THE TETHYAN JURASSIC STROMATOPOROIDS *STROMATOPORINA*, *DEHORNELLA*, AND *ASTROPORINA*

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ABSTRACT. Certain Tethyan Jurassic stromatoporoids, some formerly allocated to the Palaeozoic genus *Stromatopora*, are described with new morphological terms, and grouped in the family Parastromatoporidae (superfamily Milleporellicae). *Dehornella* Lecompte 1952 is reassessed and *Stromatopora choffati* Dehorne 1917, sometimes erroneously allocated to *Stromatoporina* Kühn 1928 (Stromatoporinidae Kühn 1928) of which the type species *Stromatopora tornquisti* Deninger 1906 is redescribed, is allocated to it. *Stromatopora harrarensis* Wells 1943 is also allocated to *Dehornella* and specimens from Oman, Sinai, and Israel are described. Newly founded species are *Dehornella omanensis* from Oman and *D. crustans* from Israel.

Astroporina gen. nov., characterized by a coenosteum consisting almost entirely of conjoined astrosystems, includes *A. stellifera* sp. nov. and *A. stellans* sp. nov. from Somaliland, and *A. orientalis* sp. nov. and related forms from the Lebanon, Somaliland, and Oman.

INTRODUCTION

SOME of the Jurassic clinogonal stromatoporoids, in which both reticulum and astrosystems are tabulate and dominantly vertical, have been variously allocated to the genera *Parastromatopora*, *Tosastroma*, and *Dehornella*: the continued allocation of others to the genera *Stromatopora* Goldfuss or *Stromatoporina* Kühn is, in the opinion of the author, erroneous. Such forms are abundant in the Upper Jurassic of the Middle East, particularly in the Beni Zaid Limestone, Musandam Limestone Group, of the Jebel Hagab area, Trucial Oman. It is to facilitate the naming of some of these that the genera *Stromatoporina* and *Dehornella* are here redefined and a new genus erected.

Acknowledgements. The specimens described in this paper include those from Somaliland collected by W. H. Macfadyen and lent to the author by A. G. Brighton of the Sedgwick Museum, Cambridge, and by H. Dighton Thomas of the British Museum (Natural History), London. The holotype of *Stromatoporina tornquisti* (Deninger) was lent to the author by Professor Pfannenstiel of the University of Freiburg and that of *Stromatopora choffati* (Dehorne) by Professor P. Pruvost of the Sorbonne, Paris. The other described and recorded specimens are from the Middle East collections of the Iraq Petroleum Company and have been generously presented to the British Museum (Natural History) by that company: those from Sinai and the Lebanon were collected by S. Nasr and some of those from Oman by Z. R. Beydoun. The work of this paper was carried out in the Geological Laboratories of the Iraq Petroleum Company and permission to publish it has been generously given by the Directors and Chief Geologist of that company. To all those mentioned above the author here records his thanks.

Registration numbers preceded by the letter H are those of specimens in the collection of the Department of Palaeontology, British Museum (Natural History), London; those preceded by the letter F are of specimens from the Sedgwick Museum, Cambridge.

STRATIGRAPHY AND LOCALITY

Eastern Arabia. The specimens (H 4833 to H 4869) described in this paper, mainly as *Dehornella harrarensis* (Wells) and *D. omanensis* sp. nov., are from the Musandam Limestone (Jurassic-Cretaceous), which is well exposed in the Jebel Hagab area of the Ruus al Jibal, the northern peninsula of the Oman Mountains, eastern Arabia (Hudson

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et al. 1954). In this limestone series the Beni Zaid Limestone Formation, 77 metres thick, is of Oxfordian s.s. age, its type section being along the south bank of Wadi Bih in the Jebel Hagab area (Hudson and Chatton 1959). The top of the formation is a light-grey, massive, pseudo-oolitic limestone, 2·5 metres thick, containing abundant stromatoporoids: it was from this uppermost limestone that the above specimens were collected by Z. R. Beydoun and the author.

Sinai. The Jurassic succession exposed in Jebel Moghara, Sinai (Arkell 1956, Said and Barakat 1958) was measured by the geologists of the Standard Oil Company of Egypt: the fossil collections of the Iraq Petroleum Company, made by S. Nasr, were keyed to that succession. The uppermost part of the succession is as follows:

	metres
9. Shale with *Knemiceras* (Albian)	5·7
8. Sandy limestone	4·5
7. Shale with marl bands. Abundant *Choffatella decipiens* (Aptian) at base (*det.* P. V. Rabanit)	30·5
Non-sequence	
6. Light-grey and white limestone with abundant stromatoporoids as *Shuqraia*, &c. (Argovian)	24·0
5. Chalky limestone (Argovian)	5·0
4. Limestone with marl. Abundant stromatoporoids as *Shuqraia*, *Promillepora*, &c. (Argovian)	31·0
3. Shale, gypsiferous	5·0
2. Limestone, light grey, hard, with flint. Stromatoporoids as *Dehornella* and *Parastromatopora* in upper part. *Pachyceras sp.* (as Douvillé 1916, pl. 8, figs. 4, 5) and *Euaspidoceras*, *det.* Spath. (Oxfordian s.s.)	104
1. Limestone, white, soft, with *Phylloceras* (Rhacophyllitid) and *Binatosphinctes* cf. *schlosseri* Krenkel, *det.* Spath. (Upper Callovian)	10

Both the lithological and faunal successions agree well with those of neighbouring areas. Beds 1 and 2 are the equivalent of the upper part of the Bihen Limestone of Somaliland and that of the Tuwaiq Mt. Limestone of Central Arabia. Beds 3 to 6 are the equivalent of the Gahodleh Shales of Somaliland and the Hanifa Formation of Central Arabia. The non-sequence cuts out the Sequanian, Tithonian, and Neocomian as at Kurnub, Palestine. Said and Barakat (1958) give a totally different stage allocation to the Jurassic of Moghara, an allocation with which the author can in no way agree.

Israel. The fauna of the Jurassic exposed in Maktesh Hathira (Kurnub Anticline) has recently been summarized by the author (Hudson 1958). The stromatoporoid formations are the Shuqraia Limestones-with-Marls of Argovian age. They contain *Shuqraia spp.*, *Promillepora kurnubi* Hudson, *P. pervinquieri* Dehorne, *P. douvillei* (Dehorne), *Steineria somaliensis* (Zuff.-Com.), *Actostroma damesini* Hudson, *A. nasri* Hudson, *A. kuehni* Hudson, *Dehornella crustans* sp. nov., and *D.* cf. *harrarensis* (Wells).

British Somaliland. In this area the Jurassic includes the Bihen Limestone (Callovian and Oxfordian), 83 metres thick, with, above it, the Gahodleh Shales (Argovian), 113 metres thick. The upper part of the Bihen Limestone (= Tuwaiq Mt. Limestone of Central Arabia, the Shuqra Limestone of southern Arabia, and the Beni Zaid Limestone of eastern Arabia) contains corals and stromatoporoids, mostly *Shuqraia zuffardiae* (Wells) (Thomas *in* Macfadyen *et al.* 1935). It was from the upper part of the Bihen Limestone that *Astroporina stellans* sp. nov. and *A.* cf. *orientalis* sp. nov. were collected. The exact horizon of *A. stellifera* sp. nov. is not known.

STROMATOPOROID SKELETAL MORPHOLOGY

Fenestrate and cellular vertical lamellae. In morphological early forms the lateral processes arising from the pillars were usually transversely aligned and thus formed an open mesh of transverse lamellae, important structural elements in the reticulum and often as equally developed as the vertical pillars. In later forms, trending to verticality, the transverse lateral processes functioned differently since they occurred more or less vertically continuously on opposite sides of a pillar and linked one pillar to the other, thus forming vertical lamellae. In some forms the lateral processes may be still occasionally aligned giving sporadic transverse lamellae. Vertical lamellae so formed are often fenestrate (Hudson 1959) due to the intermittent vertical discontinuity of the lateral processes joining the pillars. Such openings are no more than temporary coenospaces between adjacent pillars and show as such in transverse section.

In morphologically advanced forms vertical lamellae are formed by the direct lateral welding of the pillars without the intervention of lateral processes. In such forms transverse structures other than tabulae and tabular laminae are absent. This joining of the pillars may proceed farther so that the vertical lamellae are two or more layers of pillars across or are compact vertical blocks of pillars. Such compound lamellae may not, however, be completely compact. They may enclose one or more small coenospaces, usually vertically elongate and thus form cellular vertical lamellae.

Astrocorridors. In morphological early forms the astrosystem may consist of an axial astrotube from which radiate out at regular or irregular vertical intervals single or groups of transverse astrotubes. In the forms described in this paper astrosystems do not include axial astrotubes and the transverse astrotubes are vertically extended so that they form a group of narrow radial spaces extending vertically throughout the reticulum and usually bounded by vertical lamellae which meet more or less at the axis of the astrosystem. Such vertical spaces, normally tabulate, are here called astrocorridors: they are the superimposed astrorhizae of other authors.

SYSTEMATIC PALAEONTOLOGY

The systematic position of the Mesozoic 'stromatoporoids' is a matter of argument, the main point of issue being the structural, and hence systematic, independence, at both family and order level, of the Palaeozoic and Mesozoic genera. To a less degree there is the same doubt of allocation of certain Mesozoic genera to groups which are essentially Tertiary-Recent. Thus there is no certainty of allocation of the various Mesozoic genera to one or more of the variously proposed orders such as the Stromatoporoidea Nicholson and Murie, Sphaeractinoidea Kühn, Hydroida Dana *not* Johnston, Spongiomorphida Alloiteau, Milleporina Hickson, or Stylasterina Hickson and England.

In 1956 the author agreed with Kühn (1939) that the Milleporidiidae were morphologically more closely comparable to the Hydroida Dana than to the Stromatoporoidea Nicholson and Murie, and allocated them to the former order. Whatever their relation to the Hydroida, the family is closely linked to the Milleporellidae and the Parastromatoporidae, and is here grouped with them in the superfamily Milleporellicae. The Mesozoic forms show little stratigraphical continuity with the Palaeozoic Stromatoporoidea or the Tertiary-Recent Hydroida; the three groups are also more or less morphologically independent. It may be that they evolved independently, their generally similar structural pattern being based on common ancestry: it may be, therefore, that they should be allocated to independent orders. It is, nevertheless, convenient to refer to most of the Mesozoic forms as stromatoporoids rather than hydroids or sphaeractinoids and they are therefore, purely for a matter of convenience, provisionally grouped in the Stromatoporoidea.

The systematic position of the genera discussed in this paper is shown in the part-list of Jurassic and Cretaceous stromatoporoids given below.

