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DIFFINGIINA, A NEW SUBORDER OF THE RUGOSE CORALS
FROM SW TEXAS

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Diffingiina subordo n., tentatively included in *Stauriida* Verrill, 1865, is characterized by the adaxial split of the inner end of at least one (the cardinal) septum; the development of the basal plate and the vertical position of the young corallite at the beginning of its growth; the absence of septal furrows; the shortening of the counter septum at least during some part of the neanic growth; the trabecular microstructure of septa; and the biform tabularium. The attachment scars have once been illustrated for the *Rugosa*, but they were recognized only in this paper.

All taxa included in the suborder are new, because their basic characteristics have not been reported so far as present in the *Rugosa*. Two new families have been established: the monotypic family *Plerodiffiidae* fam.n., containing only a single species *Plerodiffia eaglebuttensis* sp.n., and the family *Diffingiidae* fam.n. subdivided into two subfamilies. In the monotypic subfamily *Diffingiinae* subfam.n. seven new species have been recognized. The presence of two opposite trends in the morphological development suggests the possibility of further increase in the number of genera within the subfamily. The subfamily *Turgidiffiinae* subfam.n. contains two genera: *Turgidiffia* gen.n. with three new species and the new genus and species left in the open nomenclature.

Key words: *Rugosa*, new suborder, morphogenesis, systematics, Permian, SW Texas.

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INTRODUCTION

The suborder being discussed is so far known only from southwestern Texas. Occurring in the Wolfcampian, possibly extending up to the Guadalupean, and being fairly well represented in individual formations or on the given stratigraphic levels, particular species of that suborder may be eventually used as the index fossils.

The appearance of new morphological structures as well as their fairly rapid and multidirectional development form an interesting sample from the purely biological point of view. The interpretation of those structures forms the main subject of the discussion which follows. All

taxa being discussed are new, thus the paper starts with a short taxonomic part. A comprehensive description of all Wolfcampian species included in the suborder is published separately (Fedorowski in press.).

I would like to express my thanks to Dr. Ewa Roniewicz for drawing my attention to the occurrence of the attachment scars in Scleractinia.

The collection described is housed at the United States National Museum of Natural History, Smithsonian Institution in Washington (USNM). All localities cited are USNM localities. Their complete list and all additional data are to be found in Cooper and Grant (1972—1977).

SYSTEMATICS

Subclass **Rugosa** Milne-Edwards et Haime, 1850

Order **Stauriida** Verrill, 1865

Suborder **Diffingiinae** nov.

Families assigned: Diffingiidae fam.n. Plerodiffiidae fam.n.

Diagnosis.—Rugose corals having postlarval basal plate flat, external wall without septal furrows, and at least some major septa split adaxially; microstructure of septa trabecular; tabularium biform.

Family **Diffingiidae** nov.

Subfamilies assigned: Diffingiinae subfam.n. Turgidiffiinae subfam.n.

Diagnosis.—Diffingiina having at least cardinal septum split adaxially; calice floor either funnel-shaped or flat, or elevated into axial structure.

Subfamily **Diffingiinae** nov.

Genera assigned: Monotypic.

Diagnosis.—Diffingiidae having calice floor funnel-shaped or flat.

Fig. 1. 1. *Diffingia collecticia* sp.n. Specimen USNM 197389. Holotype. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds. Transverse sections; a—late neanic/early ephebic stage; b, c—ephebic stage. All $\times 8$; 2. *Diffingia valida* sp.n. Specimen USNM 197413. Holotype. Locality USNM 701, Neal Ranch Formation. Transverse sections; a—c—early neanic stage, $\times 16$; d—neanic stage, $\times 12$; e, f—ephebic stage, $\times 8$; 3. *Diffingia tortuosa* sp.n. Specimen USNM 197441. Holotype. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds. Transverse section of early to late ephebic stage, $\times 8$. 4. *Diffingia largifica* sp.n. Specimen USNM 197468. Holotype. Locality USNM 711g, Hess Formation. Transverse sections; a—neanic stage, $\times 12$; b—d—early to late ephebic stage, $\times 8$.



Genus *Diffingia* gen.n.

Type species: *D. collecticia* sp.n.

Derivation of the name: Lat. *diffigo*, *finxi*, *fictum*—to change, to modify—after modifications of major septa.

Species assigned: *D. coita* sp.n., *D. collecticia* sp.n., *D. divisa* sp.n.; *D. largifica* sp.n., *D. tortuosa* sp.n., *D. valida* sp.n., A form described as *Diffingia* sp.n. 1 should be assigned also here.

Diagnosis.—As for the subfamily.

Diffingia collecticia sp.n.

(pls. 13: 3—5; 14: 9a, b; 16; 19: 3a, b; fig. 1: 1a—c)

Holotype: Specimen USNM 197389, pls. 13: 5; 16: 3; 19: 3a, b; fig. 1: 1a—c.

Type locality: USNM 705a.

Type horizon: Base of Scacchinella beds, Lower Skinner Ranch Formation, Upper Wolfcampian.

Derivation of the name: Lat. *collecticius*—collected, put together—after arrangement of major septa.

Diagnosis.—*Diffingia* having maximum n:d ratio at calice margin 21:7.5; major septa leave small, free axial area; split of septa, except for cardinal septum, uncommon; counter septum permanently shortened; minor septa reduced in number, form close pairs with major ones when present.

Occurrence.—Locality USNM 705a: over 200, 720e:4, base of Scacchinella beds; 707g:1, Decie Ranch member; 722h:1, 722l:4, Sullivan Peak member. All of Skinner Ranch Formation. 725c:1, 728e:37, 728f:1, Lower Bone Spring Formation. Upper Wolfcampian.

Diffingia valida sp.n.

(pls. 13: 6, 7; 17: 1a, b, 2; 19: 4a, b; fig. 1: 2a—f)

Holotype: Specimen USNM 197413, fig. 1: 2a—f; 5: 1a, b; 7: 4a, b.

Type locality: USNM 701.

Type horizon: Neal Ranch Formation, Lower Wolfcampian.

Derivation of the name: Lat. *validus*—strong—after well developed major and minor septa.

Diagnosis.—*Diffingia* having maximum n:d ratio at calice margin 21:6.0; major septa long; free axial area commonly absent, very narrow if temporarily present; split of major septa restricted to cardinal septum and adjacent major septa; minor septa in full number.

Occurrence.—Locality USNM 701:4, Neal Ranch Formation; 705:63, Lenox Hills Formation. Lower Wolfcampian.

Diffingia coita sp.n.

(pl. 13: 8a, b)

Holotype: Specimen USNM 197431, pl. 13: 8a, b.

Type locality: USNM 707b.

Type horizon: Skinner Ranch Formation, Sullivan Peak member, Upper Wolfcampian.

Derivation of the name: Lat. *coire* — to come together — after major septa almost meeting in corallite axis.

Diagnosis. — *Diffingia* having maximum n:d ratio at calice margin 24:8.9; radially or semiradially arranged major septa come close or meet at corallite axis without being united; cardinal septum slightly shortened; counter septum may be slightly elongated; minor septa lacking.

Occurrence. — 723o:1, undivided; 727f:2, upper; 705a:1, base of Scacchinella beds; 732e:3, Dugout Mountain member; 707d:1, 722h:2, 722l:2, Sullivan Peak member; 707b:10, top of Sullivan Peak member. All of Skinner Ranch Formation. Upper Wolfcampian.

Diffingia tortuosa sp.n.

(pls. 13: 10a, b; 17: 3a—c; 20: 1; fig. 1: 3a—c)

1980. "*Duplophyllum*" sp. 2 — Fedorowski, pl. 29.

Holotype: Specimen USNM 197441, pl. 20: 1; fig. 1: 3a—c.

Type locality: USNM 705a.

Type horizon: Skinner Ranch Formation, base of Scacchinella beds, Upper Wolfcampian.

Derivation of the name: Lat. *tortuosus* — after tortuous shape of septa.

Diagnosis. — *Diffingia* having maximum n:d ratio at calice margin 23:7.5; major septa tortuous, short, arranged almost radially; cardinal septum split distinctly, other major septa less well so or only thickened adaxially; minor septa long, often incomplete in number, contratingent and/or contraclined or free.

