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The oldest Jurassic cyathophorid coral (Scleractinia) from siliciclastic environments of the Kachchh Basin, western India

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with 9 figures

Kurzfassung: Elf Exemplare der Koralle *Cyathophora* MICHELIN, 1843, bekannt aus dem Oberjura und der Kreide, wurden im Mitteljura (Bajoc) des Beckens von Kachchh, westliches Indien, gefunden. Sie stammen aus dem Babia Cliff Sandstone member der Kaladongar Formation, die entlang des nördlichen Abbruchs von Kala Dongar auf Pachchham Island aufgeschlossen ist. Die Exemplare werden als die ältesten jurassischen Vertreter der Familie Cyathophoridae VAUGHAN & WELLS, 1943 beschrieben und abgebildet. Das monospezifische Auftreten von *Cyathophora* geht vermutlich auf Schwankungen im Salzgehalt des randlich marinen Ablagerungsraumes zurück.

Schlüsselwörter: Scleractinia, Korallen, Bajoc, Palökologie, Kachchh, Indien

Abstract: *Cyathophora* MICHELIN, 1843, hitherto well known from the Upper Jurassic and Cretaceous, has been found in the Middle Jurassic (Bajocian) of the Kachchh Basin, western India. Eleven specimens of *Cyathophora bourgueti* (DEFRANCE, 1826) from the Babia Cliff Sandstone member of the Kaladongar Formation, exposed along the northern scarp of the Kala Dongar, Pachchham Island, Kachchh, are described and illustrated as the earliest Jurassic record of the family Cyathophoridae VAUGHAN & WELLS, 1943. It is suggested that the monospecific occurrence of *Cyathophora bourgueti* was controlled by salinity.

Keywords: Scleractinia, corals, Bajocian, palaeoecology, Kachchh, India

Introduction

Our knowledge of the taxonomy and palaeoecology of Jurassic (Bajocian to Oxfordian) scleractinian corals of the Kachchh and Jaisalmer basins of western India has much progressed during the last decade (PANDEY & FÜRSICH 1993, 1994, 2001; FÜRSICH et al. 1994; PANDEY & LATHUILIÈRE 1997; PANDEY et al. 1999). In Kachchh, scleractinian corals commonly occur at specific horizons and localities in both carbonate and siliciclastic sediments. They are mainly autochthonous or intra-basinally transported for short distances. In all, eight coral assemblages reflecting different energy levels, depths and substrate conditions have been recognized (PANDEY & FÜRSICH 2001). *Cyathophora* MICHELIN is among the few genera that occur in the older part of the marine sequence of the Kachchh Basin exposed along the northern scarp of the Kala Dongar, Pachchham Island, Kachchh (Fig. 1), assigned to the Bajocian Babia Cliff Sandstone member (BISWAS 1980) of the Kaladongar Formation (Fig. 2). The finding of the genus *Cyathophora* in the Kachchh Basin is significant, because this is the oldest Jurassic record of the genus. Previously, the oldest Jurassic record of the genus was published by GERTH (1928) from the Early Lower Jurassic of the Neuquen Basin, Argentina, on the basis of a collection made by WEAVER (locality no. 1029; see WEAVER 1931). Unfortunately, WEAVER'S locality was never found again (DAMBORENEA 1987; MORSCH 1995). Moreover, WEAVER (1931) reassigned *Cyathophora decamera* GERTH to the genus *Cryptocoenia* D'ORBIGNY. MORSCH (1999, pers. comm.) studied the holotype and found it so poorly preserved that she did not include it in her work. Further, according to her it does not appear to be a typical specimen from the Lower Jurassic, at least as far as Argentina is concerned. Disregarding GERTH'S material, the occurrence of *Cyathophora* in Kachchh thus is the earliest Jurassic record of the genus and, at the same time, expands the geographic range of the taxon, which hitherto had not been recorded from India. The validity and taxonomic status of the genus *Cyathophora* is also of great interest for Jurassic coral experts.

Geological and stratigraphic framework

Jurassic outcrops in the Kachchh Basin form two more or less east-west running belts called the Islands Belt and the Kachchh Mainland, situated south of the Great Rann of Kachchh (Fig. 1).