STROMATOPOROIDEA Nicholson and Murie 1878 (order)
- ACTINOSTROMARIICAE Hudson 1959 (superfamily)
  - ACTINOSTROMARIIDAE Hudson 1935 (family)
    - *Actinostromaria* Munier-Chalmas *in* Haug 1909
    - *Actinostromarianina* Lecompte 1952
    - *Actinostromina* Germovšek 1954
    - *Astrostylopsis* Germovšek 1954
  - ?STROMATORHIZIDAE Hudson 1957 (family)
    - *Stromatorhiza* Bakalow 1906
    - *Actostroma* Hudson 1958
  - SIPHOSTROMIDAE Steiner 1932 (family)
    - *Siphostroma* Steiner 1932
- MILLEPORELLICAE Hudson 1959 (superfamily)
  - MILLEPORELLIDAE Yabe and Sugiyama 1935 (family)
    - *Millestroma* Gregory 1898
    - *Milleporella* Deninger 1906
    - *Stromatoporellina* Kühn 1928
  - MILLEPORIDIIDAE Yabe and Sugiyama 1953 (family)
    - *Milleporidium* Steinmann 1903
    - ?*Myriopora* Volz 1904
    - *Promillepora* Dehorne 1920
    - *Shuqraia* Hudson 1954
    - *Sporadoporidum* Germovšek 1954
    - *Steinerina* Hudson 1956
  - PARASTROMATOPORIDAE Hudson 1959 (family)
    - *Ceraostroma* Kühn 1926
    - *Parastromatopora* Yabe and Sugiyama 1930
    - *Tosastroma* Yabe and Sugiyama 1935
    - *Dehornella* Lecompte 1952
    - ?*Steinerella* Lecompte 1952
    - *Astroporina* Hudson gen. nov.
  - ?STROMATOPORINIDAE Kühn 1928 (family)
    - *Stromatoporina* Kühn 1928
    - ?*Syringostromina* Lecompte 1952

Previous assessment of Stromatoporina. In 1928 Kühn considered that the allocation by Dehorne, Osimo, Vinassa, Deninger, and others of a number of Mesozoic Tethyan stromatoporoids to the genus *Stromatopora* was an error for, in his opinion, all such Mesozoic forms had simple vertical elements whereas all species of *Stromatopora* from the Palaeozoic had compound vertical elements. He therefore founded a new genus *Stromatoporina* for the Mesozoic forms including in the genus *Stromatopora tornquisti* Deninger 1906, *S. choffati* Dehorne 1917, *S. costai* Osimo 1910, *S. franchi* Osimo 1910, *S. moluccana* Vinassa 1915, *S. virgiloi* Osimo 1910, choosing the first of these as his type species. He also considered that the straight and parallel course of the vertical elements of the reticulum was a characteristic feature of his new genus. Unfortunately the description and illustration by Deninger of *Stromatopora tornquisti* is inadequate and possibly Kühn's conception of the species was based on a redescription by Osimo in 1910, not from the holotype. This is the more probable since in 1939 he defines *Stromatoporina* as having vesicular structure like *Stromatopora* and having astrorhizae well developed, illustrating the genus by reproducing Osimo's figure (1910, pl. 1, fig. 1*c*) of *S. franchi* Osimo. It is also evident from Deninger's description and illustration of *S. tornquisti*, inadequate as they are, that the vertical elements in the reticulum of that species are not straight and parallel as they are in the other species of *Stromatoporina* cited by Kühn, especially in *Stromatopora choffati* Dehorne. *Stromatoporina* was therefore, as admitted by Kühn (1939, p. A46), a genus of convenience to which various species of differing character could be allocated, the species having only one feature in common, that they were not *Stromatopora*.

In 1952 Lecompte redefined the genus *Stromatoporina* Kühn, unfortunately basing his definition on *Stromatopora choffati* Dehorne and ignoring the type species *S. tornquisti* Deninger. This practice he also followed in 1956 illustrating the genus by figures of *S. choffati* Dehorne. The author in 1955 attempted to avoid this misconception by redefining the genus on the basis of the type species. He failed to find the holotype and redefined the genus on the basis of the topotype figured by Osimo (1910, pl. 7, figs. 7*a*, 7*b*) as *S. tornquisti*, a specimen he made a neoholotype. Fortunately, from information supplied by E. Flügel, the holotype has now been found in the collections of the Geologisch-Palaeontologisches Institut of the University of Freiburg and has been lent to the author. It is redescribed in this paper: it has no similarity to *S. choffati* and thus the concept of the genus *Stromatoporina* based on that species must be abandoned, and *Stromatoporachoffat* and related forms be allocated to other genera (see also Flügel 1958, work which did not come to the attention of the author until after this paper was written).

Order STROMATOPOROIDEA Nicholson and Murie 1878
Family STROMATOPORINIDAE Kühn 1928*b*

Nominate genus. Stromatoporina Kühn 1928*a*. *Other genus.* ?*Syringostromina* Lecompte 1952.

Diagnosis. Stromatoporoidea in which rods or short pillars, often joined by lateral processes to form lamellae, are linked to form a fine, irregular, approximately evenly meshed reticulum in which the lamellae may have no dominant direction or may be generally vertical. Reticulum traversed by regular, parallel, transverse laminae. Astrosystems, variously developed, of vertical and radially grouped lateral astrotubes, usually much wider than the coenospaces: may be very indefinite. Reticulum and astrosystems variously tabulate. Structure of skeletal tissue not definitely known.

Genus STROMATOPORINA Kühn 1928*a*

Stromatoporina Kühn 1928*a*, p. 550; 1928*b*, p. 90; 1939, p. A47; Lecompte 1952, p. 19; 1956, p. F137; Alloiteau 1952, p. 393; Hudson 1955, p. 236; Flügel 1958, p. 179.

Type species (by original designation). *Stromatopora tornquisti* Deninger 1906.

Diagnosis. Stromatoporoid with reticulum of fine rods linked to form a fine, subequla irregular angular mesh which, radially, tends to be open but not reticulate, and, trans-

EXPLANATION OF PLATE 24

Thin sections of *Astroporina* gen. nov., photographed by transmitted light and untouched. Figs. 1, 2, ×4; figs. 3–7, ×8.

Figs. 1–5. *Astroporina stellifera* sp. nov., all of holotype, F 1775, Upper Jurassic, Ahankon Tug, Inda District, British Somaliland. 1, 3, Tangential section, F 1775*b*, showing stellate astrocorridors with bounding vertical lamellae enclosing coenotubules. 2, 4, Radial section, F 1775*c*, mainly parallel to astrocorridors, showing tabulate astrocorridors, tabulate coenotubules, and alignment of tabulae. The larger spaces are along astrocorridors. 5, Oblique radial section, F 1775*a*, mainly across astrocorridors. Note pillars joined to form compound vertical lamellae bounding astrocorridors.

Figs. 6, 7. *Astroporina stellans* sp. nov., all of holotype, F 1774, Bihen Limestone (Upper Jurassic), Daghani Section, Bihendula, British Somaliland. 6, Radial section, F 1774*c*, mainly parallel to astrocorridors. The larger spaces are along astrocorridors. 7, Tangential section, F 1774*a*. Note interlacing astrosystems and merging of astrocorridors and vermiculate coenospaces. Note compound vertical lamellae with coenotubules.

versely, to be closed and irregularly polygonal. Abundant entire transverse laminae, regular, and approximately parallel and even-spaced. Ill-defined astrosystems of groups of irregular, wider tubes, approximately vertical, and occasional inclined lateral tubes. Astrotubes slightly tabulate.

Remarks. The definition of the genus is strictly based on the type species. To have widened it to include the related species *Stromatopora franchi* Osimo and *S. tornquisti* Osimo *non* Deninger (see later) would probably have relegated the genus *Syringostromina* Lecompte 1952 to the status of a junior subjective synonym.

Stromatoporina tornquisti (Deninger)

Plate 27, figs. 3–5; text-fig. 1

Stromatopora sp. Tornquist 1901, p. 19.
Stromatopora tornquisti Deninger 1906, p. 66, pl. 7, figs. 7*a*, 7*b*; Steiner 1932, p. 81; Yabe and Sugiyama 1935, p. 162; Flügel 1958, p. 179. *Not* Osimo 1910, p. 286, pl. 1, figs. 2, 2*a*, 2*b*; Dehorne 1920, p. 82.
Stromatoporina tornquisti Kühn 1928*a*, p. 550; 1928*b*, p. 90.

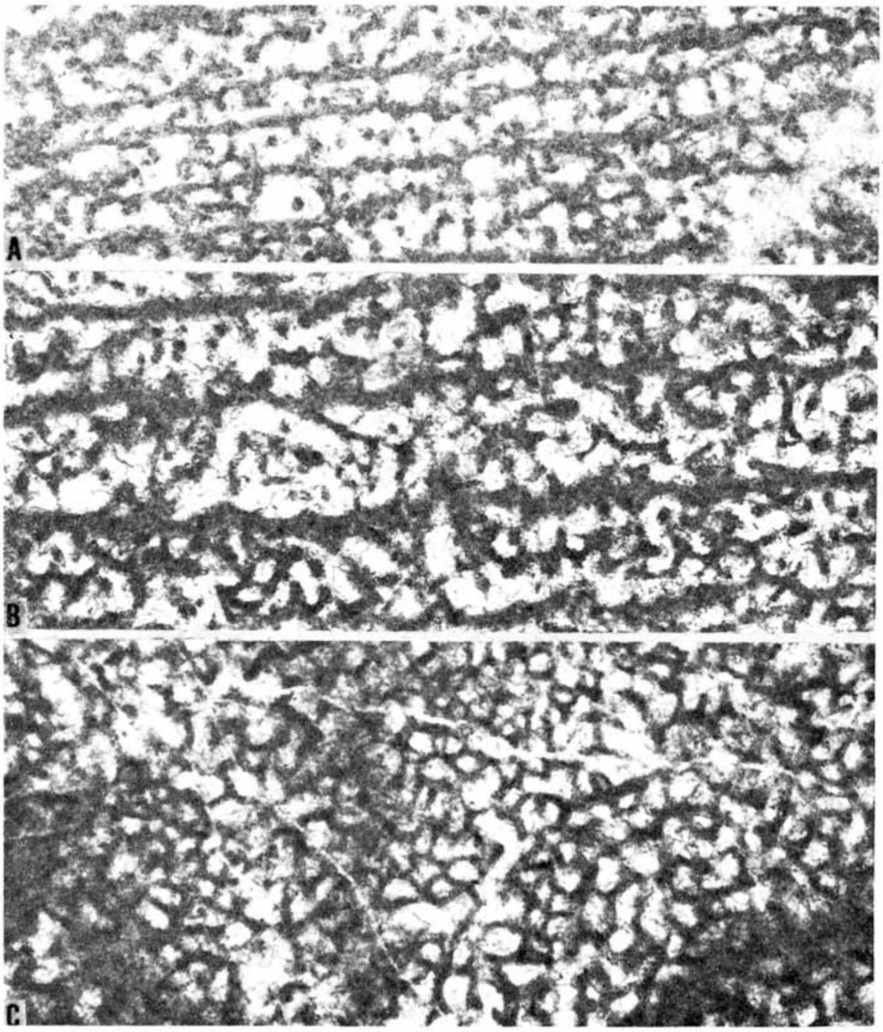
Holotype (only recorded specimen). Sections a (Deninger 1906, pl. 7, fig. 7*b*; Hudson, this paper, Pl. 27, fig. 3, and text-figs. 1A, 1B), b, and c (Deninger 1906, pl. 7, fig. 7*a*; Hudson, this paper, Pl. 27, figs. 4, 5, and text-fig. 1C). Coll. Geological-Palaeontological Institut, University of Freiburg, Austria. ??Keuper (Tornquist 1901), or Bathonian (Deninger 1906); Monte Zirra, Nurra, north-west Sardinia.
Neoholotype (chosen Hudson 1955 and here abandoned). Specimen from Bathonian of Sardinia figured Osimo (1910, pl. 1, figs. 2, 2*a*, 2*b*) as *Stromatopora tornquisti* Deninger.