Occurrence. — Locality USNM 712o:1, lower; 705a:67, 720e:2, base of Scacchinella beds; 707g:1, Decie Ranch member; 707ha:2, Poplar Tank member; 722l:5, Sullivan Peak member; 707b:1, top of Sullivan Peak member. All of Skinner Ranch Formation. 728e:2, Lower Bone Spring Formation. Upper Wolfcampian.

Diffingia divisa sp.n.

(pls. 13: 9a, b; 19: 5; fig. 2: 1a—f)

Holotype: Specimen USNM 197453, pls. 13: 9a, b; 19: 5; fig. 2: 1a—f.

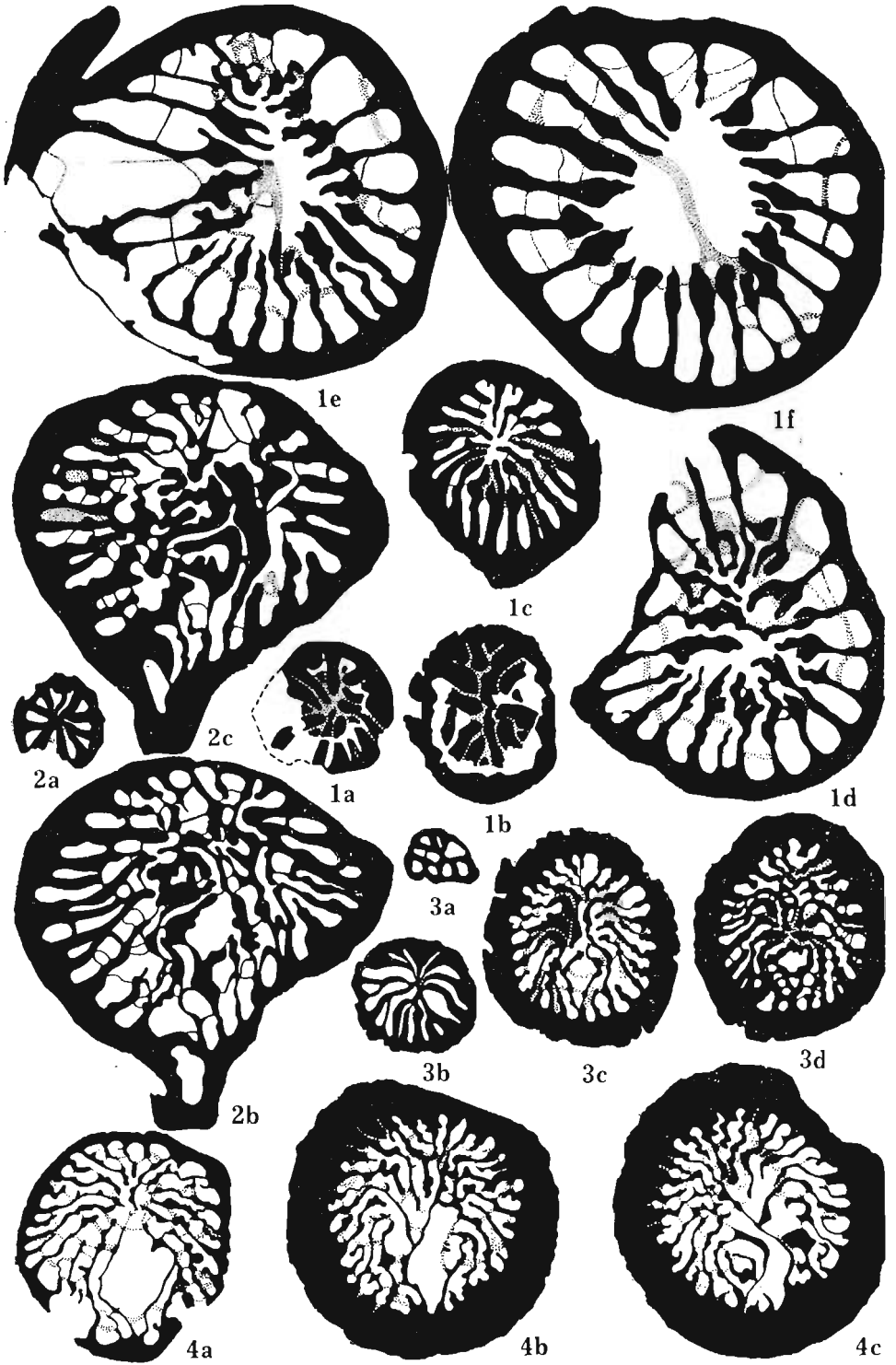
Type locality: USNM 707b.

Type horizon: Top of Sullivan Peak member, Skinner Ranch Formation, Upper Wolfcampian.

Derivation of the name: Lat. *dividere* — to divide — after split major septa.

Diagnosis. — *Diffingia* having maximum n:d ratio at calice margin 23:8.0; inner parts of major septa commonly split; cardinal septum indistinct; cardinal tabular fossula shallow or lacking; axial area free of radially arranged septa from early maturity; minor septa seen occasionally in some septal loculi.

Occurrence. — Locality USNM 723o:1, undivided; 720f:3, lower; 727f:3, upper; 705a:9, base of Scacchinella beds; 707a:1, Decie Ranch member; 732e:6, Dugout Mountain member; 707c:1, 722h:1, 722l:11, 733j:1, Sullivan Peak member; 707b:5, top of Sullivan Peak member. All of Skinner Ranch Formation. 721:3, Lower Hueco Formation. 711g:1, Hess Formation. Upper Wolfcampian.



Diffingia largifica sp.n.

(pls. 13: 12; 18: 1a—c; 20: 2a—d; fig. 1: 4a—d)

Holotype: Specimen USNM 197468, pls. 13: 12; 18: 1a—c; 20: 2a—d; fig. 1: 4a—d.*Type locality*: USNM 711g.*Type horizon*: Hess Formation.*Derivation of the name*: Lat. *largificus* — abounding, plentiful — after abundance of septa.*Diagnosis*.—*Diffingia* having maximum n:d ratio at calice margin 22:7.5; amplexoid, wavy major septa come close to or meet at corallite axis; split of cardinal septum temporary in ontogeny; counter septum invariably long; minor septa long, contratingent and contraclined.*Occurrence*.—Locality USNM 705a:3, base of Scacchinella beds; 720f:1, 707w:1, Decie Ranch member; 732e:1, Dugout Mountain member; 707b:2, top of Sullivan Peak member. All of Skinner Ranch Formation. 711g:1, undivided; 702d:2, 702e:1, Taylor Ranch member. All of Hess Formation. Upper Wolfcampian.*Diffingia* sp.n. 1

(pl. 13: 11)

Characteristics.—Like *Diffingia collecticia* sp.n., but with “third order” septa (?meiosepta of Weyer 1984).*Occurrence*.—Locality USNM 7221:1, Skinner Ranch Formation, Sullivan Peak member. Upper Wolfcampian.Subfamily **Turgidiffiinae** subfam.n.*Genera assigned*: Monotypic (but a form *Turgidiffiinae* gen. et sp.n. characterized on p. 217 should be assigned also here).*Diagnosis*.—*Diffingiidae* having axial structure or columella derived from inner end of counter septum.Genus *Turgidiffia* gen.n.*Type species*: *T. composita* sp.n.

Fig. 2. 1. *Diffingia divisa* sp.n. Specimen USNM 197453. Holotype. Locality USNM 707b, Skinner Ranch Formation, top of Sullivan Peak member. Transverse sections; a, b—neanic stage, $\times 12$; c—late neanic stage, $\times 8$; d—f—early to late ephebic stage, $\times 8$. 2. *Turgidiffia composita* sp.n. Specimen USNM 197497. Holotype. Locality and horizon as above. Transverse sections; a—neanic stage, $\times 12$; b, c—ephebic stage, $\times 8$. 3. *Turgidiffia completa* sp.n. Holotype specimen USNM 197500. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections: a—early neanic stage, $\times 16$; b—neanic stage, $\times 16$; c, d—ephebic stage, $\times 8$. 4. *Turgidiffia columellata* sp.n. Specimen USNM 197512. Holotype. Locality and horizon as above; a—c—transverse sections of early to late ephebic stage, $\times 8$.

Derivation of the name: Lat: *turgidus*, *a*, *um* — swelled, tumescend and *diffigo*, *fixi*, *fictum* — to modify — after tumescend axial area and modified septa.

Species assigned: *T. columellata* sp.n., *T. completa* sp.n., *T. composita* sp.n.