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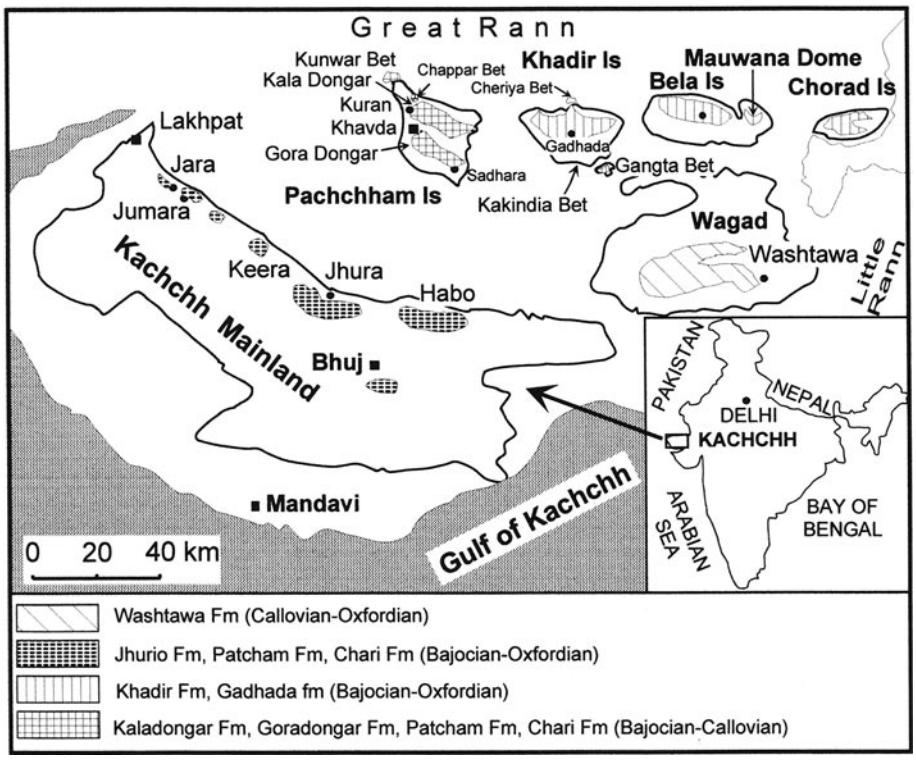


Fig. 1. Locality map of Jurassic corals in the Kachchh basin, western India.

The sea transgressed onto the pericratonic rift basin, situated at the western margin of the Indian plate, during or before Bajocian times (SINGH et al. 1982; FÜRSICH et al. 2001) and remained there with minor fluctuations until the early Cretaceous. The sediments range from nearshore coarse-grained siliciclastics to offshore clays, silts and carbonates.

Several lithostratigraphic schemes have been proposed for the Jurassic sediments of the Kachchh Basin (WYNNE 1872; WAAGEN 1873-75; RAJNATH 1932; AGRAWAL 1956; BISWAS 1980). We adopt a revised classification of more regional applicability proposed after detailed field investigations by FÜRSICH et al. (2001) (Fig. 2).

Material and methods

In all, eleven specimens (RUC1998I 779-781, RUC1999I 6-9, 145-147; RUC1999III 414) were collected in the years 1998 and 1999 from the northern scarp of the Kala Dongar, a large anticline forming part of Pachchham Island (Kachchh). Of these, three were collected from the northern scarp near the Pachchhmaipir temple as stray samples (RUC1998I 779-781), three more specimens (RUC1999I 6, 145; RUC1999III 414) were collected near the top of the northern scarp of the Kala Dongar, along the so-called Babia Cliff Sandstone member near the Pachchhmaipir temple. Four specimens (RUC1999I 7, 9, 146-147) were collected from debris at the base of the slope at the Narweri Wandh, probably derived from the northern limb of the Babia Cliff Sandstone member. One specimen (RUC1999I 8) was found in the scree halfway up the cliff at the same locality and most likely comes from the same stratigraphic level. All specimens are moderately preserved and apparently have been reworked. Details of the microstructure of the skeletal elements could not be studied, due to recrystallisation.

Repository: The specimens are housed in the Palaeontological Laboratory, Department of Geology, University of Rajasthan, Jaipur (prefix RUC).

Systematic palaeontology

Order Scleractinia BOURNE, 1900
Suborder ? Stylinina ALLOITEAU, 1952
Family Cyathophoridae VAUGHAN & WELLS, 1943
emend. ALLOITEAU, 1952
Genus *Cyathophora* MICHELIN, 1843

Type species: *Cyathophora richardi* MICHELIN, 1843 (: 104).

Original diagnosis (MICHELIN 1843: 104): Polyparium lapideum, fixum, glomerato-globosum vel ramosum, tubulosum; superficie cellulis immersis; cellulis sparsis, per diaphragmata transversa divisis, distinctis, obsoletè stellatis; lamellis subnullis.

Remarks: Several authors pointed out some difficulties when referring to the types of *Cyathophora* MICHELIN and other closely related genera (MILNE-EDWARDS & HAIME 1851: 107; ALLOITEAU 1948; RONIEWICZ 1966; LÖSER 1994, 1998; BARON-SZABO & BERTLING 1996). MILNE-EDWARDS & HAIME (1851) felt that MICHELIN established the genus "on a very imperfect specimen", with only rudimentary septa and no columella. Instead, they found *Astrea bourgueti* in the DEFRANCE collection a better preserved specimen with well developed septa. Today, *C. bourgueti* is differentiated from *C. richardi* on basis of well developed septa (see below). LÖSER (1994:

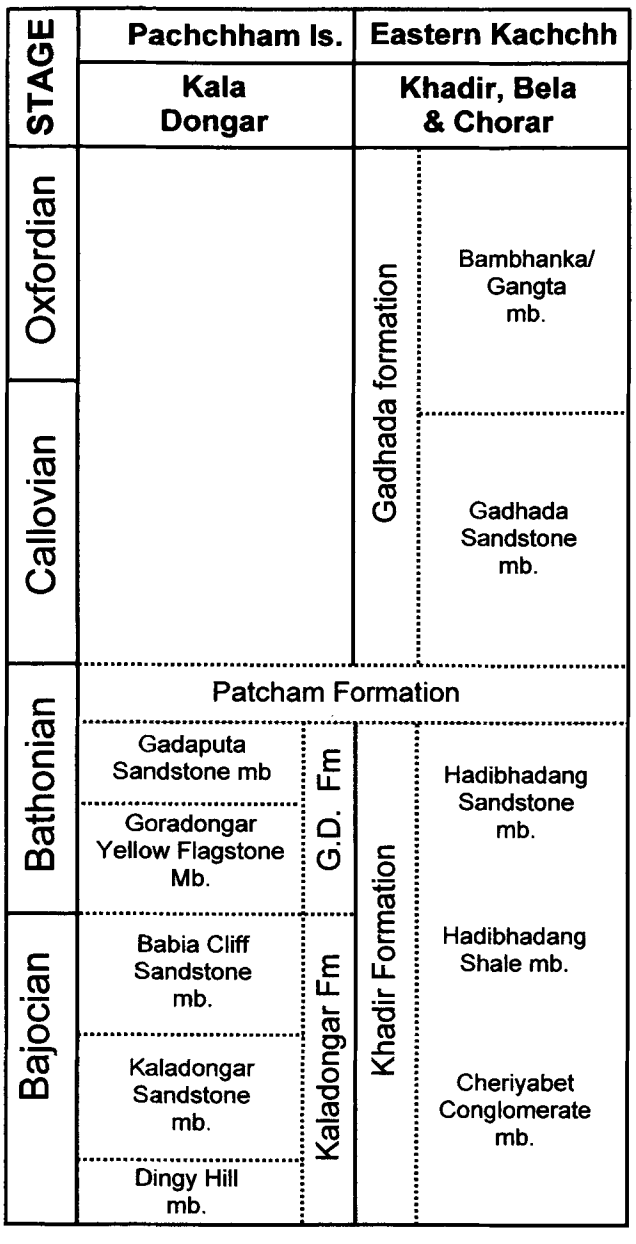


Fig. 2. Lithostratigraphic framework of Middle Jurassic rocks of Kachchh.

9, 1998: 31) found that the four specimens of *C. richardi* (type species of *Cyathophora*) in the MICHELIN collection either belong to *Stylina* or are poorly preserved specimens. We (D.K.P. & B.L.) have studied the specimens and confirm his observations. LÖSER's conclusion was that the genus is uncertain and should no longer be used. However, the sample no. M 00067 (MNHN Paris) mentioned by him as the "closest of the figured specimens" comes from Clamecy (Burgundy), instead of Agey (Burgundy), Is sur Thil (Burgundy) or St Mihiel (Lorraine) as stated in MICHELIN. We consider this specimen different from the specimen figured by MICHELIN (1843: 104, pl. 26 fig. 1b). This throws some doubt on the correct identification of the specimen. Furthermore, the Latin text is quite clear about the development of septa: "lamellis subnullis" and tabulae: "diaphragmata transversa divisis". Quite clearly, the concept of *C. richardi* has not been based on the remaining samples in the MICHELIN collection but on a specimen that should be considered as lost.

The stability of the nomenclature of this genus has been amply documented (e.g. KOBY 1881: 96, 1889: 541; ALLOITEAU 1948: 715; WELLS 1956: F375; FLÜGEL 1966: 55; RONIEWICZ 1966: 176, 1976: 44; MORYCOWA 1971: 40, tab. 5; BENDUKIDZE 1982: 7; ERRENST 1990: 165). We consider that the characters (mentioned below) that are coherent with the original figure and description and the past use of this genus differ sufficiently from *Stylina*.

The diagnostic characters of *Cyathophora* are a massive, flat, globose, ramose, plocoid to cerioid corallum; superficial or depressed corallites, polygonal or circular in outline; corallites that are divided by tabulae, and very small or rudimentary septa.

The samples in the MICHELIN collection should not be considered as syntypes. Consequently, a neotype should be defined comformably to the traditional taxonomic concept of the genus and to the original diagnosis, but this is beyond the scope of the present paper.

The taxonomic placement of the genus is quite ambiguous. MICHELIN (1843: 104) compared this genus to *Cyathophyllum* GOLDFUSS (1826: 54). FROMENTEL (1865: 27) described it under "Madréporaires Tabulés". A few authors remarked that the morphology of tabulae is like that of Palaeozoic corals (e.g. RONIEWICZ 1976: 44). However, it has always been placed within the order Scleractinia. KOBY (1889: 567) assigned the genus to the family Stylinidae. VAUGHAN & WELLS (1943: 109) placed it in their new subfamily Cyathophorinae within the Stylinidae, suborder Astrocoeniina (see also WELLS 1956: F375). Subsequent authors have elevated this subfamily to the rank of a family (Cyathophoridae) within the suborder Stylinina (RONIEWICZ 1966: 178, 1976: 44; BEAUVAIS 1980; CHEVALIER 1987).