Diagnosis. *Stromatoporina* with nodular coenosteum. Reticulum of linked rods (0·04–0·075 mm. across) forming an irregular monomorphic mesh which, transversely, is either open and vermiculate or closed and approximately polygonal (0·06–0·1 mm. across); vertically the reticulum mesh is irregularly open and continuous. Regular, entire, and parallel transverse laminae are of approximate constant thickness (*c*. 0·05 mm.) and *c*. 0·2–0·5 mm. apart. In parts of the coenosteum, the laminae are conically raised (concentric-circular in cross-section). Astrosystems very ill-defined with slightly tabulate axial and lateral astrotubes (*c*. 0·1– 0·15 mm. across). Laminae cross the astrosystems.

Remarks. The reticulum of *Stromatoporina tornquisti* shows no evidence of pillars or pillar-lamellae as generally understood in stromatoporoid morphology. The reticulum apparently consists of rods angularly linked, mainly laterally, so that in transverse section they form an irregular polygonal mesh, but in vertical section there is no regular pattern and many of the rods show isolated cross-sections. Each of these rods consists of dark-coloured small rounded 'nodes' (*c*. 0·02–0·05 mm. across) linked by lighter-coloured lateral processes. These 'nodes' usually form the angles of the polygonal mesh. The reticulum is therefore a close scaffolding of rods which tend to have a lateral linkage.

Comparisons. The form from the Bathonian of Sardinia figured by Osimo (1910) as *Stromatopora tornquisti* Deninger and redescribed from the figures by Hudson (1955, p. 236) has a tabulate reticulum in which the rods tend to be dominantly vertical, and common and well-developed astrosystems, each confined to a space between laminae. The species is not '*tornquisti*' nor is it considered to be a *Stromatoporina*, as defined above. It is here named *Stromatopora osimae* new name (holotype: specimen figured Osimo 1910, pl. 1, figs. 2, 2*a*, 2*b*).

Stromatopora franchi Osimo (1910, pl. 1, figs. 1*a*, *b*, *c*), also from the Bathonian of Sardinia, differs even more from *Stromatoporina tornquisti* since both its reticulum and



A

B

C

TEXT-FIG. 1. *Stromatoporina tornquisti* (Deninger). Thin sections, a and c, × 40, of holotype. Bathonian, Mt. Zirra, Nurra, north-west Sardinia. A, Part of vertical section a, showing area of close laminae. B, Part of vertical section a, showing vertical and transverse astrotubes. C, Part of transverse section c, showing astrosystem. Darker areas laminae, secondary after pillars.

abundant astrosystems have a dominant verticality, and thickened laminae are not common. Nevertheless, the similarity of the fineness and general pattern of the reticulum of both Osimo's forms to that of *S. tornquisti* suggests that they too belong to the Stromatoporinidae.

The general pattern of the reticulum and its fineness when compared with the coarse astrosystems is not unlike the general coenosteal pattern of *Syringostromina pruvosti* Lecompte gen. *et* sp. (1952, pl. 1, figs. 2, 2*a*) and it may be that *Stromatopora osimae* nom. nov. and *S. franchi* Osimo should be allocated to that genus. They, with *S. pruvosti*, may be expressions of a trend to verticality within the Stromatoporinidae.

Superfamily MILLEPORELLICAE Hudson 1959
Stromatoporoids with clinogonal-fibrous skeletal tissue

Family PARASTROMATOPORIDAE Hudson 1959

Nominate genus. Parastromatopora Yabe and Sugiyama 1930. *Other genera. Dehornella* Lecompte 1952; *Tosastroma* Yabe and Sugiyama 1935; *Astroporina* gen. nov.; ?*Steinerella* Lecompte 1952.

Milleporellicae with reticulum mainly of fenestrate vertical lamellae formed by pillars joined directly or by lateral extension. Lamellae variously bound coenospaces, enclose coenotubes, or outline astrocorridors. May be some subordinate transverse lamellae. Astrosystems, variously developed, generally composed of astrocorridors, variously stellate or irregular; no transverse astrotubes. Tabulae common or abundant, may be closely spaced vertically in coenospaces, coenotubes, and astrocorridors; may be aligned. Laminae generally absent. Not markedly latilamellate.

Morphological trends within the Parastromatoporidae. The similarity linking the various forms in this family is the verticality of both reticulum and astrosystem: the differences separating them are partly the relative proportion in the coenosteum of reticulum and astrosystem and partly the extent to which verticality has become dominant in these structures. The structure of the morphological ancestral form seems to be that of *Stromatopora choffati* in which the coenosteum is almost equally composed of reticulum and astrosystem and in which the reticulum retains some element of horizontality. A closely related form is *Dehornella hydractinoides* in which the thinly encrusting coenosteum has an even more horizontally lamellate reticulum. Parastromatoporidae with this approximately equal division between reticulum and astrosystem may persist throughout the Upper Jurassic and Lower Cretaceous, in which latter they may be represented by *Steinerella* in which the astrosystems are better though not more abundantly developed and tend to be divided into vertical astrotubes.

From such forms as *Stromatopora choffati*, structure seems to evolve in two directions. The one is represented by *Parastromatopora* and *Tosastroma* in which the coenosteum consists mainly or wholly of reticulum, astrosystems being absent or more probably not distinguishable; the other is represented by forms, here grouped as *Astroporina* gen. nov., in which the coenosteum tends to be wholly of conjoined astrosystems.

Genus DEHORNELLA Lecompte 1952

Dehornella Lecompte 1952, p. 16; 1956, p. F133.

Type species (by original designation). *Stromatoporella hydractinoides* Dehorne 1920.

Diagnosis. Parastromatoporidae usually nodular and encrusting reticulum of pillars and vertical lamellae, often composite and thick, bounding irregular labyrinthine tabulate coenospaces. Lateral processes may be aligned to form intermittent transverse lamellae. Common and well-developed astrosystems of irregularly vermiculate tabulate astrocorridors, irregularly radial, often bounded by thick vertical lamellae. Tabulae common, may be aligned to form occasional laminae. Skeletal tissue clinogonal or not known.

Family allocation. The genus *Dehornella*, like so many of the Mesozoic stromatoporoid genera, was founded as a one-species one-specimen genus. Its foundation was the more unfortunate since the one-type specimen of the species is a thinly encrusting form and, like all such forms, has a specialized reticulum in the first few millimetres of upward growth. The diagnostic features of the genus, as stated by Lecompte (1952, 1956), are here summarized as follows: (*a*) stellate astrosystems forming mamelons, (*b*) continuous vertical pillars and discontinuous transverse lamellae beneath mamelons, and continuous transverse lamellae and discontinuous vertical pillars between mamelons, (*c*) skeletal tissue possibly originally chitinous. It is now generally accepted that the occurrence of mamelons is specifically but not generically diagnostic. That the pillars were originally chitinous was first tentatively suggested by Dehorne (1920) who considered that growth stages of the skeletal tissue (Dehorne 1920, text-fig. 9) showed a similarity to those of the Recent hydroid *Hydractinia echinata* Fleming in which the skeleton may be in part chitinous. This suggestion was adopted by Lecompte on the grounds that the pigmented core of the pillars seen by transmitted polarized light showed single extinction, a very doubtful assumption that certainly cannot be used as a diagnostic character. The distinction between the vertical structure of astrosystems consisting of astrocorridors and that of the reticulum occurring between them is mainly expressed by the presence of transverse lamellae continuous in the reticulum but limited to between the vertical lamellae in the astrosystem. This is generally the case in those Parastromatoporidae which have transverse lamellae though it is most marked in the initial stages of encrust-

EXPLANATION OF PLATE 25

Thin sections (except fig. 6) of *Astroporina* and *Dehornella* photographed by transmitted light.

Figs. 1–3. *Astroporina* cf. *orientalis* sp. nov., F 1773, ×8. Bihen Limestone (Upper Jurassic), Daghani Section, Bihendula, British Somaliland. 1, Transverse section, F 1773*b*; note merging of astrocorridors and coenospaces, and lack of individuality of astrorhizal systems. 2, Oblique section, F 1773*a*, in general across astrocorridors. 3, Radial oblique section, F 1773*c*; note general alignment of tabulae.

Fig. 4. *Astroporina stellans* sp. nov., oblique section, F 1774*b*, from holotype, ×8. Bihen Limestone (Upper Jurassic), Daghani Section, Bihendula, British Somaliland. Note coenotubules within vertical lamellae.

Figs. 5–7. *Dehornella crustans* sp. nov. Upper part of Shuqraia Limestones-with-Marls (Argovian), Maktesh Hathira, Israel. 5, Radial section, H 5618*a*, ×4·5. Encrusting on fine stromatoporoid on coral. 6, Polished tangential surface (photographed reflected light), H 5168, ×7. Note formation of walls of astrocorridors by closely compacted coenosteal pillars. Large circular openings are subsequent borings. 7, Radial section, H 5170*d*, ×7 (as Pl. 26, fig. 1), mainly along astrocorridors and vertical lamellae.

