper part), early Serpukhovian, Legrand-Blain 1978;
ML 481 Dôme à Collenias, lower Assekaifaf Fm (upper part), early Serpukhovian, Legrand-Blain 1978;
ML 486 N. of Dôme à Collenias, middle Oued Oubarakat Fm , late Serpukhovian , Legrand-Blain 1978;
ML 511 Ikebrane, upper Oued Oubarakat Fm, late Serpukhovian, Legrand-Blain 1978;
ML 517 Assekaifaf, lower Assekaifaf Fm (lower part), late Viséan, Legrand-Blain 1978.

APPENDIX 2

Overview on the studied specimens: collection number of MNHN, identification, number of thin section (**T**, transverse; **L**, longitudinal) and the presence of the entire specimen.

No. coll. MNHN	Identification	Thin-sections	Specimen
MNHN.F.A32948	?*Amplexizaphrentis illizidensis* n. sp.	3T	×
MNHN.F.A32949	?*Amplexizaphrentis* sp.		×
MNHN.F.A32950	?*Amplexizaphrentis* sp.		×
MNHN.F.A32951	?*Amplexizaphrentis* sp.	1T	×
MNHN.F.A32952	?*Amplexizaphrentis* sp.		×
MNHN.F.A32953	?*Amplexizaphrentis* sp.	2T	×
MNHN.F.A32954	?*Amplexizaphrentis* sp.		×
MNHN.F.A32955	?*Amplexizaphrentis* sp.		×
MNHN.F.A32956	?*Amplexizaphrentis* sp.		×
MNHN.F.A32957	?*Amplexizaphrentis* sp.	1T	×
MNHN.F.A32958	?*Amplexizaphrentis* sp.	1T	×
MNHN.F.A32959	?*Amplexizaphrentis* sp.		×
MNHN.F.A32960	?*Amplexizaphrentis* sp.	1T	×
MNHN.F.A32961	?*Amplexizaphrentis* sp.		×
MNHN.F.A32962	?*Amplexizaphrentis* sp.	1T	×
MNHN.F.A32963	?*Amplexizaphrentis* sp.	2T	×
MNHN.F.A32964	*Zaphrentites* sp.	1T	×
MNHN.F.A32965	*Zaphrentites* sp.	1T	×
MNHN.F.A32966	*Zaphrentites* sp.	1T	×
MNHN.F.A32967	*Zaphrentoides* sp.	1T	×
MNHN.F.A32968	*Zaphrentoides* sp.	1T	×
MNHN.F.A32969	*Zaphrentoides* sp.	1T	×
MNHN.F.A32970	*Zaphrentoides* sp.		×
MNHN.F.A32971	*Zaphrentoides* sp.	1T	×
MNHN.F.A32972	*Zaphrentoides* sp.	1T	×
MNHN.F.A32973	*Zaphrentoides* sp.	1T	×
MNHN.F.A32975	*Saharaphrentis tirechouminoidense* n. gen., n. sp.	4T, longit.cut	×
MNHN.F.A32974	*Saharaphrentis tirechouminoidense* n. gen., n. sp.	3T	×
MNHN.F.A32976	*Saharaphrentis tirechouminoidense* n. gen., n. sp.		×
MNHN.F.A32977	*Saharaphrentis tirechouminoidense* n. gen., n. sp.		×
MNHN.F.A32978	*Saharaphrentis tirechouminoidense* n. gen., n. sp.		×
MNHN.F.A32979	*Saharaphrentis* cf. *tirechouminoidense*	1T	×
MNHN.F.A32980	Stereolasmatina gen. indet. 1 sp. indet. 1	1T	×
MNHN.F.A32981	Stereolasmatina gen. indet. 2 sp. indet. 1	1T	×
MNHN.F.A32982	Stereolasmatina gen. indet. 2 sp. indet. 1	1T	×
MNHN.F.A32983	*Lophophyllidium* sp.	1T	
MNHN.F.A32984	*Lophophyllidium* sp.	1T	
MNHN.F.A32985	*Siphonophyllia samsonensis* (Salée, 1913)	4T, 1L	
MNHN.F.A32986	*Haplolasma paraarciferum* n. sp.	2T, 1L	×
MNHN.F.A32987	*Haplolasma* aff. *paraarciferum*	1T, 1L	
MNHN.F.A32988	*Palaeosmilia murchisoni* Milne Edwards & Haime, 1848	1T	×
MNHN.F.A32989	*Palaeosmilia murchisoni*	1T, 1L	×
MNHN.F.A32990	*Palaeosmilia* sp.	2T	×
MNHN.F.A32991	*Palaeosmilia* sp.		×
MNHN.F.A32992	*Palaeosmilia* sp.	1T	×
MNHN.F.A32993	*Palaeosmilia* sp.		×
MNHN.F.A32994	*Palaeosmilia* sp.		×
MNHN.F.A32995	*Amygdalophyllum* sp.	2L, 1T	×
MNHN.F.A32996	*Espielia columellata* Rodríguez & Hernando, 2005	1T, 1L	×
MNHN.F.A32997	*Clisiophyllum keyserlingi* McCoy, 1849	2T, 2L	
MNHN.F.A32998	*Clisiophyllum keyserlingi*	3T	
MNHN.F.A32999	*Clisiophyllum keyserlingi*	1T	×
MNHN.F.A33000	*Dibunophyllum bipartitum* (McCoy, 1849)	1T, 1L	×