The main character of the family is the predominance of tabulae over septa in construction of the corallite. This means that septa originate each time on a new tabula in the form of a fold and imbricate with the corresponding preceding septa along the periphery of the corallite (Fig. 8). We believe that this character allows to distinguish *Cyathophora* and cyathophorids from a large set of genera such as *Cryptocoenia*, *Pseudocoenia*, *Orbignycoenia*, *Adelocoenia*, and *Pentacoenia*. These genera evolved after the Bajocian, their nomenclatorial status remains often unclear (BARON-SZABO & BERTLING 1996; LÖSER 1998), and/or the state of preservation of the types is so poor that the types do not contribute to the solution of taxonomic problems.

On the character of septa, *Bilaterocoenia* MORYCOWA (1974) should also be excluded from the family Cyathophoridae. *Confusaforma* LÖSER, 1987, initially proposed as a cyathophorid, has been transferred to the heterocoeniids (KOLODZIEJ 1995; STOLARSKI & RUSSO 2001). According to their authors, *Amphiphora* ALLOITEAU & BERNIER, 1969 differs from *Cyathophora* on the basis of

budding ("Taschenknospung"). According to STOLARSKI (written comm.), the figures of ALLOITEAU & BERNIER are not convincing, and we consider *Amphiphora* to be possibly a *Cyathophora*. The first representatives of the family have been described from the Middle Triassic under the name *Cyathophora* (*Procyathophora*) *fuerstenbergensis* by WEISSERMEL (1928). The subgenus has been subsequently promoted to generic rank (ALLOITEAU 1952).

We cannot exclude that some other Triassic taxa might have been described under non-cyathophorid names such as *Cyathocoenia*, *Cassianastrea*, or even *Convexastrea*. No Liassic form has been recorded. *Bathycoenia* TOMES, 1883 and *Elasmophora* ALLOITEAU, 1958 are possible Jurassic representatives of the family, having been described from the Bathonian and Lower Callovian, respectively. They are still in need of revision. *Cyathophora* is clearly the more common genus of the family during the Jurassic. Other representatives are Cretaceous in age: *Cyathophoropsis* ALLOITEAU, 1947, *Columellophora* ELIASOVA, 1989, *Holocystis* LONSDALE, 1849 and *Nowakocoenia* KOLODZIEJ, 2000 are very close to *Cyathophora* from which they differ only by septal symmetry. From this follows that the specimens from Kachchh correspond to the reappearance of cyathophorids in the fossil record, after a gap of some 40 million years.

Cyathophora bourgueti (DEFRANCE, 1826)
Figs. 3-8

* 1826 *Astrea bourgueti* sp. nov. – DEFRANCE: 380.
1843 *Cyathophora richardi* sp. nov. – MICHELIN: 104, pl. 26 fig. 1.
1859 *Cyathophora claudiensis* sp. nov. – ETALLON: 479.
1875 *Cyathophora bourgueti* (DEFRANCE). – BECKER: 149, pl. 37 fig. 5.
pt 1881 *Cyathophora thurmanni* sp. nov. – KOBY: 96, pl. 26 fig. 7 only.
1881 *Cyathophora bourgueti* (DEFRANCE). – KOBY: 99, pl. 26 figs. 1-3.
1964 *Cyathophora richardi* MICHELIN. – BEAUVAIS: 114, non pl. 3 fig. 5.
1966 *Cyathophora claudiensis* ETALLON. – RONIEWICZ: 178, pl. 1 fig. 4.
1966 *Cyathophora richardi* MICHELIN. – RONIEWICZ: 178, pl. 1 figs. 3a-c.
1976 *Cyathophora claudiensis* ETALLON. – RONIEWICZ: 44, pl. 4 fig. 1.
1990 *Cyathophora bourgueti* (DEFRANCE). – ERRENST: 166, pl. 2 figs. 3a-c [see for extensive synonymy].
1990 *Cyathophora claudiensis* ETALLON. – ERRENST: 167, pl. 2 fig. 4a-d [see for extensive synonymy].
1991 *Cyathophora claudiensis* ETALLON. – LAUXMANN: 114 [see for extensive synonymy].
1993 *Cyathophora bourgueti* (DEFRANCE). – BERTLING: 84, pl. 1 fig. 3 [see for extensive synonymy].