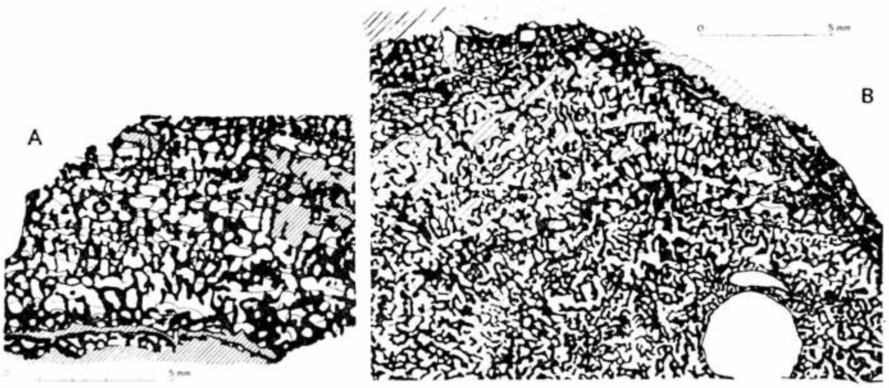
Fig. 8. *Dehornella choffati* (Dehorne). Upper Jurassic (Lusitanian–Pterocerian), Cezimbra massif, Arabida, Portugal. Tangential section, 25*a*, ×9·5, of holotype, specimen 25, Stromatoporoid Coll., Geol. Lab., Sorbonne, Paris (as Dehorne 1917, text-fig. 1; 1920, text-fig. 26 and pl. 13, fig. 2; 1923, pl. 1, fig. 1*c*).

ing forms where transverse lamellae tend to be more developed than in the rest of the reticulum.

The main features of *Dehornella* such as the abundant astrosystems of radial tabulate astrocorridors, and the dominant vertical pillars or vertical lamellae enclosing irregular, tabulate coenospaces or bounding the astrocorridors are characteristic of certain of the Parastromatoporidae such as *Stromatopora choffati* Dehorne and *S. harrarensis* Wells and it is therefore included in that family.

Morphological range. *Dehornella* Lecompte could therefore remain as a genus with an eccentric limited diagnosis which would apply only to the type species. In which case the numerous similar forms such as *Stromatopora choffati* Dehorne and *S. harrarensis* Wells must be allocated to a new genus since there is no other genus within the Parastromatoporidae suitable for them. To avoid the creation of only slightly differing genera, *Dehornella* has been more redefined as above and is thus available for many species other than the type.

The various species which can be allocated to *Dehornella* can be mainly grouped into those with a fine reticulum with lamellae about 0·1–0·2 mm. across and coenospaces up to about 0·3 mm. across, and those with a coarse reticulum with lamellae up to 0·3 mm. across and coenospaces up to 0·5 mm. across. The former group includes *Stromatopora choffati* Dehorne, *S. kurtchensis* Wells, *Dehornella hydractinoides* (Dehorne), *D. crustans* sp. nov., and *D. omanensis* sp. nov.; the latter group includes *S. harrarensis* Wells. There are other species, some with an even coarser reticulum and some with a very fine, encrusting reticulum. When these species occur in the same fauna, they are often intergrown or encrust each other. Otherwise many of them encrust crinoids, corals, or gastropods.



TEXT-FIG. 2. *Dehornella choffati* (Dehorne). Sections of holotype. Oblique lines represent areas infilled with mud. A, Oblique section 25*b*, wider spaces are across or along astrocorridors. Note lamellate character of initial reticulum after cessation of growth due to mud deposition. B, Section 25*c*, encrusting? coral. Section around coral is tangential, that of outer part is oblique. Note irregular lamellate character of initial reticulum.

Dehornella hydractinoides (Dehorne)

Stromatoporella hydractinoides Dehorne 1920, p. 77, text-fig. 9, pl. 6, fig. 2, pl. 17, fig. 3 (not pl. 15, fig. 3); 1923, p. 19, pl. 1, figs. 2*a*, *b*.
Stromatoporellina hydractinoides Kühn 1928*a*, p. 550; Kühn 1928*b*, p. 39.
Stromatoporella hydractinoides Steiner 1932, p. 80.
Dehornella hydractinoides Lecompte 1952, p. 16, pl. 2, figs. 1, 1*a*; 1956, p. F133, text-fig. 109, 5.

Holotype (only recorded specimen). Specimen (Dehorne 1920, pl. 6, fig. 2; 1923, pl. 1, fig. 2*a*) and thin sections a (Dehorne 1920, text-fig. 9, pl. 17., fig. 3; 1923, pl. 1, fig. 2*b*), b (Lecompte 1952, pl. 2, fig. 1; 1956, text-fig. 109, 5), and c (Lecompte 1952, pl. 2, fig. 1*a*). Stromatoporoid coll., Geological Laboratory, Sorbonne, Paris. From Abbadia Marls (upper Lusitanian), 150 metres north-west of Silveiras, Arrabida massif, Portugal.

Diagnosis. *Dehornella* with encrusting lamellate coenosteum with conical mamelons about 5·0 mm. across at base and about 7·0 mm. apart. Reticulum with irregularly developed vertical pillars (0·1–0·2 mm. across) and lamellae, and irregular transverse lamellae. Astrosystems common, with well-developed but tortuous astrocorridors, about 0·25–0·3 mm. across, often with thick (*c.* 0·1–0·25 mm. across) bounding vertical lamellae.

Dehornella choffati (Dehorne)

Plate 25, fig. 8; Plate 26, figs. 7, 8; text-fig. 2

Stromatopora Choffati Dehorne 1917, p. 117, text-fig. 1, 2; Dehorne 1920, p. 83, text-figs. 12, 18, 25, 26, pl. 5, fig. 6, pl. 7, fig. 1, pl. 13, figs. 1, 2 (not pl. 6, figs. 3, 4); Dehorne 1923, p. 15, pl. 1, figs. 1*a–c*, pl. 2, fig. 1; Steiner 1932, p. 82.
Stromatoporina Choffati (Dehorne), Kühn 1928*a*, p. 550; 1928*b*, p. 90.
Stromatoporina choffati (Dehorne), Lecompte 1952, p. 20; Lecompte 1956, text-fig. 109 (3*a*, *b*).
Not *Syringostomina choffati* (Dehorne), Lecompte 1956, text-fig. 106 (4*a*, *b*).

Lectotype (Chosen Lecompte 1952, p. 20). Specimen 25 and sections 25*a–e* cut from it, Stromatoporoid coll., Geological Laboratory, Sorbonne, Paris. Nerinea elsgaudiae Limestones (Upper Jurassic: Lusitanian–Pterocerian), Pedreiras, Cezimbra massif, Arabida, Portugal. Figured Dehorne 1917, text-fig. 1, 2; 1920, text-figs. 12, 25, 26, pl. 5, fig. 6, pl. 13, figs. 1, 2; 1923, pl. 1, figs. 1*a–c*, pl. 2, fig. 1; Lecompte 1956, text-figs. 109 (3*a*, *b*); Hudson, this paper, Pl. 25, fig. 8, Pl. 26, figs. 7, 8, text-figs. 2A, 2B.

EXPLANATION OF PLATE 26

Thin sections of *Astroporina* and *Dehornella*, photographed by transmitted light and showing clinogonal microstructure of coenopillars, all × 100.

Fig. 1. *Dehornella crustans* sp. nov. Radial section H 5170*g* (as Pl. 25, fig. 7). Shuqraia Limestones-with-Marls (Argovian), Maktesh Hathira, Israel. Medial strands with groups of dark-rimmed circles (transverse sections) and elongate tubes (longitudinal sections), both with clear centres.

Figs. 2, 3. *Astroporina* cf. *orientalis* sp. nov., F 1773, Bihen Limestone (Upper Jurassic), Daghani Section, Bihendula, British Somaliland. 2, Radial section, F 1773*a*. Section does not pass through medial strand. 3, Transverse section, F 1773*b*, medial strand present though faintly shown.

Fig. 4. *Astroporina orientalis* sp. nov. Radial thin section H 4850*b*. Cladocoropsis Limestones (Sequanian), near Ain Safra, Yanta, Lebanon.

Figs. 5, 6. *Astroporina stellans* sp. nov., both of holotype, F 1774. Bihen Limestone (Upper Jurassic), Daghani Section, Bihendula, British Somaliland. 5, Radial section, F 1774*a*, showing medial strand. 6, Longitudinal section, F 1774*b*, not through medial strand.

Figs. 7, 8. *Dehornella choffati* (Dehorne). Both part of thin section, 25*c*, of holotype. Note clear tubules at position of origin of clinogonal fibres. 7, Radial section. 8, Transverse section. Upper Jurassic, Arabida, Portugal.

The uncut lectotype (Dehorne 1920, pl. 5, fig. 6) was a thin slab about 1·5 cm. thick, a fragment from across the centre of a concentric encrusting nodule of about 4 cm. diameter. The sections cut from it consist of *a*, a tangential (Dehorne 1920, pl. 13, fig. 2; Lecompte 1956, text-fig. 109 (3*a*); this paper, Pl. 25, fig. 8), *b*, an oblique radial (Lecompte 1956, text-fig. 109 (3*b*); this paper, text-fig. 1A), *c*, a tangential with outer part radial (this paper, text-fig. 1B), *d*, a radial (Dehorne 1920, pl. 13, fig. 1) and *e*, an oblique radial (Dehorne 1920, text-fig. 18). The last two are now missing.

Dehorne (1920) gave the magnifications of her figures of the type specimen as follows: text-fig. 20, ×5; pl. 5, fig. 6, ×1; pl. 13, fig. 2, ×?7: they should respectively be ×8·2, ×1·5, ×12. In her 1923 paper the magnification of pl. 1, fig. 1*c*, is ×10.

Diagnosis. *Dehornella* with encrusting nodular coenosteum with vertical pillars (*c*. 0·1 mm. thick) joined directly or, at intervals, by transverse pillar-outgrowths to form vertical lamellae (0·1 mm. thick). Prominent astrosystems (centres 3–4 mm. apart), often conjoined, of irregularly stellate branching astrocorridors (0·2 mm. across). Reticulum of irregular and usually narrow elongate coenospaces and irregularly shaped coenotubes (0·12–0·15 mm. across) bounded by vertical lamellae, and occasionally crossed, for varying distances, by transverse lamellae formed by aligned transverse pillar-outgrowths. Occasional isolated pillars. Tabulae common in both coenospaces and astrocorridors.

Dehornella crustans sp. nov.