Diagnosis. — *Turgidiffiinae* having axial structure developed from inner ends of major septa.

Turgidiffia composita sp.n.

(pls. 14: 1, 2, 3a, b; 18: 2; fig. 2: 2a—c)

Holotype: Specimen USNM 197479, pl. 14: 3a, b; fig. 2: 2a—c.

Type locality: USNM 707b.

Type horizon: Skinner Ranch Formation, top of Sullivan Peak member, Upper Wolfcampian.

Derivation of the name: Lat. *compositus* — formed of parts — after morphology of axial area.

Diagnosis. — *Turgidiffia* having maximum n:d ratio at calice margin 21:6.5; major septa differentiated in length, semiradially arranged in sections, occasionally split; axial parts of some of them protrude above calice floor to form pinnacles; cardinal septum long, often split; counter septum vary in length; minor septa well developed.

Occurrence. — Locality USNM 705a:2, base of Scacchinella beds; 720f:3, Decie Ranch member; 732e:1, Dugout Mountain member; 727f:1, upper; 707d:1, 722h:2, 722l:11, Sullivan Peak member; 707b:12, 707c:1, top of Sullivan Peak member. All of Skinner Ranch Formation. 721:1, Lower Hueco Formation. Upper Wolfcampian.

Turgidiffia completa sp.n.

(pl. 14: 4, 5a—d, 6, 7; fig. 2: 3a—d)

Holotype: Specimen USNM 197500, pl. 14: 5a—d; fig. 2: 3a—d.

Type locality: USNM 722l.

Type horizon: Skinner Ranch Formation, Sullivan Peak member, Upper Wolfcampian.

Derivation of the name: Lat. *complere* — to fill up, to overload — after axial area crowded with major septa.

Diagnosis. — *Turgidiffia* having maximum n:d ratio at calice margin 17:5.7; axial ends of major septa protruded above calice floor, bent towards widely split cardinal septum; counter septum distinctly shortened; minor septa well developed.

Occurrence. — Locality USNM 721:3, Lower Hueco Formation. 728e:4, Lower Bone Spring Formation. 738r:1, Cibolo Formation, Breccia Zone. 707ha:1, Poplar Tank member; 722l:19, Sullivan Peak member; 707b:1, top of Sullivan Peak member. All of Skinner Ranch Formation. Upper Wolfcampian.

Turgidiffia columellata sp.n.

(pls. 14: 8; 20: 3a, b; fig. 2: 4a—c)

Holotype: Specimen USNM 197512, pls. 14: 8; 20: 3a, b; fig. 2: 4a—c.

Type locality: USNM 722l.

Type horizon: Skinner Ranch Formation, Sullivan Peak member, Upper Wolfcampian.

Derivation of the name: *columellata*—after formation of a kind of columella.

Diagnosis.—*Turgidiffia* having maximum n:d ratio at calice margin 21:5.5; counter septum distinctly elongated in maturity; minor septa underdeveloped in calice; distinct foundations of septa occur at calice margin; inner ends of major septa bent towards split cardinal septum.

Occurrence.—Locality USNM 721:3, Lower Hueco Formation. 722h:1, 722i:9, Skinner Ranch Formation, Sullivan Peak member. Upper Wolfcampian.

Turgidiffiinae gen. et sp.n.

(pl. 15: 1a—d; fig. 3: 1a—c)

Characteristics.—Distinct foundations of septa, often common for both cycles, occur at calice margin; cardinal septum split distinctly; counter septum elongated to form columella; inner ends of major septa bent towards cardinal septum; minor septa underdeveloped.

Sp.n.A

Occurrence.—Locality USNM 705a:1(?), base of Scacchinella beds; 722i:1, Sullivan Peak member. Both of Skinner Ranch Formation. Upper Wolfcampian.

Family Plerodiffiidae fam.n.

Genera assigned: Monotypic.

Diagnosis.—Diffingiina having protosepta differentiated in length accordingly to plerophylloid plan.

Genus *Plerodiffia* gen.n.

Type species: *P. eaglebuttense* sp.n.

Derivation of the name: named after similarity to the genera *Plerophyllum* Hinde, 1890 and *Diffingia* gen.n.

Species assigned: Monotypic.

Diagnosis.—As for the family.

Plerodiffia eaglebuttensis sp.n.

(pls. 15: 2, 3, 4, 5a, b, 6, 7, 8a, b; 18: 3—5; 19: 1a, b, 2; fig. 3: 2a—i)

Holotype: Specimen USNM 197525, pls. 15: 6; 18: 4; fig. 3: 2a—i.

Type locality: USNM 721.

Type horizon: Lower Hueco Formation, Upper Wolfcampian.

Derivation of the name: *eaglebuttensis*—after Eagle Butte, the area of the type locality.

Diagnosis.—*Plerodiffia* having maximum n:d ratio at calice margin 20:7.5; major septa irregularly wavy; thickened, split and/or bend inner ends of lateral

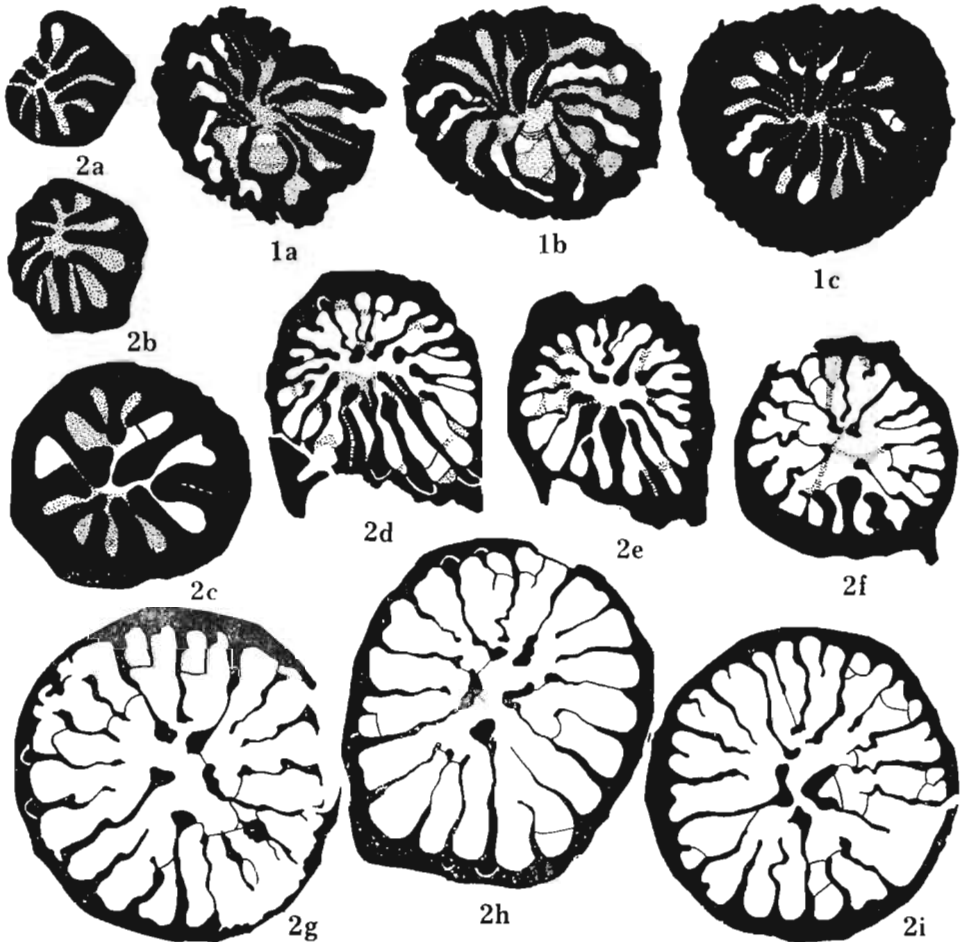


Fig. 3. 1. *Turgidiffinae* gen. et sp.n. Specimen USNM 197522. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member. Transverse sections; a, b—early ephelbic stage; c—ephebic stage. All $\times 8$. 2. *Plerodiffia eaglebuttensis* sp.n. Specimen USNM 197525. Holotype. Locality USNM 721, Lower Hueco Formation. Transverse sections; a—c—neanic stage, $\times 16$; d—f—early ephelbic stage, $\times 8$; g—i—ephebic stage, $\times 8$.

protosepta surround axial area; counter septum only slightly shortened; minor septa in maturity absent or incomplete.