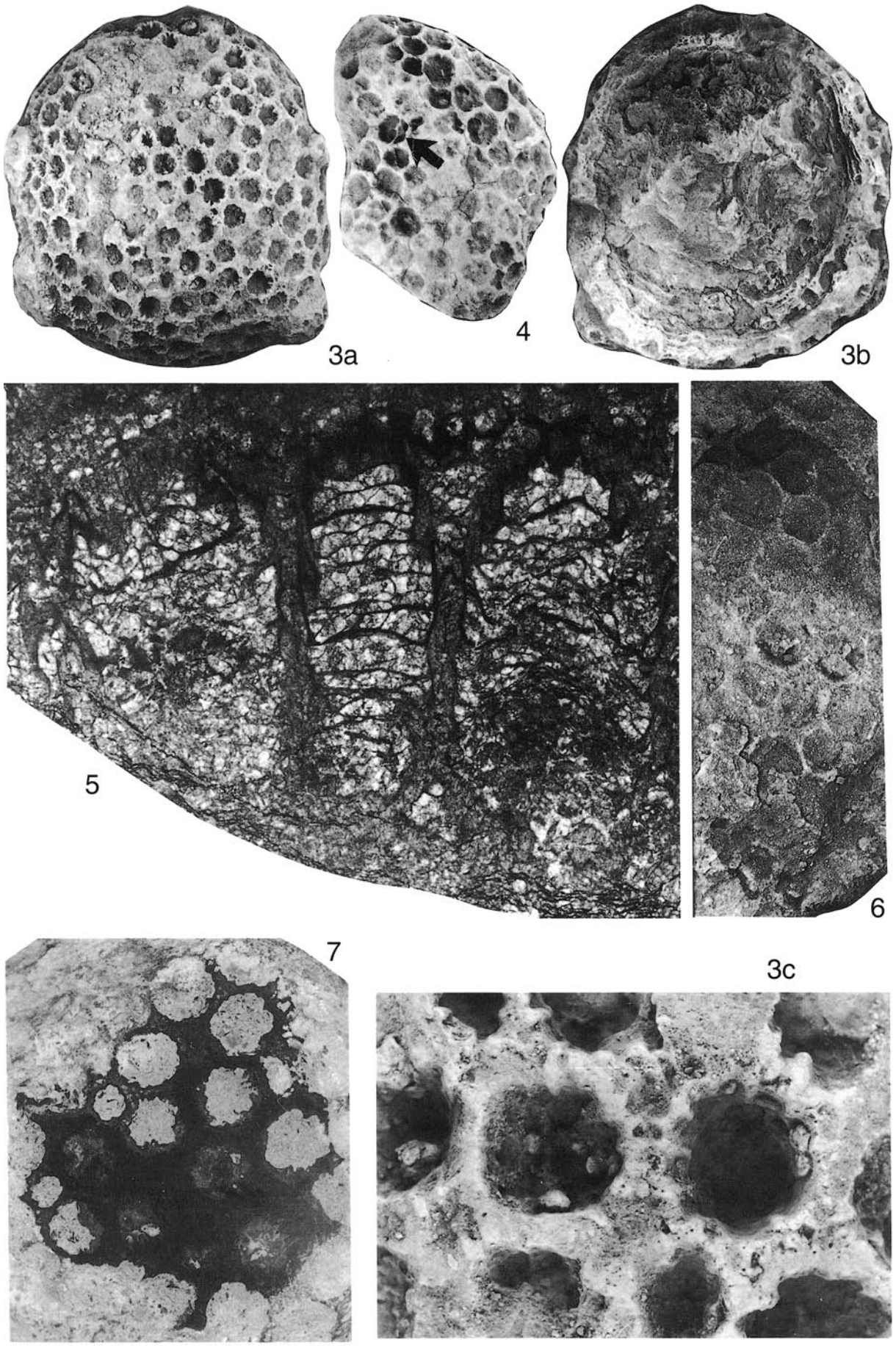
Description: Corallum colonial, massive plocoid to cerioid, shape varying from subpedunculate, fungiform or nodular to flat. Shape in plan-view subcircular to irregular. Attachment area small. Calices demarcated by prominent wall, diameters ranging from 3 to 8 mm, not projecting above the inter-calicular surface. Budding both inter- and intracalicular: If seen from the distal surface, intercalicular budding is more common. However, the calices of the specimens RUC1999I 9 (Fig. 4) and RUC1999III 414 display septal budding. In plocoid colonies, the corallites are circular in outline, the peritheca is thin to thick consisting of costae (density 3 per 2 mm) and exothecal vesicular dissepiments (Fig. 5). In cerioid colonies corallites are polygonal; mostly pentagonal, hexagonal or tetragonal.

Tabulae are common (density 5 per 2 mm or 11-12 per 5 mm), thin, concave or convex upward to undulating, joining the wall asymmetrically i.e., occasionally the upper surface of the tabulae forms an obtuse angle with the wall whereas the lower surface meets the wall at approximately right angle. Septa rudimentary, numbering 12 to 42, confined to the wall near the distal margin and becoming gradually more prominent proximally until they merge at the centre of the youngest tabula (Fig. 8). Septa occurring in multiples of six are arranged mostly in two cycles that differ morphologically. The septa of the first cycle are slightly thicker and larger than those of the second one. Rarely, a few septa of the third cycle can also be seen. The lower surface of the corallum is covered with concentric folds. The numerous rudimentary septa and the tangential attachment of tabulae suggest a mixed nature of the wall.

Remarks: The ploco-cerioid form is a characteristic feature of the colony. In the same colony, the lower part may be cerioid while the upper part becomes plocoid. In some cases, the upper surface exhibits both cerioid and plocoid growth structures. A longitudinal thin-section of specimen RUC1999III 414 (Fig. 5) exhibits a well-developed parathecal wall formed by the upward continuation of the tabulae. In the case of septal budding two to three septa reach the centre.