Plate 25, figs. 5–7; Pl. 26, fig. 1

Holotype. H 5168, two pieces (Pl. 25, fig. 6) and section a (Pl. 25, fig. 5). *Paratypes*. H 5170, one piece and sections *a–c*, d (Pl. 25, fig. 7), e, f, g (Pl. 26, fig. 1). H 5166, one piece and section *a*. All from the upper part of the Shuqraia Limestones-with-Marl (Upper Jurassic, Argovian), Maktesh Hathira, Israel (Hudson 1958).

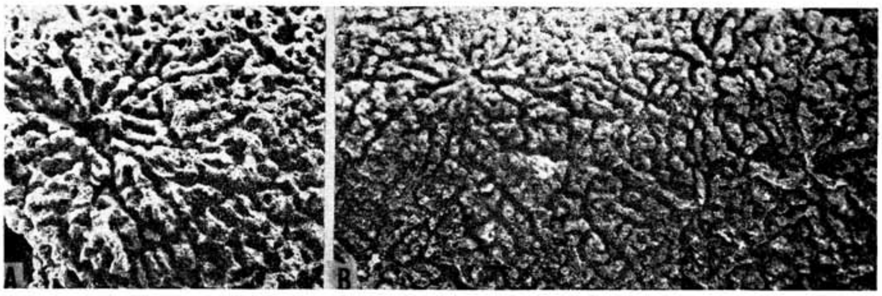
Diagnosis. *Dehornella* with small, nodular, and encrusting coenosteum consisting of abundant astrosystems separated by small areas of irregular reticulum. Vertical lamellae (*c*. 0·1–0·2 mm. across) which bound astrocorridors of astrosystems and coenospaces of reticulum, formed of vertical pillars (*c*. 0·15 mm. across) linked by transverse processes which, occasionally, may be aligned. Vertical lamellae, generally vermiculate, may be fenestrate and compound. Coenospaces (*c*. 0·2–0·3 mm. across) irregular and elongate. Astrosystems abundant, about 0·5 mm. apart, of irregularly radial astrocorridors (*c*. 0·2–0·3 mm. across). Tabulae abundant, irregularly aligned.

Dehornella omanensis sp. nov.

Plate 28, figs. 1, 2, 5–8; text-figs. 3B, 4, 5

Holotype. H 4833 (one piece, text-fig. 3B). *Paratypes*. H 4834 (one piece, Pl. 28, fig. 6), H 4835 (two pieces, Pl. 28, fig. 8), H 4836, 4838–43, 4845–7 (each one piece), H 4837 (one piece and section *a*, text-fig. 5), H 4844 (four pieces, Pl. 28, fig. 1, and sections a, Pl. 28, fig. 1, b, and c, Pl. 28, fig. 7), H 4848 (one piece, Pl. 28, fig. 5), and H 4849 (three pieces and sections a–c). All from Beni Zaid Limestone (Oxfordian), Wadi Bih, Ruus al Jibal, Trucial Oman, Arabia.

Description. Coenosteum nodular, concentric, often an aggregate of several independent concentric growth nodules (only fragments known; greatest diameter 80 mm.; greatest height, 80 mm.). May be encrusting (as H 4844, Pl. 28, figs. 1, 2, grown around a coral). Surface even, no mamelons, ostia-mesh mainly vermiculate. Surface astrosystems, about 0·4 mm. across, consist of irregularly radial and irregularly dichotomizing astrocorridors, commonly 0·2 mm. wide. Reticulum of dominant vertical lamellae and occasional transverse lamellae, the former both transversely and longitudinally vermiculate so that the reticulum pattern is loose and irregular. In the vertical lamellae which are commonly 0·12–0·15 mm. thick and generally discontinuous, it is possible to recognize the component pillars. The transverse lamellae, formed of joined transverse processes, are widely



TEXT-FIG. 3. Coenosteal surfaces of *Dehornella* from Beni Zaid Limestone, Oman, showing astrosystems. A, *D. harrarensis* (Wells), H 4865, ×4. Surface slightly mammelate. B, *D. omanensis* sp. nov., holotype, H 4833, ×4·5. Surface worn smooth.

spaced, and may be continuously aligned across a number of coenospaces. These are commonly 0·2–0·25 mm. wide, vermiculate and generally not completely enclosed; coenotubes are not common. Widely spaced simple tabulae cross the coenospaces but are not abundant. Latilamellation which is mainly due to variation in thickness of the vertical lamellae and to the varying occurrence of the transverse lamellae is never very strong. Basal holotheca present. Astrorhizal systems entirely composed of tabulate astrocorridors of the same width as the coenospaces and therefore not discernible in vertical section.

Specific differences of Dehornella choffati *group*. There is so little difference between the members of this group, of which *D. choffati* is the senior species, that their distinction is probably infraspecific. That they were not designated subspecies is due to the author's dislike of departure from the binominal system of nomenclature, a dislike based on the general lack of agreement as to the meaning and function of a subspecies in invertebrate palaeontology.

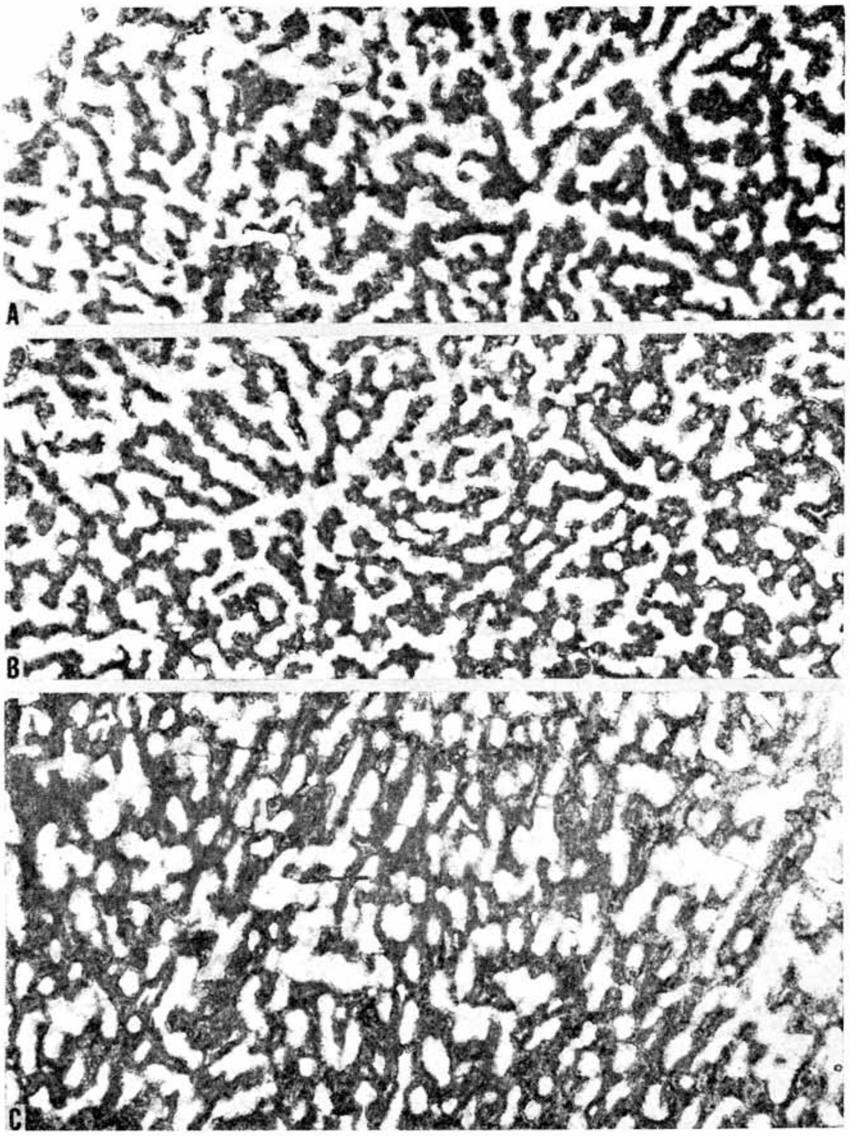
The type of the genus, *D. hydractinoides*, is mamellate and its astrosystems are more

EXPLANATION OF PLATE 27

Figs. 1, 2. *Astroporina stellifera* sp. nov. Polished surfaces (radial and transverse) of holotype, H 3657, ×2·7. Upper Jurassic, Ahankon Tug, Inda District, British Somaliland. Note tendency to latilamellation and, in fig. 1, columnar grouping of reticulum.

Figs. 3–5. *Stromatoporina tornquisti* (Deninger). Thin sections A, C, ×8, from holotype. Bathonian, Monte Zirra, Sardinia. 3, Vertical section A. Wider tubes between laminae belong to astrosystems. 4, 5, Transverse sections C. Tangential in fig. 4 and in upper part of fig. 5. Lower part of fig. 5 across ? mamelon. Note slightly wider lateral tubes of astrosystems.

Figs. 6, 7. *Astroporina orientalis* sp. nov. Thin sections of holotype, H 4850, from Cladocoropsis Limestones (Sequanian), near Ain Safra, Yanta, Lebanon. 6, Radial section, H 4850*b*, ×8. Note conjoined pillars and aligned tabulae. Wide spaces are along astrocorridors. 7, Transverse section, H 4850*a*, ×4.



TEXT-FIG. 4. *Dehornella omanensis* sp. nov. Thin sections of H 4844, $\times$ 12, from Beni Zaid Limestone, Oman, eastern Arabia. A and B, Transverse section H 4844*c*, showing astrosystem and vermiculate reticulum. C, Vertical section, H 4844*b*, slightly oblique. Wide spaces are along astrocorridors. Note fewness of tabulae.

common and coarser than in *D. choffati*; otherwise there is no significant difference between them since in both the vertical lamellae are irregular, transverse lamellae are sporadically developed especially in early growth, and tabulae are common. *D. crustans* differs from them in that transverse lamellae are rare and the reticulum is generally more vertical; it also is not mamellate.

D. omanensis, as befits its stratigraphical position, is morphologically simpler than the above species. It is generally finer and much more evenly meshed, has smaller astrosystems with narrower astrocorridors, and, generally, less tabulae. *D. kurtchensis* (Wells) is a mamellate form which is otherwise apparently similar to *D. omanensis*. It may have the same relationship to that species as *D. hydractinoides* has to *D. choffati*.

Dehornella harrarensis (Wells)

Plate 28, figs. 3, 4, 9, 10; text-fig. 3A

Stromatopora harrarense Wells 1943, p. 50, pl. 8, figs. 1–5.
Stromatopora harrarensis Wells, Hudson 1954, p. 219, pl. 7, fig. 4.
Stromatopora cf. *harrarensis* Wells, Hudson 1955, p. 318.