Occurrence.—Locality USNM 721:41, Lower Hueco Formation. 705:2 Lenox Hills Formation. Wolfcampian.

CONSIDERATIONS

EARLY SKELETOGENESIS

In contrast to the representatives of the suborder Diffingiina subordo n., all other rugose corals from the Permo-Carboniferous of SW Texas as well as the great majority of species of the Rugosa described so far in adequate details, have their tips pointed and more or less clearly flattened on the attachment side. Those early attachment flattenings might have continued to develop during a fairly long period of growth of the corallite or might have disappeared just above the tips in the specimens of species loosely resting on the sea floor or being vertically embedded in the sea floor mud. In all cases mentioned, the ecological control over the development of more or less strong attachment and over a shape of corallites (Yakovlev 1910, 1914, 1964) can easily be accepted, although the genetic control over a mode of life of individual taxa seems also obvious. Weak traces of the attachment, developed only at the very beginning of the ontogeny were often destroyed by diagenesis, but the pointed shape of the tips themselves leaves no doubts as to the mode of their early skeletogenesis. Further considerations on those interesting problems are avoided in the following discussion as being unimportant for the purpose of this paper. From the latter point of view, the presence or absence of the aseptal stage and development of the aseptal cup at the very beginning of the postlarval stage of the Rugosa is one of the taxonomically most important questions. A positive answer to it seems to have been confirmed by some investigations in thin and serial sections (e.g. Schindewolf 1942, Easton 1945, Fedorowski 1973, Ilina 1984) but especially by rare observations on the juvenile corallites etched out from the rocks (Sando 1961, Fedorowski in press). Also Weyer (1974), reconstructing the insertion of septa in the Rugosa as having taken place at the upper limit of the calice, at the same time supported the notion of the presence of the aseptal cup at the beginning of the skeletogenesis.

There are numerous investigations in the thin and serial sections, however, (eg. Carruthers 1906, Faurot 1909, Schindewolf 1942, Fedorowski 1965, Neuman 1969, etc.) which seem to contradict the above opinions by showing a presence of septa in the tips. The sequence in the appearance of first septa and first tabula in the young corallite explains that seeming contradiction adequately. In the case of an unambiguous occurrence of the aseptal postlarval cup the insertion of the first tabula precedes the appearance of first septa and cuts out the empty tip, producing the morphology best shown by Rózkowska (1956) in *Protomacgeea dobruchnensis* Rózkowska, 1956. In the case of lack of the empty tip, but not the empty cup, the insertion of septa precedes the appearance of

the first tabula. The sequence is in this case slightly more complex. It can be divided into two steps: 1) an insertion of the aseptal cup, 2) an insertion of the first septa. It is beyond these considerations to discuss here the area of the occurrence of foundations of those first septa. The calice margin suggested by Weyer (1974) may be at least tentatively accepted. The first tabula, inserted after the appearance of the first septa, fixed the morphology which is now excavated by sections. In some cases the empty tip is not separated from the rest of the growing skeleton by a tabula. Instead, there is the amorphous stereoplasmic mass, which filled in the tip prior to the insertion of the first septum (Fedorowski in press).

Considering the creation of the aseptal cup at the beginning of the ontogeny of the majority of the Rugosa has been at least tentatively proven, there may be two ways of secretion of that cup: 1. That suggested by Yakovlev (1910), according to whom the settled planula cemented itself to the hard substrate laterally without forming any basal plate. The lateral flattening of the cup resulted from the attachment. 2. The settled planula cemented itself to the hard substrate by the calcium carbonate fabric produced by its sole, i.e. forming a kind of basal plate and only then metamorphosed into a polyp. The latter incorporated that larval attachment and adopted it as a base of its newly produced, aseptal cup, attached laterally to the hard substrate. The strength of that attachment was ecologically controlled. Thus, the cup would only have formed the second step of the skeletogenesis, but the first at the polyp stage. Such a reconstruction seems to be confirmed by the very well preserved tips (pl. 13: 1,2). It does not differ considerably from the earlier one, and may well be treated only as its variant.

The mode of the early skeletogenesis of the most of the rugose corals briefly discussed above contrasts well with that observed in *Diffingiina subordo n.* A flat basal plate invariably present in the latter taxon (pls. 13: 9b, 12; 14: 3b, 5b, d; 15: 4, 5a, b, 6,7) forms the only attachment of those corals to the hard substrate over one to three millimeters of their postlarval growth, rarely more. The direction of growth of corallites is, at that stage of growth, perpendicular to the substrate (pl. 15: 6). This type of vertical attachment by means of the basal plates has already been reported (Fedorowski 1973, Ilina 1980, 1984) but it has not been discussed in detail. In both cases mentioned, the phenomenon in question was established in corals showing the pleurophylloid septal plan, i.e. similar to that observed in *Plerodiffiidae fam.n.*

The complete specimens of *Diffingiina subordo n.* present in fairly large numbers in the collection studied allow one to note that dimensions of basal plates are differentiated. This phenomenon may be either primary, i.e. the plates did not increase their diameters after being

originally secreted, or secondary, i.e. they extended peripherally. In both cases, the taxonomic indications may or may not be expected.

Assuming that the larvae belonging to a given species are similar in size, one may consider dimensions of the basal plates as either ecologically or genetically controlled. No data supporting the second case were established. It has been stated, however, that long, narrow corallites, having weak attachment processes were attached to the substrate by narrow basal plates while the corallites attached by wide basal plates are at the same time massive specimens, armed with strong attachment processes (pls. 13: 9b; 14: 3b, 5b, d; 15: 7). The corals intermediate in this respect have also been observed (pls. 13: 12; 14: 6; 15: 4). The ecological variant has thus been accepted and only a presence of the basal plate is considered taxonomically important.

The possibility of the secondary differentiation in dimensions of the basal plates does not contradict the above solution as to the phenotypic character of their size. It may have, however, some important taxonomic implications. Accepting this variant, i.e. assuming that the basal plates might have increased their width eccentrically, one has to accept that the external wall was not secreted at the very beginning of the skeletogenesis, and that a young polyp was devoid of its external skeletal protection during the longer or shorter period of its early postlarval growth (fig. 4A). This may lead to the conclusion that the very early skeletogenesis was in the suborder discussed similar to that described by Jell (1980) in Scleractinia.

The eccentric growth lines of the basal plates have not been established in *Diffingiina* subordo n. However, the attachment surface of some basal plates is broader than the slightly higher part of the coral skeleton (pl. 15: 6). That broadening can be explain in two ways: 1) as resulting from a simple flattening of the sole of larva settled in the turbidite water and being forced to strength its cementation to the substrate, 2) as resulting from the eccentric growth of the basal plate prior to the secretion of the external wall (fig. 4: Aa-a'-c-c'). Both those cases might have been ecologically controlled, but only during the second one was the scleractiniid growth possible. This important problem must be left unsolved for the time being.

The thin sections of the completely silicified basal plates also did not provide any clear data concerning their histology. Some structures present in the thickness of the basal plates were here identified as possible pseudomorphoses of septa, however. A very early insertion of at least the axial septum, which reaches the lower portion of the basal plate, has also been observed (pl. 15: 5a, b).

The state of preservation of the ontogenetically youngest corallites present in the collection was inadequate for establishing the relation of their septa to the upper portion of the external wall during the early

skeletogenesis. The morphology of the calice margin (see below) helps in solving that problem.