Cyathophora bourgueti (DEFRANCE) described by earlier authors has a wide variability in diameter and number of septa (Fig. 9). The variability of the number of septa may relate, at least in part, to the rudimentary nature of septa. We believe that in *Cyathophora* the counting of costae is more efficient in order to understand the structure of the variability. The range of diameter and number of septa in the Kachchh specimens fit within the variability of *C. bourgueti*. Interestingly, many other nominal species also fit within this range (Fig. 9). Most of them are probably not biological species and, according to our

Figs. 3-7. *Cyathophora bourgueti* (DEFRANCE) from the Babia Cliff Sandstone member, Kaladongar Formation, Kala Dongar. – **3:** RUC1999I 12; **a.** View of upper surface, x0.97; **b.** View of lower surface, x0.97; **c.** Part of upper surface showing the rudimentary septa, x6.5. – **4:** RUC1999I 9, x1; view of upper surface showing septal budding. – **5:** RUC1999III 414, x8; Longitudinal thin-section of the colony showing tabulae and their relationship with the wall, peritheca consisting of exothecal vesicular dissepiments. – **6:** RUC1999I 145, x2; part of upper surface showing cerioid growth form. – **7:** RUC1999I 6, x2; part of upper surface showing varying thickness of peritheca.


3a
4
3b
5
6
7
3c

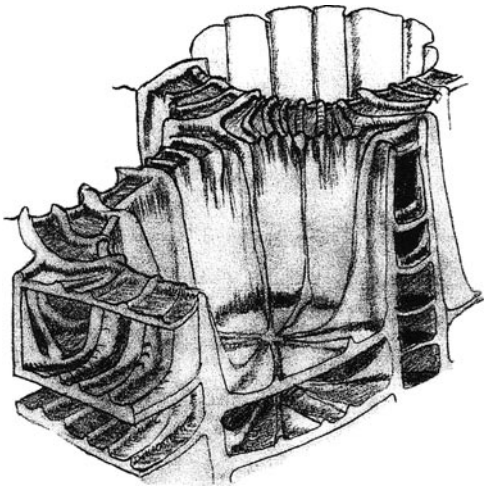


Fig. 8. Sketch showing skeletal structure of *C. bourgueti* (DEFRANCE). Note the rudimentary septa confined to the wall near the distal margin and becoming gradually more prominent proximally until they merge at the centre of the youngest tabula.

knowledge about the variability of Recent species of corals, they could represent, at least in part, ecophenotypic variants of one and the same unit (e.g. BUDD FOSTER 1979; VERON 1995). However, it was not possible to study whole populations with more refined characters and to observe all the types. For this reason, we restrict the synonymy to the list given above.

Based on the range of variation of the dimensions, variability of the radial elements and other morphological features in the present specimens, *Cyathophora claudiensis* ETALLON and *Cyathophora richardi* MICHELIN are considered synonyms of *Cyathophora bourgueti* (DEFRANCE) (see also MICHELIN 1843; ÉTALLON 1859; RONIEWICZ 1966, 1976; BEAUVAIS 1964; ERRENST 1990; LAUXMANN 1991). ERRENST (1990) differentiated the massive cerioid colony of *Cyathophora bourgueti* (DEFRANCE) from the massive plocoid colony of *C. claudiensis* ETALLON. As mentioned above, the Kachchh specimens exhibit both types of growth structures in the same colony.

Cyathophora bourgueti in THURMANN & ETALLON (1864: 373, pl. 52 fig. 8) and *C. thurmanni* KOBY (1881: 96, pl. 26 fig. 7) are objective synonyms, which RONIEWICZ (1966: 173, pl. 1 fig. 3) assigned to *Cyathophora richardi* MICHELIN.

C. thurmanni KOBY (1881: 96, pl. 26 figs. 4-6, non fig. 7) shows a range of corallite diameter which is similar to the present specimens but differs in having a high septal and costal density and septa reaching up to the center of the calicular cavity.

Cyathophora gresslyi KOBY (1881: 98, pl. 26 fig. 8, pl. 29 fig. 6) and *C. pratti* MILNE-EDWARDS & HAIME (1851: 108, pl. 21 fig. 3; BEAUVAIS 1970: 45, pl. C fig. 3) also exhibit similar ranges of corallite diameter, but *C. gresslyi* shows large septa and dense costal density (at least 4 per 2 mm), and *C. pratti* displays a large and more uniform septal system.

Cyathophora nonseptata LAUXMANN (1991: 115, pl. 1 figs. 4-6) is an extreme form in which the septa are still smaller than in *Cyathophora bourgueti* (DEFRANCE) and costae are very poorly developed.

Cyathophora denseta ELIASOVA (1981: 120, pl. 2 fig. 1) from the Tithonian of Czechoslovakia, was created for its dense tabulae (23-24 per 10 mm). The range of the dimensions and the density of the tabulae are quite similar to *Cyathophora bourgueti* (DEFRANCE).

The sketch figure of *Cyathophora solida* PHILLIPS (1871: 239, pl. 11 fig. 1) shows very short septa confined to the periphery of the corallites and few tabulae. Thus it looks similar to the present specimens, but since no description has been given by PHILLIPS, no further comment is possible.