Holotype. Amer. Mus. Nat. Hist., Spec. 25285, Wells 1943, pl. 8, figs. 1, 2. Upper Jurassic, Kurtcha, Harrar Province, Eastern Ethopia.

Middle East material. H 4851 (one piece and sections a–c), H 4852–6, 4858–60, 4863, 4867, 4869 (each one piece), H 4861 (one piece and sections a, b), H 4862 (one piece and sections a, Pl. 28, fig. 4, and b), H 4864 (two pieces, Pl. 28, figs. 3, 9, 10), H 4865 (one piece, text-fig. 3A, and section *a*), H 4866 (one piece and section a), and H 4868 (three pieces and sections a, b). All from Beni Zaid Limestone (Oxfordian), Wadi Bih, Ruus al Jibal, Trucial Oman, Arabia. H 4832 (one piece and section a, text-fig. 6). Oxfordian, Jebel Moghara, Sinai, Egypt.

Description. Nodular (largest specimen, fragmentary, 14 cm. across), usually a confluent aggregate of either concentric coenosten or coenosteal columns, about 8–12 mm. across, each with axial and peripheral reticula; often encrusting or intergrown with other species. Surface undulant with low rounded basses (not mamelons). Coenosteum may be lightly latilamellate due to alternation of layers (*c*. 40 mm. thick) in which vertical lamellae are thick and closely joined or thinner and separate. Reticulum with dominant vertical lamellae of conjoined pillars, transversely vermiculate, and, vertically, tending to be

EXPLANATION OF PLATE 28

Dehornella spp., all from Beni Zaid Limestone (Oxfordian s.s.) of Wadi Bih, Jebel Hagab area, Ruus al Jibal, eastern Arabia. All specimens are partly silicified.

Figs. 1, 2, 7. *Dehornella omanensis* sp. nov., H 4844, encrusting coral. 1, Weathered upper surface, ×1·7, showing holotheca at base of coenosteum. 2, Thin section a, ×1·7, across coenosteum, showing vertical pattern of reticulum. Photographed by reflected light. Note holotheca at base of coenosteum and lamellate pattern of initial reticulum. 7, Tang. thin section c, ×3, photographed by reflected light, showing astrocorridors.

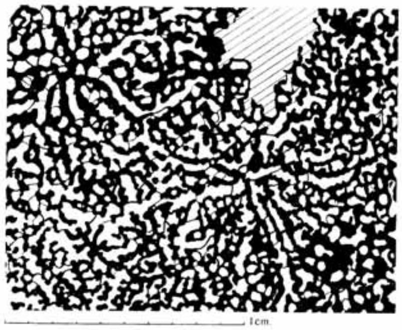
Figs. 3, 9, 10. *Dehornella harrarensis* (Wells) H 4864. 3, Coenosteal surface, ×1·1, showing astrosystems and intervening reticulum. 9, Polished surface, ×1·1, across middle of nodular coenosteum showing adjoining coenosteal columns and latilamellae. 10, Radial polished surface, ×1·7, showing latilamellae.

Fig. 4. *Dehornella harrarensis* (Wells), tangential thin section H 4862*a*, showing astrocorridors.

Figs. 5, 6, 7. *Dehornella omanensis* sp. nov. 5, Weathered radial surface, H 4848, ×1·5. 6, Polished surface across middle of coenosteal nodule, H 4834, ×2. 7, Radial polished surface, H 4835, ×2. Compare fineness of texture with that of *D. harrarensis* Wells, fig. 10. Note indefinite latilamellation.

irregular in thickness (generally 0·2–0·3 mm. across) and direction. Lamellae enclose elongate vermiculate coenospaces, generally 0·4 mm. across, or, less common, smaller coenotubes. Transverse processes arising laterally from the vertical lamellae may occur and join to link two lamellae. Aligned transverse lamellae are occasionally present usually at wide intervals; they show better in weathered specimens than in sections.

TEXT-FIG. 5



TEXT-FIG. 6

TEXT-FIG. 5. *Dehornella omanensis* sp. nov. Vertical thin section, H 4837*a* from Beni Zaid Limestone, Oman, eastern Arabia. Wide spaces are along astrocorridors. Thin white lines in vertical lamellae indicate junction of adjoining pillars. Note slight latilamellation.

TEXT-FIG. 6. *Dehornella harrarensis* (Wells), H 4832*a*, from Upper Jurassic (Oxfordian s.s.) of Jebel Moghara, Sinai. Note plan of astrorhizal systems and reticulum as those of *Dehornella choffati* (Dehorne). In *D. harrarensis* the vertical lamellae are thicker and astrocorridors wider.

Coenotabulae not uncommon. Abundant astrosystems, about 5–6 mm. across, occasionally contiguous, but centres usually about 7–9 mm. apart, consist of irregularly radial, long, dichotomizing, tabulate astrocorridors, generally 0·4 mm. across, and bounded by vertical lamellae joining at or near the astrosystem axis.

Many of the Oman specimens, such as H 4852, 4854, 4858, 4869 are encrusted on or by a form with much coarser skeletal elements than *D. harrarensis*: others as H 4859, 4866, 4867 are encrusted on or by *D. omanensis*.

Dehornella aff. *harrarensis* (Wells)

Material. H 5159, H 5169 (each one piece and a thin section), H 5160–2, H 5165, H 5167 (each one piece), and H 5164 (two pieces and a thin section). All from Shuqraia Limestone-with-Marl (Upper Jurassic, Argovian). Maktesh Hathira, Israel (Hudson 1958).

Description. *Dehornella* with small nodular coenosteum (up to 6 cm. across) encrusting (usually small phaceloid corallites) and with irregular slightly nodose surface. Coarse reticulum with thick vertical lamellae (*c*. 0·2–0·5 mm. across) of pillars joined directly or by short lateral processes, and enclosing irregular coenospaces (*c*. 0·2–0·3 mm. across), often irregularly vermiculate and joining each other. Astrosystems of coarse irregular astrocorridors (0·2–0·3 mm. across) joining coenospaces. Tabulae fairly common. Skeletal tissue largely replaced by silica and hence specimens not preserved well enough for illustration or definite identification.

The skeletal elements of these forms have generally the same dimensions as *D. harrarensis*. They differ in that their lamellae are generally more vertical and perhaps thicker (more compound) and there are few or no transverse lamellae.

ASTROPORINA gen. nov.

Type species *Astroporina stellifera* sp. nov.

Diagnosis. Parastromatoporidae with coenosteum of abundant conjoined or interlaced astrosystems of well-developed tabulate astrocorridors, variously radial or irregular and indefinite, bounded by vertical lamellae, often composite with cellules. Reticulum of coenospaces and coenotubes, if present, very subordinate. Tabulae abundant and irregularly aligned.

Astroporina stellifera sp. nov.

Plate 24, figs. 1–5; Plate 27, figs. 1, 2

Holotype. F 1775, one piece and sections a (Pl. 24, fig. 5), b (Pl. 24, figs. 1, 3), and c (Pl. 24, figs. 2, 4) and H 3657, two pieces (Pl. 27, figs. 1, 2) and sections H 3658–9 (cut from H 3657). Upper Jurassic, Ahankon Tug (11° 01′ N., 48° 26′ E.), Inda District, British Somaliland.

Diagnosis. *Astroporina* with nodular coenosteum of conjoined distinct astrosystems (centres 3·5–5 mm. apart) consisting of astrocorridors (0·25–0·30 mm. wide), irregularly stellate and well branched, bounded by vertical lamellae (pillars 0·15 mm. across) enclosing abundant coenotubules (0·12 mm. across).

Astroporina orientalis sp. nov.

Plate 26, figs. 1, 2; Plate 27, figs. 6, 7

Holotype. H 4850, one piece and thin sections a (Pl. 26, fig. 1; Pl. 27, fig. 7) and b (Pl. 27, fig. 6; Pl. 26, fig. 2). Cladocoropsis Limestones (Sequanian), near Ain Safra, Yanta, Lebanon.

Diagnosis. *Astroporina* with coenosteum of vertical pillars, occasionally isolated but mainly joined laterally to form extensive vertical lamellae (*c*. 0·15–2·0 mm. across), vertically fairly straight, occasionally enclosing ?coenotubes. Interlaced astrosystems of astrocorridors (*c*. 0·3–0·4 mm. across) bounded by vertical lamellae joining at or near the axis. In parts of the coenosteum the corridors are intermingled and lose their identity as astrocorridors. Tabulae abundant, close (about 7 to 2 mm.), and irregularly aligned.

Astroporina cf. *orientalis* sp. nov.

Plate 25, figs. 1–3; Plate 26, figs. 2, 3

Material. F. 1773, three pieces and sections a (Pl. 25, fig. 2; Pl. 26, fig. 2), b (Pl. 25, fig. 1; Pl. 26, fig. 3), and c (Pl. 25, fig. 3; Pl. 3, fig. 3). Upper Jurassic, Bihen Limestone, Daghani Section (10° 09′ N., 45° 10′ E.), Bihendula, British Somaliland.

Description. Astroporina with nodular coenosteum of vertical lamellae (constituent pillars 0·13–0·19 mm. across), vertically and transversely irregular, occasionally enclosing coenotubes, and bounding interlacing corridors (0·22–0·38 mm. across). The general plan of this specimen is that of *Astroporina orientalis*. The vertical lamellae are, however, more irregular and the astrocorridors are more indefinitely radial: the overall transverse plan is that of the more indefinite parts of *A. orientalis*.

Astroporina stellans sp. nov.

Plate 24, figs. 6, 7; Plate 25, fig. 4; Plate 26, figs. 5, 6

Holotype. F 1774, one piece and sections a (Pl. 24, fig. 7; Pl. 26, fig. 5), b (Pl. 25, fig. 4; Pl. 26, fig. 6), and c (Pl. 24, fig. 6). Upper Jurassic, Bihen Limestone, Daghani Section (10° 09′ N., 45° 10′ E.), Bihendula, British Somaliliand.

Diagnosis. Astroporina with nodular coenosteum. Reticulum of thick irregular vertical lamellae (*c.* 0·2–0·5 mm. across) formed of joined pillars (*c.* 0·2 mm. across). Lateral processes not common. Lamellae occasionally enclose coenotubes (*c.* 0·125–0·2 mm. across) but generally bound irregular vermiculate conjoined coenospaces (*c.* 0·2–0·3 mm. across). Astrosystems, centres about 2·5–4·5 mm. apart, of irregularly branching astrocorridors (*c.* 0·25–0·33 mm. across) bounded by irregular vertical lamellae. Tabulae common (about 0·4–0·6 mm. apart).

Astroporina sp.