On the basis of the above discussion, the following reconstruction of the very early skeletogenesis in *Diffingiina subordo n.* is proposed: the planula invariably settled on a hard substrate which offered a fairly flat surface for the planula's sole. Secretion of the basal plate started immediately after the settlement as a strengthening of the attachment of the

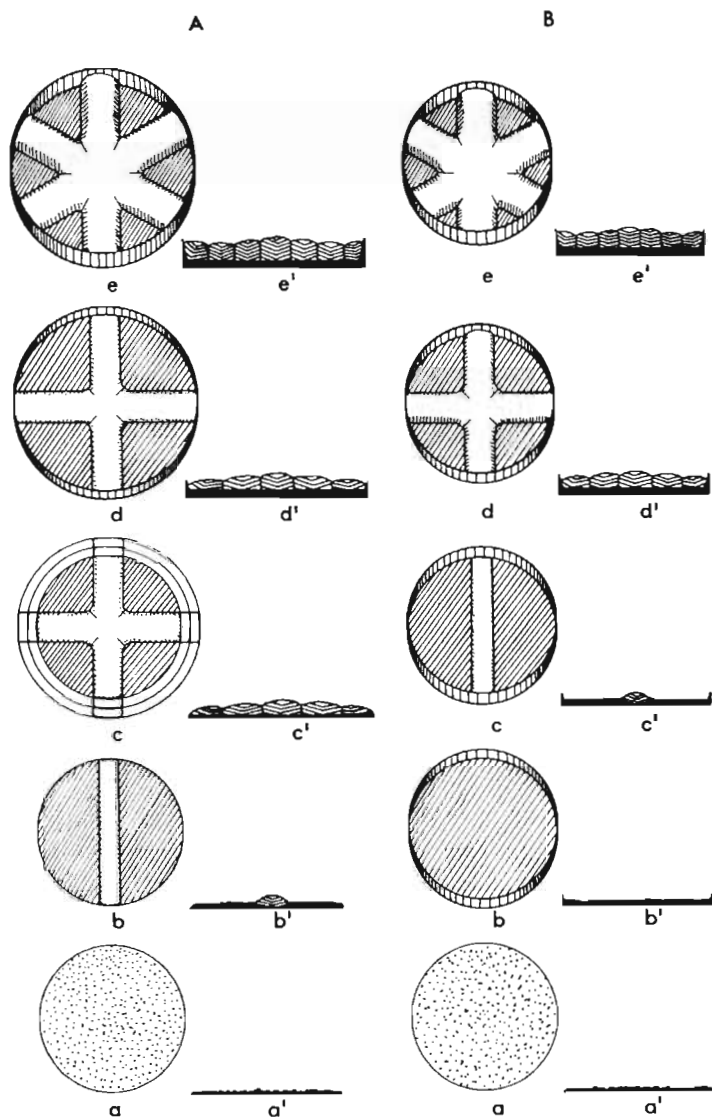


Fig. 4. The hypothetical reconstruction of the early skeletogenesis in *Diffingiina subordo n.* Variant A—the insertion of first protosepta and the eccentric growth of the basal plate (a, a'—c, c') precede the appearance of the external wall (d, d'). Variant B—the external wall (b, b') precedes the appearance of first protosepta. a—e—the top view, a'—e'—longitudinal sections.

planula during its stage of metamorphosis. At the same time that plate forms the basis of the skeleton of the polyp (fig. 4: A, B a, a'). The further skeletogenesis might have taken place in two ways: 1) in almost immediate surrounding of the basal plate by the foundation of the external wall, which made any further widening of the former impossible (fig. 4: B b-e), 2) in the eccentric growth of the basal plate, without any external wall being inserted at the beginning (fig. 4: A b, c). In the first variant the formation of a very shallow and comparatively wide aseptal skeleton may be expected (fig. 4: B b, b') while in the second one the almost contemporaneous insertion of the basal plate and at least the axial septum took place (fig. 4: A b, b'). The axial septum and, possibly, the first pair of the lateral protosepta, might have been founded at that very beginning stage in both variants, but only in the second one could the peripheral increase in length of the already inserted septa have possibly been parallel to the broadening of the basal plate (fig. 4: A c, c').

Both of those two theoretical variants are in a similar position: neither has been proved or disproved. There is the comparatively narrow, juvenile corallite in the collection, having the external wall developed at the stage of four septa (pl. 13: 10a) as well as broader corallites having comparatively numerous septa, the insertion of which directly on the basal plate may at least be suspected (pl. 13: 10b), but there is no way at the moment to prove whether the larger number of septa is accompanied by the eccentric growth of the basal plate. In such a situation I can only conclude that the ability to insert more or less numerous septa on the basal plate may depend on the width of the latter. The arrangement and possibly also the sequence in increase of first septa is typical of the Rugosa, leaving no doubts as to the close relationship of *Diffingiina* subordo n. to the rest of the Rugosa.

The external wall, independently of the time of its appearance in the skeletogenesis, must have been produced by a polyp. The shape and morphology of planulae (if we accept their similarity to those in *Scleractinia*) exclude the possibility that they produced the external wall of the histology as reconstructed. Thus, in contrast with the appearance of the basal plate and the first septa, which was possible prior, during or after the metamorphosis of planulae, the external wall appeared as the first skeletal element produced undoubtedly by a polyp. Together with its appearance the first step of the skeletogenesis in *Diffingiina* subordo n. must be considered as completed.

THE CALICE MARGIN

The calice margin is one of the most important structural elements allowing the proper reconstruction of the early ontogeny of specimens

and the insertion and growth of septa. Two kinds of the marginal zones of interiors of the calices can be distinguished: 1. completely smooth (pl. 13: 3), 2. with massive foundations of septa (pls. 14: 1; 15: 1b). The intermediate corals (pls. 13: 6; 14: 2, 7, 9a) and the fact that none of those two kinds is exclusively characteristic of a given taxon of a high rank restrict their taxonomic value to no more than specific in some instances and none in the others. There is often a strong difference in width of the marginal zone. In some taxa or even individual specimens, the septal blades started to develop very close to the upper calice limits. Even slight damage may in this case produce a false impression of septa as being developed directly in that area (pls. 13: 8a; 15: 1a, b). This is especially clearly seen in the case of development of the "tertiary septa" (pl. 13: 11) (? meiosepta of Weyer 1984). In other taxa or specimens the smooth marginal zone of calices may be wide and the septal blades may there start to develop "suddenly" without having any obvious foundations developed first (pl. 13: 3). The calices showing low and wide undulations of the marginal zone of calices (pls. 13: 6; 14: 9a) were mentioned above as the corallites intermediate between the two main kinds. They also have the septal blades developed quite "suddenly" from those low elevations, which are the foundations of septa either common for both major and minor septa (pl. 14: 2, 7, 9a) or developed separately (pl. 14: 1). The coarse external granulation of some foundations (pl. 14: 1) may be interpreted as the reflection of their diffusotrabecular microstructure. It seems also possible, however, that those granulae were diagenetic alterations caused by the silica precipitation.

In the calice margins with massive foundations of septa, the granulation mentioned is common (pl. 15: 1a, b). Those foundations are commonly divided into those of the major and minor septa (pl. 14: 4) although the uppermost portions of some pairs of them may be common for both cycles of septa. Only foundations of the cardinal, counter and counter-lateral minor septa are invariably clearly separated. Foundations of the minor septa are also often present in the case of the absence of their blades (pl. 15: 1b).

The uppermost part of the calice margin commonly differs from its slightly deeper portion, being clearly thinner and invariably smooth (pl. 14: 2, 5a, c, 7). This distinction is especially well accentuated in the specimens having massive foundations of septa (pl. 14: 5a). Vertical arrangement of the calcium carbonate fibres (fig. 5a) is suspected in that part of the calice, corresponding with the outline portion of the external wall. The supposition has not been confirmed in the thin sections, however. The deep, silica caused alterations prevent any detailed study of the histology of that area. The very strong growth striae, looking sometimes as though they have their peripheral crystals free and up-growing, may support the above supposition. Unfortunately, the crystals

mentioned are all secondary quartz crystals and again, one may only suspect that their arrangement follows that of the original calcite crystals. Vertical undulation of the growth striae (pl. 15: 1c, d) and lack of septal furrows speak in favour of the above reconstruction of histology of the external wall outline.

The polyp-skeleton relationship and the skeletogenesis of the calice margin is thus reconstructed as follows: the upper, peripheral part of the polyp body, i.e. that beneath the ring of tentacles, rested on the top of the external wall (fig. 5a) in a way similar to that reconstructed for *Flabellum* by Wells (1956), but not inside the calice, as it is commonly attributed to the most of the Rugosa (fig. 5b). That polyp body which was not infolded was responsible for the vertical growth of the calcium carbonate fibres, produced in the day-night cycles, for the smooth inner surface of the uppermost part of the calice margin, and for the absence of septal furrows outside. The formation of growth striae may well be compared with Wells' (1963) and Scruton's (1965) reconstruction of this phenomenon. This part of the skeletogenesis was common for all Diffingiina subordo n.