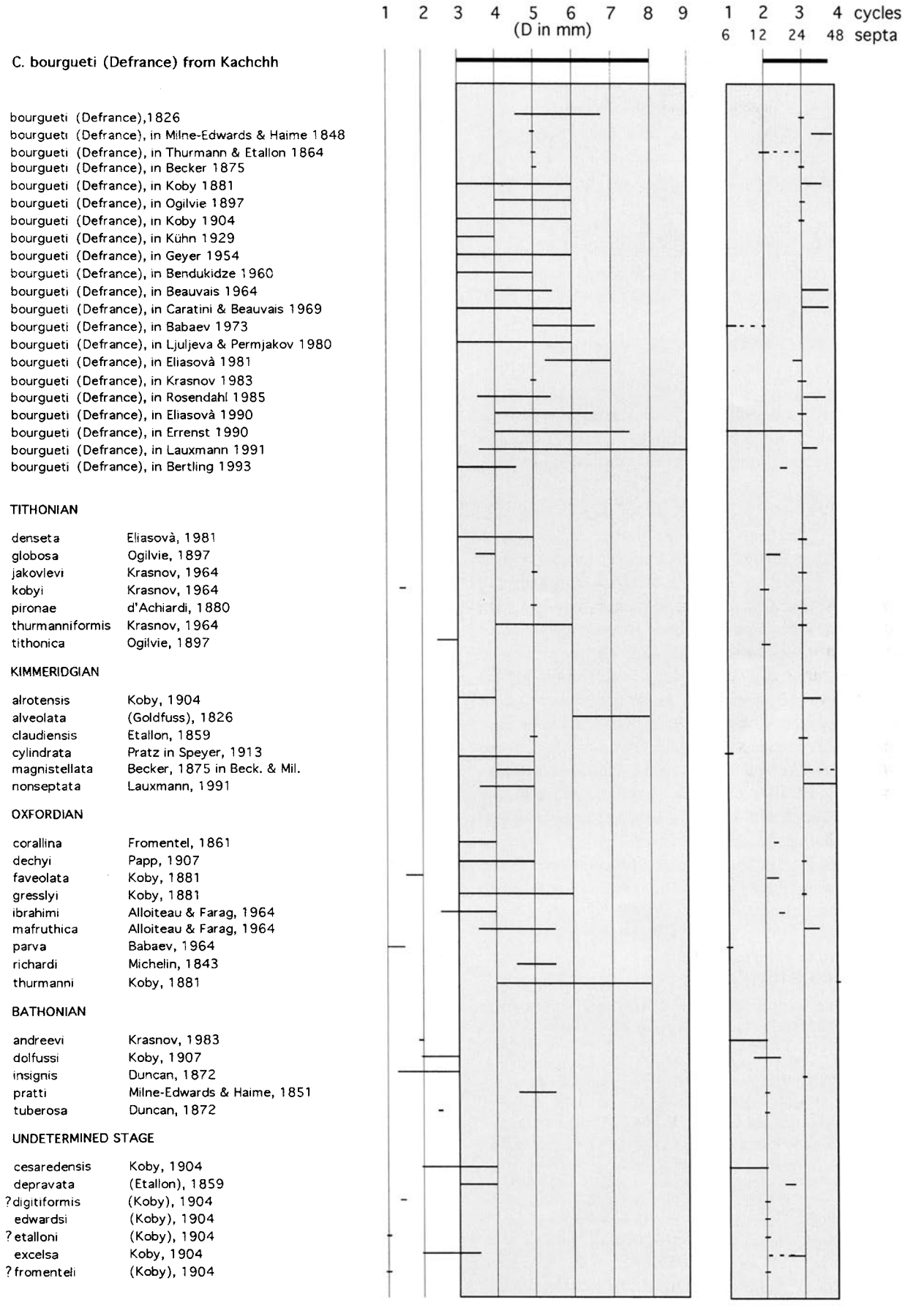
A few species display a very small corallite diameter (Fig. 9). It is difficult to ascertain from the literature their assignment to the genus *Cyathophora*. Among these, some of the species described by KOBY (1904) from the Jurassic of Portugal under the name *Convexastrea* should probably be classified as *Solenocoenia*.

Palaeoecology

All specimens come from calcareous sandstone. Interestingly, all coral specimens found on the scarp of Kala Dongar belong to *Cyathophora bourgueti*. Such a monospecific coral assemblage obviously points to an extreme environment. More than one century ago, TOMES (1883: 194) made the same observation for the occurrence of the Bathonian *Cyathophora* from Stonesfield, southern England.