Material. H 4857, four pieces and sections a–d. Beni Zaid Limestone (Oxfordian s.s.), Wadi Bih Jebel Hagab area, Ras al Khaima, Trucial Oman, Arabia.

Description. Astroporina with nodular coenosteum of intergrown coenosteal columns forming low bosses at surface. Astrosystems dominant, of long radial astrocorridors (*c.* 0·4 mm. across), bounded by irregular but continuous vertical lamellae (*c.* 0·25 mm. across). Reticulum between astrosystems not extensive, of isolated vertical lamellae and pillars, and wide joined coenospaces similar to astrocorridors. Occasional transverse lamellae. Tabulae not common, mainly aligned.

Specific distinction in *Astroporina*

Species of *Astroporina*, as species of *Dehornella* and *Parastromatopora*, include those with fine structural elements as *A. stellifera* and *A. orientalis* (compare *D. choffati* and *D. omanensis*) and those with coarse structural elements as *A. stellans* and *Astroporina* sp. (compare *D. harrarensis*): it seems probable that fine and coarse structural forms are independent lineages. The difference between *Astroporina* and *Dehornella* and the distinction between the species of *Astroporina* is based on the progressive elimination of the normal reticulum within the coenosteum. In *A. stellifera* the astrosystems remain about the same size (*c.* 5 mm. across) but so increase in number and completely occupy the coenosteum, the reticulum being represented by the cellular skeletal blocks between the astrocorridors. The coenosteum is therefore a complex of short corridors.

In *A. orientalis* the astrosystems increase in width up to 12 mm. across, the astrocorridors widening, lengthening, and increasing in number. The single tubes enclosed by the lamellae and usually in an astrocorridor wall have as far as is known no special significance; they appear to be normal coenotubes. Otherwise there is no remnant of the reticulum. The general pattern is therefore a mesh of wide and comparatively straight radial astrocorridors. Occasionally the walls of the astrocorridors break up into pillars or small lamellae and the astropattern is lost. This is especially the case in *A.* cf. *orientalis*.

The coenosteum of *A. stellans* consists of a mesh of close short branching corridors, many of which have a radial arrangement and all of which are considered to be astrocorridors. The astrosystems are small, with few astrocorridors and closely intermingled. The astrocorridors are separated by thick short vertical lamellae and columns enclosing coenotubes. *A. stellans* is thus more closely similar to *Dehornella*.

Astroporina sp. occurs with and has the dimensions of *Dehornella harrarensis*. It differs from that species in that astrosystems are more numerous, have long astrocorridors, and occupy a much greater part of the coenosteum.

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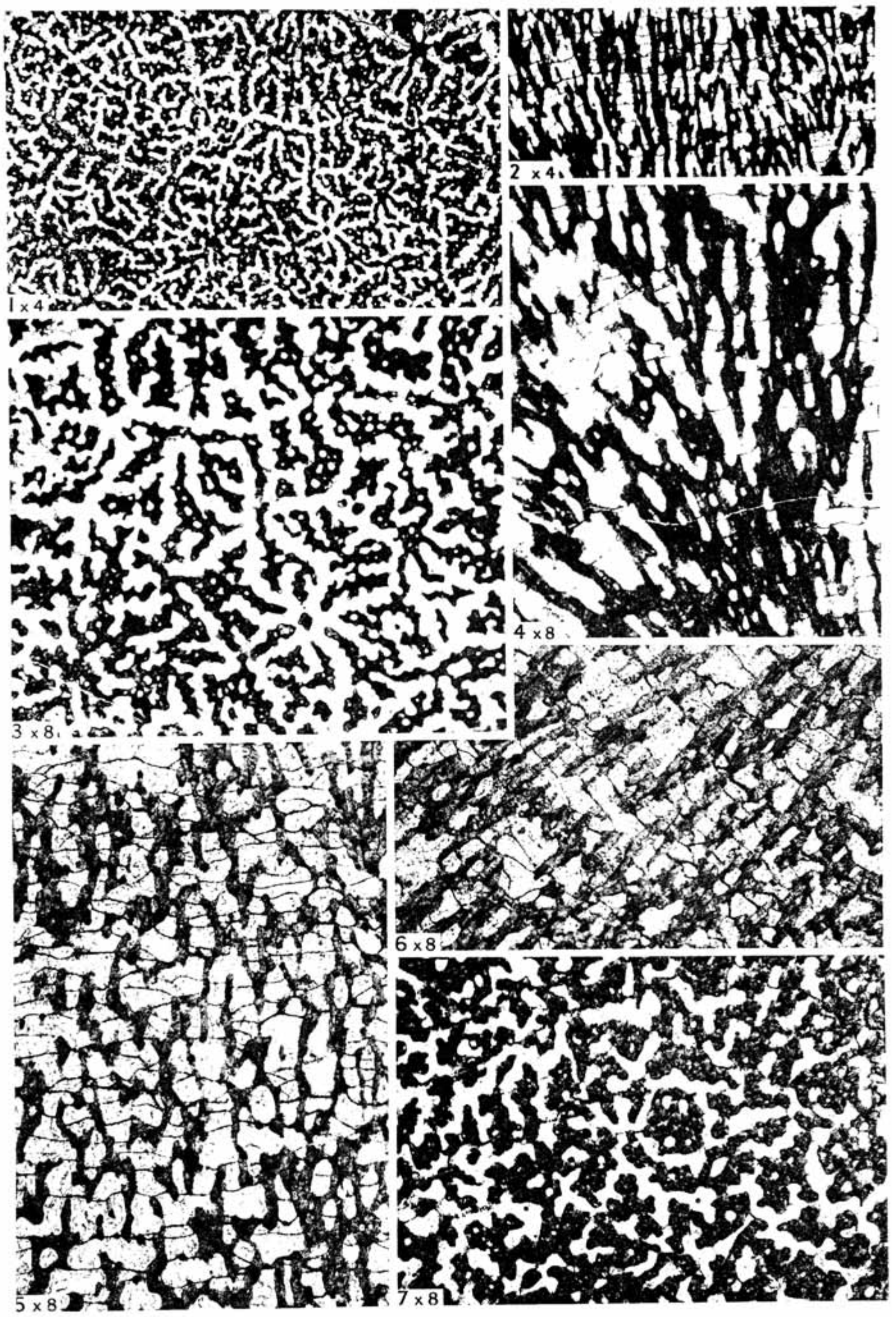
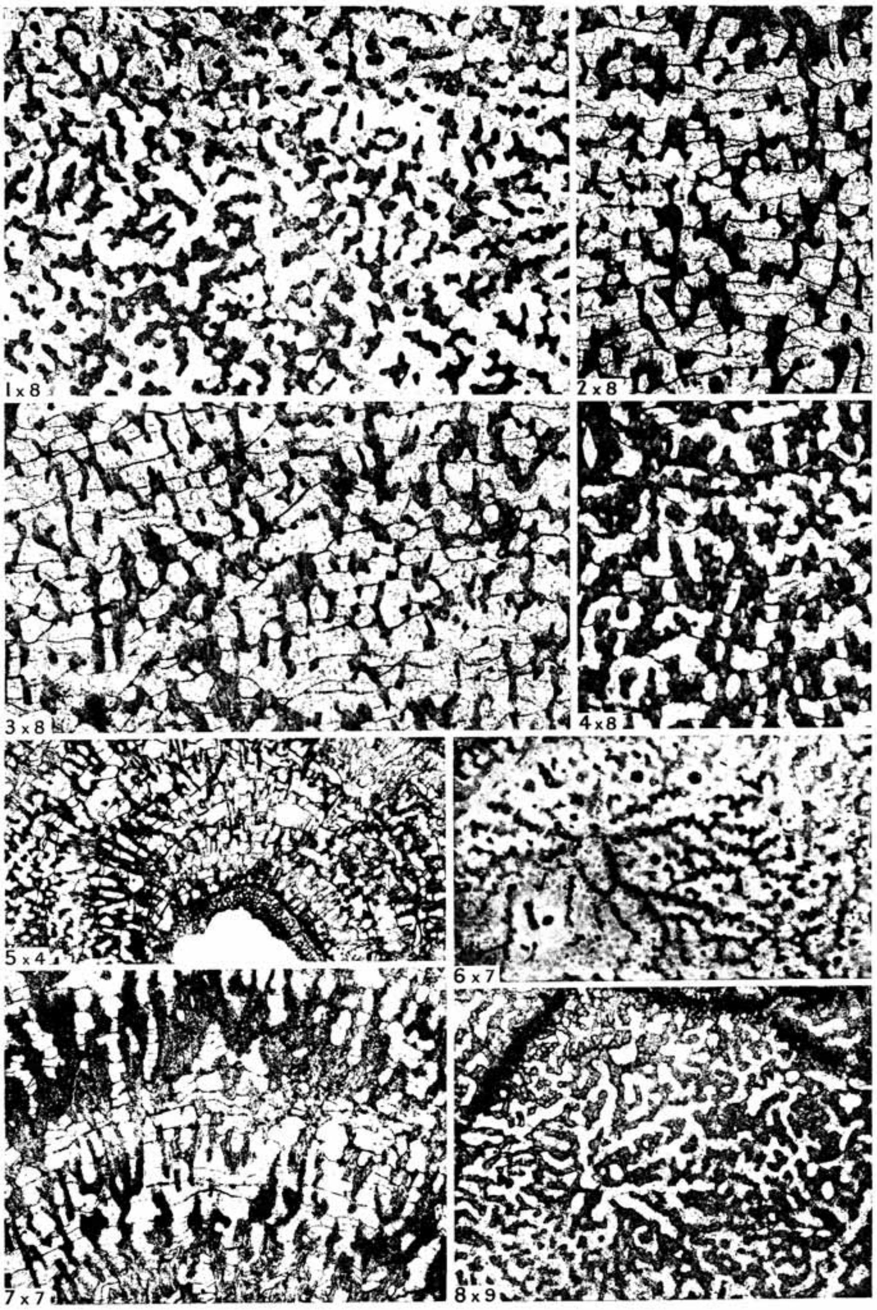
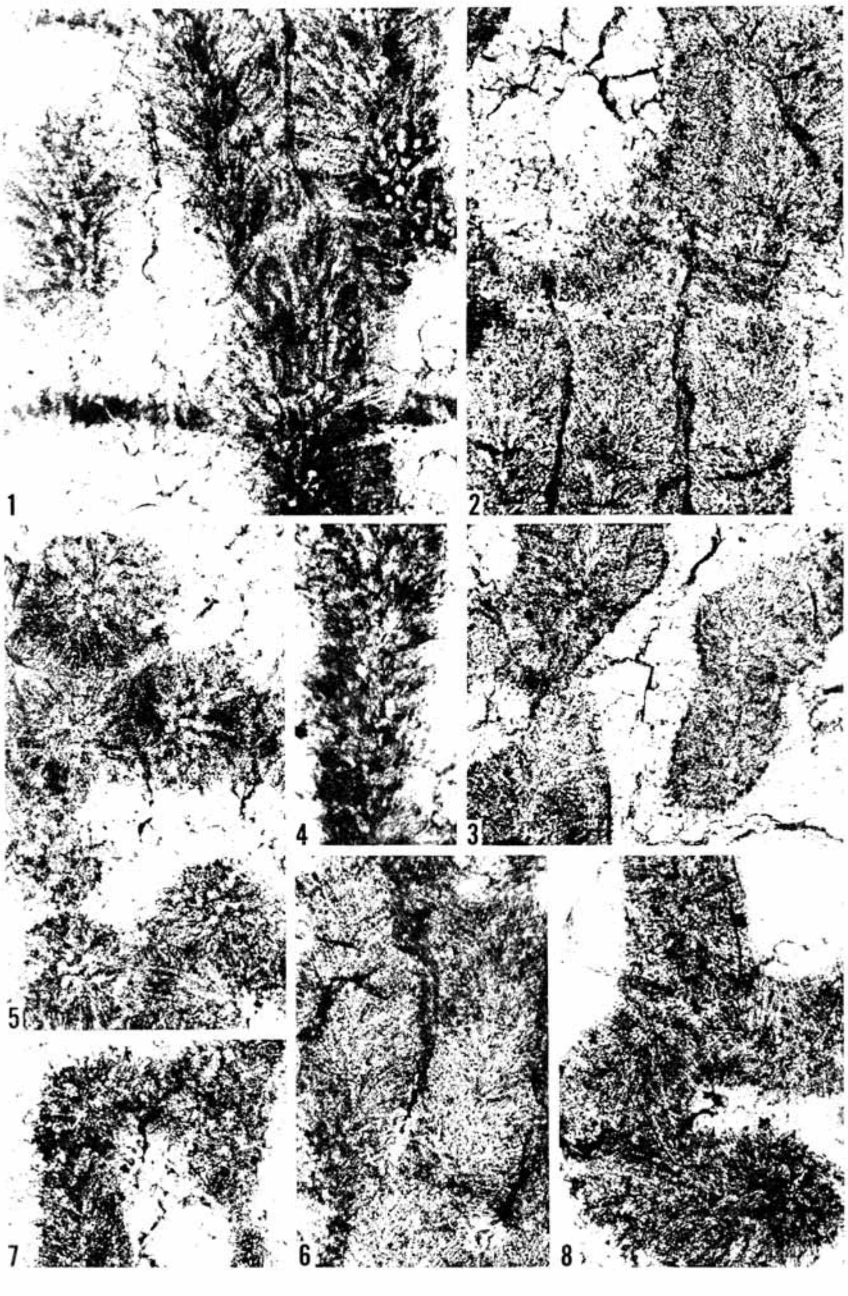