The secretion of the deeper part of the marginal zone of calices was slightly differentiated. In corallites which had that zone smooth, the not folded ectoderm produced the inwards growing calcite fibres probably arranged in straight layers corresponding to the growth striae. Those layers and fibres were diagenetically destroyed in most of the corallites observed. In the especially well-preserved calices the attachment scars (pls. 13: 6; 14: 9a, b) may be seen in that area (see below).

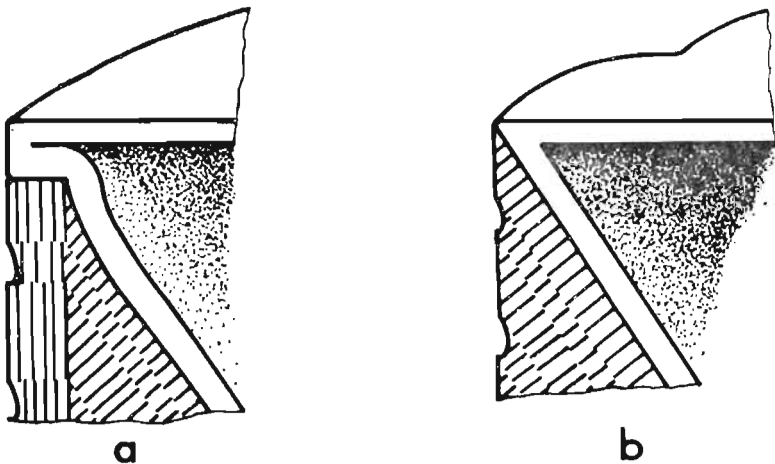


Fig. 5. The hypothetical reconstruction of the relation of the peripheral part of the polyp body to the upper limit of the external wall and direction of growth of fibres and their length in layers corresponding to the growth striae of the day-night cycles; a—Diffingiina subordo n.; b—other Rugosa except for those having the *Pterorrhiza*-like calices.

In the second kind of the calice margin, i.e. that with the massive foundations of septa, the latter were inserted in more or less deep infolds of the ectoderm developed slightly below the smooth upper calice limit. The individual layers of growth were undulated here due to the infolds of ectoderm mentioned. As in the first case they were diagenetically altered (pl. 17: 2, 3a-c).

The thickness of the external wall produced by either smooth or slightly infolded ectoderm depends mainly on the time of the strong narrowing of septal pockets, allowing production of the trabecular septal blades. Some additional increase in thickness of the external wall was then possible only between septa (pls. 16: 1a, b, 3; 17: 1b).

It is supposed here that the upwards growth of the upper calice limit caused an upward motion of the marginal parts of the polyp body. This, in turn, has involved an upwards extension of septal pockets and, in consequence, the upward and inward growth of the sclerosepta. The distance between the uppermost beginnings of septal pockets and the peripheral part of the polyp resting on the top of the external wall, forms in fact the only difference between the two kinds of the marginal zone of calices (smooth versus folded) mentioned at the beginning of this chapter.

THE EXTERNAL WALL AND ITS RELATION TO SEPTA

The diagenetic alterations prevent detailed investigation of the microstructure of the external wall and of bases of septa. thus an attempt has been made only in reconstructing the relation of those two structural elements and the origin of the latter. In almost all thin sections of the adequately preserved specimens, the widely broadened bases of septa contrast well with the surrounding calcitic mass of the external wall (pls. 16: 1a, 3; 17: 2, 3a-c; 19: 1a). This contrast is commonly emphasized by a darker colour of the boundaries of those bases (pls. 16: 1a; 17: 1a; 19: 3a-b).

The outline of the external wall is invariably precipitated with silica and is lacking in any structure available for the study by means of thin sections. In the rest of the thickness of the external wall only shadows of the original microstructure may be sometimes detected. First of all there are almost no calcitic fibres or growth lines seen although, judging from the morphology of the calice margin and the presence of distinct growth striae, the original development of those elements must have taken place. The remains of the growth lines are present in some comparatively well-preserved fragments of walls (pls. 16: 1b; 17: 1a, b). It may happen (pls. 16: 1b, left; 17: 1a, b, major septum) that the folds seen in there are located not against septal bases, but between them. Such an arrangement is in total disagreement with the observations in

calices and cannot be explained at present. Other remains of the growth lines are either not folded or their foldings are better correlated with septal bases (pls. 16: 1b, right; 17: 1b, minor septa).

The typical microstructure of the peripheral portions of septa (pl. 17: 2, 3a-c) can be characterised as a kind of peripherally elongated fan of fibres, surrounding the dark middle line of a septum. This fan appears to be much less altered diagenetically than the external wall itself. This impression is apparent, however. The very large size of individual fibres, having their diameter in the peripheral parts of the fans almost as large as the middle line of the septum (pl. 17: 2, 3a-c), as well as the disappearance of those fibres inwards, towards the middle line, indicate their diagenetic nature. It seems possible to accept that their diagenetic alterations lead towards a formation of aggregates of primary fibres at the periphery of fans, and to an almost total destruction of fibres inside bases of septa, looking as though they were structureless, except for the middle line. The jagged boundary of septal bases, observed in the greater majority of the adequately preserved corallites are similar to the stylo-lites and might have a similar origin. The originally different arrangement of the calcite fibres in the foundations of septa and the surrounding external wall caused by the curvature of the former is best exposed to the diagenetic alterations of the stylo-litic kind. The darker colour of those boundaries (pls. 16: 1a, 3; 17: 1a, 2, 3a-c) might have resulted from the concentration of carbon, iron, magnesium or other substances, not established at present. It is proposed here to call such a boundary of septal bases stylo-litic. It appeared in the process of diagenesis due to the wedging of aggregates of fibres of the septal bases between the fibres of the external wall and vice versa.

The relation of the aggregates of fibres to the middle lines of bases of septa is not clear, because the former lost their structure inside the inner portion of those bases. The invariable distinction of the middle line may indicate two distinct phases of growth of those parts of septa, corresponding to the primary and secondary secretion of septa in the meaning of Schouppé and Stacul (1955). In most cases observed, the middle line of a septum extends to the peripheral boundary of the fan of fibres (pls. 16: 1a, 3; 19: 1a) only in rare instances being shorter (pl. 17: 2, 3a-c). The microstructure in these parts of septa is uncertain. It might have been formed either from small flattened trabeculae, or from pairs of fibres which started to grow so closely to each other as to give the impression of a solid middle line. Such a variant may well be considered a modification of the fibro-normal microstructure of Kato (1963). None of those variants was confirmed by reliable observations in the thin sections and none can be fully supported by the data collected from the calice margins. It may only be said that the microstructure of the inner parts of septa is trabecular (pl. 19: 1b).

Considering the above remarks concerning the diagenetic alterations of the external wall and septa, the skeletogenesis of septa in the majority, if not in all, of *Diffingiina subordo n.* may possibly be reconstructed as passing the following steps: 1. The secretion of the not folded growth lines of the peripheral part of the external wall. This part corresponds with the smooth upper limit and the marginal zone of calices (pls. 13: 3; 14: 2, 5a, c, 7). 2. The inwards protuberances of growth lines, corresponding with the beginning of the formation of septal pockets of the ectoderm. Fibres of calcium carbonate, always growing perpendicularly to the ectoderm surface form the beginning of the future fan of fibres. This part corresponds with the topmost portions of foundations of septa (pl. 14: 1, 2, 5a, 7). 3. Growth of the fibres and expansion of the septal pockets leading upwards to the formation of complete bases of septa. This part corresponds to the calice margins with complete development of foundations of septa (pls. 14: 1, 2, 4, 7, 8; 15: 1a, b). 4. The rapid narrowing of a septal pocket inwards towards the corallite lumen, allowing the formation of the septal blade and the reorientation of the calcium carbonate fibres from the fibro-normal like (?) microstructure of the middle line of the peripheral part of the septum into the first trabecula. This part corresponds with the transformation of the foundation of the septum into the septal blade as seen in the intermediate zone of the calice (pls. 13: 5, 6; 14: 1, 2, 4, 5a, 7, 8; 15: 1a, b). 5. The further modifications of septa, which are described in one of the following sections.

In the single specimen (pl. 18: 1a-c) the septa seem to start as trabecular, although their bases are wide. This is again only a supposition, because the peripheral parts of the external wall are diagenetically altered and a possible peripheral fan of fibres might have been destroyed.