From a functional morphology point of view, the plocoid structure and the calicular relief may be related to high turbidity as has been proposed by HUBBARD & POCOCK (1972) and HUBBARD (1973). Nevertheless, neither the cerioid structure, which is sometimes observed together with the plocoid growth form in *Cyathophora*, nor the U-shaped calicular relief, and the very simple morphology of septa fit this ecological explanation. Furthermore, the morphology of the colonies does not show any skullcap shapes as seen elsewhere (e.g. HÖFLING 1989) which might result from rapid sedimentation. Another controlling factor might have been salinity. The close association with bivalves such as the brackish water *Eomiodon* and the euryhaline *Indocorbula* as well as the marginal marine sediments that interfinger with fluvial channel sandstones support the idea of brachyhaline or even mesohaline waters (FÜRSICH et al. 2002). Areas

Fig. 9. Range chart for diameter (D) of corallites and number of septa in *Cyathophora* available from the literature and for the samples from the Bajocian sediments of Kachchh. Few of the dimensions were taken from the respective figures. The grey areas show the variability range of specimens described as *C. bourgueti*. The species with ? are dubious *Cyathophora*. The undetermined stage represents either Upper Oxfordian or Lower Kimmeridgian. For bibliographical references see LATHUILIÈRE (1989).


1 2 3 4 5 6 7 8 9
(D in mm)
1 2 3 4 cycles
6 12 24 48 septa
C. bourgueti (Defrance) from Kachchh
bourgueti (Defrance),1826
bourgueti (Defrance), in Milne-Edwards & Haime 1848
bourgueti (Defrance), in Thurmann & Etallon 1864
bourgueti (Defrance), in Becker 1875
bourgueti (Defrance), in Koby 1881
bourgueti (Defrance), in Ogilvie 1897
bourgueti (Defrance), in Koby 1904
bourgueti (Defrance), in Kühn 1929
bourgueti (Defrance), in Geyer 1954
bourgueti (Defrance), in Bendukidze 1960
bourgueti (Defrance), in Beauvais 1964
bourgueti (Defrance), in Caratini & Beauvais 1969
bourgueti (Defrance), in Babaev 1973
bourgueti (Defrance), in Ljuljeva & Permjakov 1980
bourgueti (Defrance), in Eliasovà 1981
bourgueti (Defrance), in Krasnov 1983
bourgueti (Defrance), in Rosendahl 1985
bourgueti (Defrance), in Eliasovà 1990
bourgueti (Defrance), in Errenst 1990
bourgueti (Defrance), in Lauxmann 1991
bourgueti (Defrance), in Bertling 1993
TITHONIAN
denseta Eliasovà, 1981
globosa Ogilvie, 1897
jakovlevi Krasnov, 1964
kobyi Krasnov, 1964
pironae d'Achiardi, 1880
thurmanniformis Krasnov, 1964
tithonica Ogilvie, 1897
KIMMERIDGIAN
alrotensis Koby, 1904
alveolata (Goldfuss), 1826
claudiensis Etallon, 1859
cylindrata Pratz in Speyer, 1913
magnistellata Becker, 1875 in Beck. & Mil.
nonseptata Lauxmann, 1991
OXFORDIAN
corallina Fromentel, 1861
dechyi Papp, 1907
faveolata Koby, 1881
gresslyi Koby, 1881
ibrahimi Alloiteau & Farag, 1964
mafruthica Alloiteau & Farag, 1964
parva Babaev, 1964
richardi Michelin, 1843
thurmanni Koby, 1881
BATHONIAN
andreevi Krasnov, 1983
dolfussi Koby, 1907
insignis Duncan, 1872
pratti Milne-Edwards & Haime, 1851
tuberosa Duncan, 1872
UNDETERMINED STAGE
cesaredensis Koby, 1904
depravata (Etallon), 1859
?digitiformis (Koby), 1904
edwardsi (Koby), 1904
?etalloni (Koby), 1904
excelsa Koby, 1904
?fromenteli (Koby), 1904

close to the occurrence of Bathonian *Cyathophora* at Stonesfield, southern England (TOMES 1883), may have also been subject to changing salinity values (ARKELL 1947: 52). In the Kimmeridgian of Portugal, *Cyathophora cesaredensis* occurs, together with only few other corals, at the base of a low diversity *Praeexogyra* ("*Liostrea*") patch reef and is considered to have tolerated at least brachyhaline salinity conditions (WERNER 1986: 68).

The skeleton density of *Cyathophora* seems to be very low compared to other corals. We know that salinity stress (values deviating from fully marine conditions or strongly fluctuating values) in corals may lead to difficulties in the calcification of the skeleton (CHEVALIER 1987: 617). This low density can be a purely internal evolutionary character, but we cannot exclude that the rudimentary septa in *Cyathophora bourgueti* from Kachchh could be also interpreted as an adaptive response to brackish water conditions. This idea still needs to be supported by examination of the intraspecific variation.

Conclusions

The oldest Jurassic cyathophorid known so far has been collected from the scarp of the Kala Dongar, Kachchh (western India). The specimens come from Bajocian siliciclastic sediments and have been determined as *Cyathophora bourgueti* (DEFRANCE). The eleven specimens of the present study display a wide morphological variability which suggests that the definitions of *Cyathophora* species need to be revised. For a scleractinian, *Cyathophora* exhibits a very special relationship between septa and tabulae. Tabulae were the fundamental functional structures of growth. Septa originated each time on a new tabula in the form of a fold and imbricate with the corresponding preceding septa along the periphery of the corallite (Fig. 8). The monospecific coral assemblage of *Cyathophora bourgueti* is interpreted as related to brackish water environments.

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