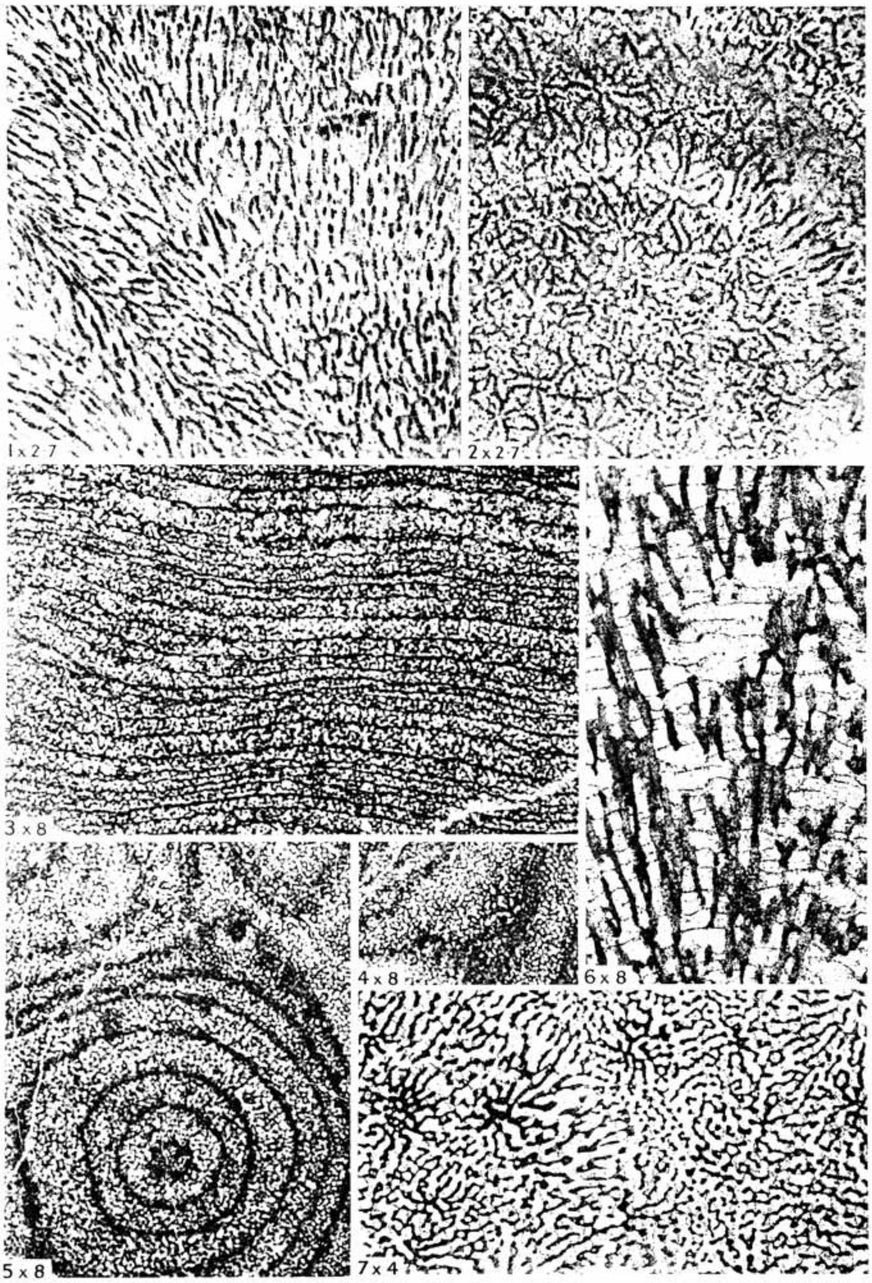
HUDSON, Jurassic stromatoporoid *Astroporina*



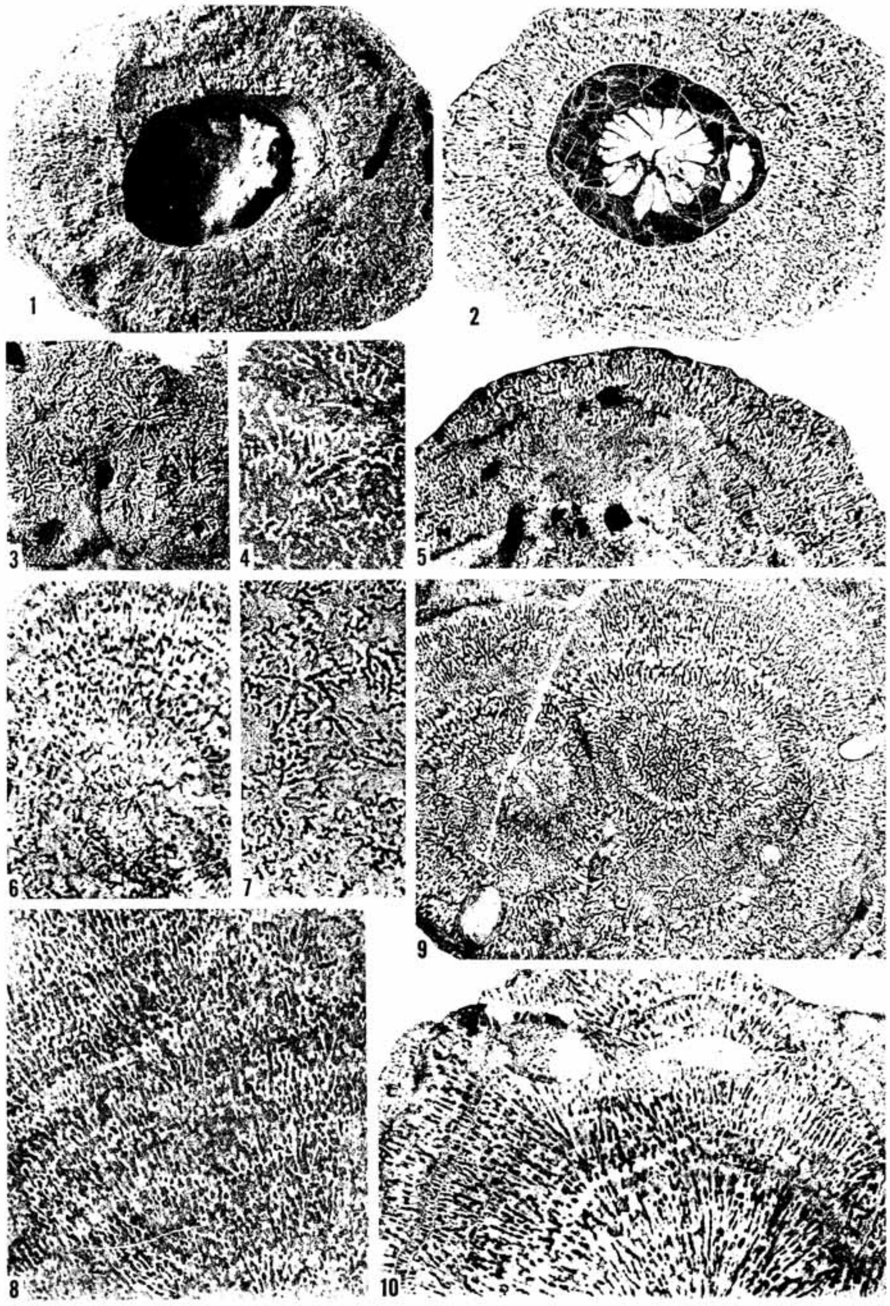
HUDSON, Jurassic stromatoporoids



HUDSON, Pillar clinogonal structure, *Astroporina* and *Dehornella*, x100.



HUDSON, *Astroporina* and *Stromatoporina*.



HUDSON, *Dehornella*.