The skeletogenesis of the peripheral parts of septa and the relation of the latter to the external wall, discussed in detail above, can easily be compared to that reconstructed by Schouppé and Stacul (1955, fig. 5a). There is only one important difference, however. In the corals discussed by Schouppé and Stacul (1955) the upper calice limits are wavy and form septal furrows not shown by those authors in their reconstruction of the external wall, while in the suborder here under discussion the external wall bears only growth striae and the foundations of septa were formed exclusively inside calices without any disturbances of the external surface of the upper calice limit. This may mean there is a substantial difference in the origin of septa between *Diffingiina subordo n.* and all other *Rugosa*, if the rule introduced by Weyer (1974) is accepted as general. According to the latter author, the insertion of septa in *Rugosa* took place at the upper calice limit due to the divergence of septal furrows. Although the generalization of that modus cannot possibly be accepted, there is a close relation between septa and their furrows

in the most of the rugose corals investigated so far in more detail and none in *Diffingiina* subordo n. in which the septal furrows are absent. There are no adequately confirmed data as far as the *Rugosa* with almost smooth external wall are concerned (eg. *Neaxon* Kullmann, 1965), but they may well be more similar to the typical *Rugosa* rather than to the suborder discussed.

THE EARLY ONTOGENY

The skeletogenesis of the earliest stage of the coral growth reconstructed above is here accepted as being identical or very similar in all species of *Diffingiina* subordo n. described so far. After the insertion of the first four or six septa and the external wall in the way reconstructed earlier, the juvenile specimen of the suborder discussed differs from the other juvenile rugosans only in the relation of the peripheral part of the polyp body to the outline of the external wall and in the way septal pockets and sclerosepta were created, if Weyer's (1974) concept of the insertion of septa in the *Rugosa* is accepted.

The insertion of the first six septa was reconstructed above as having taken place on the basal plate. There is a possibility, however, that the insertion of further septa might have taken place near the calice margin. A single specimen was found in the collection (pl. 14: 4) which has a „spare” foundation of septum present at the calice margin. Such a single finding does not form an adequate basis for any generalisation, however, and further investigations are required in order to solve that problem.

The sequence of the insertion of the protosepta is as follows: the axial septum (not divided into the cardinal and the counter septum at the beginning), the counter-lateral septa, the alar septa. The above sequence in the insertion of the first major septa is identical with that generally accepted for the *Rugosa*, if the minor septa are not counted. Also, the first metasepta were in *Diffingiina* subordo n. inserted in accordance with the general morphology of the *Rugosa*, i.e. at the cardinal septum side of the counter-lateral and alar protosepta. The minor septa were not inserted on such an early stage of growth in *Diffingiina* subordo n. (pls. 13: 10a; 15: 3, 5a, b) although exceptions are possible (fig. 2: 2a). The zaphrentoid arrangement of septa of that early stage of growth soon became modified as follows: the counter septum was separated from the axial septum in such a way that its remaining part is distinctly shortened; the cardinal septum remains as long as it was in the axial septum, which makes it one of the most prominent septa; the inner ends of other major septa bend towards the inner end of the cardinal septum and/or tend to a junction with each other across the corallite lumen and above the cardinal septum. The above modifications

are to be found in all representatives of *Diffingiina* subordo n. described so far, even in the genera or species having the counter septum in the mature stage distinctly elongated (pl. 15: 1a). Insertion of the minor septa is very irregular and individualized, requiring further investigations. It may already be said, however, that they may appear fairly late in the ontogeny (pl. 15: 3) and not in a sequence attributed by Weyer (1974) for the *Rugosa*.

MORPHOGENESIS OF SPLIT SEPTA

A simple explanation of the phenomenon in question, i.e. the digitation of the innermost parts of septal pockets is confirmed by the microstructure in the transverse sections of septa (pls. 16: 1a, 2, 3; 18: 2-5; 19: 2), by observations on the morphology of split septa in calices (pls. 13: 4, 5, 7; 14: 5a, 8; 15: 1a, 2), and in the broken specimen (pl. 15: 8a, b). Three general kinds of split can be distinguished: 1. A very shallow to comparatively deep but simple split. Its depths depended on the moment of digitation of a septal pocket. The latter might have digitate only at its inner end to form two short, independent forks, or a point of its digitation is located farther and farther back, i.e. closer to the external wall. The independent growth of the forks produced in those two digitations is long and depends on the formation of the latter. 2. A complete split of septum, which may be considered as an absolute maximum of the former one. Two forks of septum are here located directly on the external wall as seemingly independent two septa (pl. 13: 7). The middle trabecular lines of such septal forks are identical with those in regular septa and their correct interpretation is possible only due to the increase of other major septa. 3. Secondary modifications of the splits of septa by means of the formation of septal pinnacles (pl. 14: 3a, 4, 5a, 8), completely locked rings of two forks (fig. 2: 3d, 4c), secondary split of individual forks (pls. 16: 1a; 18: 4), strong thickening at the point of split (pl. 19: 5), or the formation of thickening instead of split (pl. 19: 3b, 5; 20: 2d, some septa), etc. All those modifications were caused only by the secondary digitations of the given parts of septal pockets, or by more intensive or longer secretion of calcium carbonate in some places, or by a digitation of a septal pocket taking place not on the inner, but on the upper ridge of a septum (locked rings). The latter digitation can be called rather a break of growth of some parts of a septum (fig. 6a, b).

All kinds of split of septa listed above are present in the family *Diffingiidae* fam. n., while in *Plerodiffiidae* fam. n. only the first kind is to be found. In the latter family a simple and shallow split into the T-shaped septum is most common in the ephebic stage (pls. 18: 5; 19: 2), while the more typically diffingioid split is present there in septa of some neanic specimens (pl. 18: 3, 4).

The physiological reason of split of the cardinal septum may in some cases be explained as a possible increase of the water flow inside the gastral cavity of a polyp. The split cardinal septum, the other major septa bent right and left from the former in the cardinal quadrants, but having their inner ends in the counter quadrants directed back to the cardinal septum, might have directed the inflow of water right and left around the gastral cavity of the polyp and then back upwards to the mouth along the inner ends of septa in the counter quadrants. However, this by no means concerns all the species described, but only

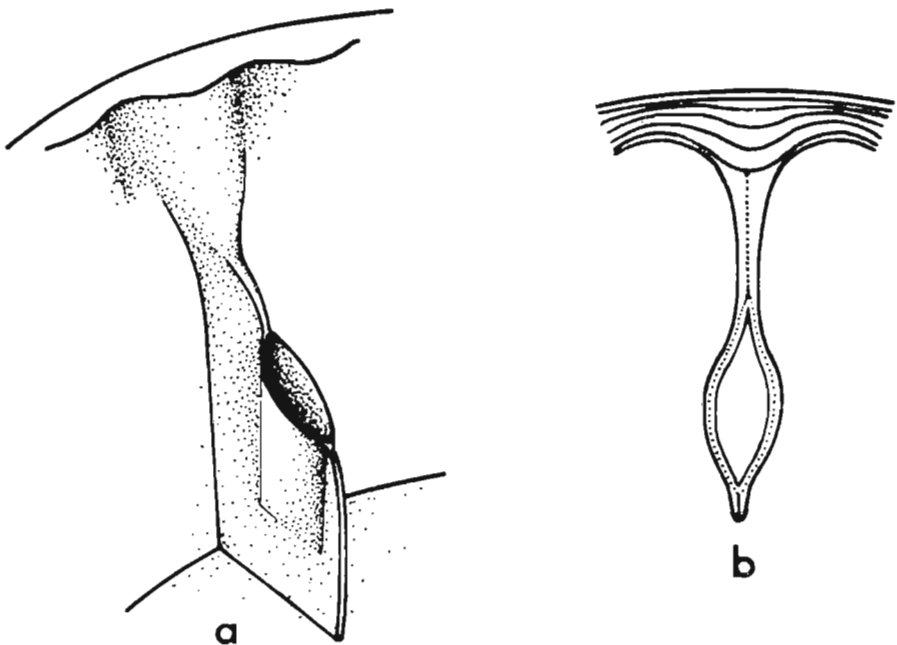


Fig. 6. Reconstruction of the septum split so as to form the ring of two united forks; a—the calice; b—the transverse section made through the split part of septum.

those morphologically most similar to *Diffingia collecticia* sp.n. (pl. 13: 4, 5, 7, 11). A trivial explanation of the increase in number of the mesenteria or a need of strenghtening of the skeleton in the case of split and thickening of septa around the free axial area (*D. divida* sp.n. and *D. tortuosa* sp.n.) may be the next attempts at an explanation. I cannot be sure that those were the only or the most important factors. The situation might have well been inverted and the morphology observed might easily have resulted from the genetic modifications, and not have been influenced by the extrinsic factors in such a direct and naturalistic manner.