APPENDIX 2 – Continuation.

No. coll. MNHN	Identification	Thin-sections	Specimen
MNHN.F.A33001	*Dibunophyllum bipartitum*	1T, 1L	×
MNHN.F.A33002	*Dibunophyllum bipartitum*	1T	×
MNHN.F.A33003	*Dibunophyllum bipartitum*	2T, 2L	×
MNHN.F.A33004	*Dibunophyllum bipartitum*	2T, 1L	×
MNHN.F.A33005	*Dibunophyllum bipartitum*	2T	×
MNHN.F.A33006	*Dibunophyllum bipartitum*	2T, 1L	×
MNHN.F.A33552	*Dibunophyllum bipartitum*	2T, 1L	×
MNHN.F.A33553	*Dibunophyllum bipartitum*	2T, 1L	×
MNHN.F.A33007	*Dibunophyllum arachnoforme* Vassiljuk, 1960	2T, 1L x	×
MNHN.F.A33008	*Arachnolasma* sp.	2T, 2L	×
MNHN.F.A33009	*Koninckophyllum magnificum* Thomson & Nicholson, 1876	2T	×
MNHN.F.A33010	*Koninckophyllum magnificum*	1T	×
MNHN.F.A33011	*Koninckophyllum interruptum* Thomson & Nicholson, 1876	1T, 1L	×
MNHN.F.A33012	*Koninckophyllum interruptum*	1T, 1L	×
MNHN.F.A33013	*Koninckophyllum* cf. *interruptum* Thomson & Nicholson, 1876	3T, 1L	×
MNHN.F.A33014	*Koninckophyllum* aff. *variabile* Semenoff-Tian-Chansky, 1974	2T, 1L	×
MNHN.F.A33015	*Koninckophyllum* sp.	1T	×
MNHN.F.A33016	*Turbinatocaninia* sp.	2T, 2L	×
MNHN.F.A33017	*Bothrophyllum proteum* Semenoff-Tian-Chansky, 1974	2T	×
MNHN.F.A33018	*Bothrophyllum proteum*	1T	×
MNHN.F.A33019	*Bothrophyllum proteum*	1T	×
MNHN.F.A33020	*Bothrophyllum proteum*		×
MNHN.F.A33021	*Bothrophyllum proteum*		×
MNHN.F.A33022	*Caninophyllum archiaci* (Milne Edwards & Haime, 1852)	1T	×
MNHN.F.A33023	*Caninophyllum* sp.	1T, 1L	×
MNHN.F.A33024	*Lithostrotion decipiens* (McCoy, 1849)	1T, 2L	×
MNHN.F.A33025	*Lithostrotion decipiens*	2T, 1L	×
MNHN.F.A33026	*Lithostrotion decipiens*	1T	×
MNHN.F.A33027	*Lithostrotion vorticale* (Parkinson, 1808)	2T, 1L	×
MNHN.F.A33028	*Lithostrotion vorticale*	1T, 1L	×
MNHN.F.A33029	*Lithostrotion vorticale*	1T	×
MNHN.F.A33554	*Lithostrotion vorticale*	2T, 1L	×
MNHN.F.A33030	*Lithostrotion vorticale*	1T, 1L	×
MNHN.F.A33031	*Siphonodendron martini* (Milne Edwards & Haime, 1851)	1T, 1L	×
MNHN.F.A33032	*Aulina* (*Pseudoaulina*) *botanica* Nudds, 1977	1T	×
MNHN.F.A33033	?*Ivanovia* sp.	1T	×
MNHN.F.A33034	*Syringopora* sp.		×
MNHN.F.A33035	*Syringopora* sp.		×
MNHN.F.A33036	*Multithecopora* sp.	1T, 1L	×
MNHN.F.A33037	*Multithecopora* sp.	1T	×
MNHN.F.A33038	*Michelinia* sp.		×
MNHN.F.A33039	*Michelinia* sp.		×
MNHN.F.A33040	?*Michelinia* sp.		×