THE ATTACHMENT SCARS

On the surface of smooth marginal zone of some well preserved calices shallow grooves have been observed. They extend from the upper part of this zone down to the inner zone of the calice, disappearing between septa (pls. 13: 6; 14: 9a, b). The number of those grooves seems to be equal to the number of major septa. Unfortunately, I have no calice complete enough to ascertain this. They are located at approximately the same distance between the adjacent major septa. The minor septa are here subordinated, located close to the neighbouring major septa and do not occur in a full number. The grooves discussed in their best preserved parts, i.e. already between the uppermost portions of the major septa, have distinctly deeper pits, located at a distance of approximately 0.2 mm apart, when measured at their middle points. The position of the grooves as well as their morphology permits a close comparison with the attachments scars described by Wise (1970), Sorauf and Podoff (1977) and Roniewicz and Morycowa (in press). The occurrence of the attachment scars in the Rugosa was here recognized for the first time, but very clear and well-preserved scars have already been illustrated by Ilina (1980, pl. 18: 1e) in the Devonian *Oligophyllum* Počta, 1902. They were interpreted by that author as "imprints of denticular ends of trabeculae of distal edges of septa on the inner surface of the calice wall" (translated here from the Russian explanation by Ilina (1980, pl. 18: 1e).

Judging from the position of scars and the relation of the major and minor septa, the scars here under discussion correspond to those parts of the polyp body, which were most closely connected with the external wall, but less folded and less strongly tied to the skeleton at the same time. It seems understandable that that particular area required a straightening of the polyp-skeleton connection.

CONCLUSIONS

The group of corals discussed is characterised by a set of morphological characters completely different from all other Rugosa, although individual characteristics of that set may be found in individual groups of the order Stauriida Verrill, 1865, except for the split of septa and possibly also the morphogenesis of the outline of the external wall and, in consequence, the morphology of the latter.

The morphology of the early ontogeny described, and especially a sequence in increase of the major septa suggest an offshoot of *Diffringiina* subordo n. from a rather primitive group of the Rugosa by means of a fast reorganization of the internal structure and mode of attachment of a planula and increase of first skeletal elements at a very

early stage of the ontogeny. The ancestral taxon of the suborder discussed should thus have the trabecular microstructure of septa, the fairly weak septal furrows, if any at all, the biform tabularium or at least a tendency to form it, and a fairly wide larval attachment, which might have been transformed into the flat basal plate. I cannot indicate any taxon of such morphological parameters not only among the SW Texas taxa, but also among the other Upper Carboniferous Rugosa described so far.

In spite of the substantial differences between the group of corals discussed and the rest of the Rugosa I do not propose an independent order for them. This is partly because of some uncertainties in the reconstruction of their early skeletogenesis and partly because of the uncertain status of individual suborders included by Hill (1981) in order Stauriidae Verrill, 1865. The suborder rank seems, therefore, to be the most proper to propose in such a situation.

REFERENCES

- CARRUTHERS, R. G. 1906. The primary septal plan of the Rugosa. — *Ann. Mag. Nat. Hist.*, 7, 18, 356—363.
- COOPER, G. A. and GRANT, R. E. 1972—1977. Permian brachiopods of West Texas. — *Smith. Contr. Paleobiology*, 14, 1—231; 32, 3161—3370.
- EASTON, W. H. 1945. Kinkaid corals from Illinois. — *J. Paleont.*, 19, 4, 383—389.
- 1945a. Amplexoid corals from the Chester of Illinois and Arkansas. — *Ibidem*, 19, 6, 625—632.
- FAUROT, L. 1909. Affinités des tétracoralliaires et des hexacoralliaires. — *Ann. Paléontol.*, 4, 69—108.
- FEDOROWSKI, J. 1965. Lindstroemiidae and Amplexocariniidae (Tetracoralla) from the Middle Devonian of Skaly, Holy Cross Mountains, Poland. — *Acta Palaeont. Polonica*, 10, 3, 335—363.
- 1973. Rugose corals Polycoelaceae and Tachylasmatina subord.n. from Dalia in the Holy Cross Mts. — *Acta Geol. Polonica*, 23, 1, 89—133.
- in press. Upper Palaeozoic rugose corals from southwestern Texas and adjacent areas. — *Palaeont. Polonica*, 48.
- HILL, D. 1981. Rugosa and Tabulata, v. 1, 2. In *Treatise on Invertebrate Paleontology, Part F Coelenterata, Supplement 1* Geological Society of America and University of Kansas, Press, Lawrence.
- (ILINA, T. G.) ИЛЬИНА, Т. Г. 1980. Морфогенез септального аппарата полице-лиид. — In: Б. С. Соколов (ред.), *Кораллы и рифы фанерозоя СССР*. — „Наука”, Москва, 148—156.
- 1984. Историческое развитие кораллов. Подотряд Polycoeliina. — *Тр. Палеонт. Инст.*, 198, 1—184.
- JELL, J. S. 1980. Skeletogenesis of newly settled planulae of the hermatypic coral *Porites lutea*. — *Acta Palaeont. Polonica*, 25, 3—4, 311—320.
- KATO, M. 1963. Fine skeletal structures in Rugosa. — *J. Fac. Sci. Hokkaido Univ.*, 4, 11, 571—630.

- NEUMAN, B. 1969. Upper Ordovician streptelasmatic corals from Scandinavia. — *Bull. Geol. Inst. Uppsala Univ.*, n.s., 1, 1—73.
- RONIEWICZ, E. and MORYCOWA, E. Development and variability of *Flabellum rariseptatum* (Tertiary, Antarctica) — In: A. Gaździcki (ed.), *Palaeont. Results Polish Antarctic Expeds. I.* — *Palaeont. Polonica*, 49 (in press).
- RÓŻKOWSKA, M. 1956. Pachyphyllinae from the Middle Devonian of the Holy Cross Mts. — *Acta Palaeont. Polonica*, 1, 4, 271—330.
- SANDO, W. J. 1961. Morphology and ontogeny of *Ankhelasma*, a new Mississippian coral genus. — *J. Paleont.*, 35, 1, 65—81.
- SCHINDEWOLF, O. H. 1942. Zur Kenntnis der Polycoelien und Plerophyllen. — *Abh. Reichsamt Bodenforsch.*, n.s., 204, 1—324.
- SCHOUPPÉ, A. and STACUL, P. 1955. Die Genera *Verbeekiella* Penecke, *Timorphyllum* Gerth, *Wannerophyllum* n.gen., *Lophophyllidium* Grabau aus dem Perm von Timor. — *Palaeontographica*, Suppl. — Bd. 4, 5, 3, 95—196.
- SCRUTTON, C. T. 1965. Periodicity in Devonian coral growth. — *Palaeontology*, 7, 4, 552—558.
- SORAUF, J. E. and PODOFF, N. 1977. Skeletal structure in deep water ahermatypic corals. — *Mém. Bur. Rech. Géol. Miniér.*, 89, 2—11.
- WELLS, J. W. 1956. Scleractinia. — In: R. C. Moore (ed.), *Treatise on Invertebrate Paleontology*, Part F, Coelenterata. F328—F444. Geological Society of America and University of Kansas Press, New York, Lawrence.
- 1963. Coral growth and geochronometry. — *Nature*, 197, 4871, 948—950.
- WEYER, D. 1974. Das Rugosa-Genus *Antiphyllum* Schindewolf, 1952 (Unternamur, Oberschlesisches Steinkohlenbecken). — *Čas. mineral. geol.*, 19, 4, 345—365.
- WISE, S. 1970. Scleractinian coral exoskeletons: surface microarchitecture and attachment scar patterns. — *Science*, 169, 978—980.
- [YAKOVLEV, N. N.] ЯКОВЛЕВ, Н. Н. 1910. О происхождении характерных особенностей Rugosa. — *Тр. Геол. Ком.*, н.с., 66, 1— .
- 1914. Этюды о кораллах Rugosa. — *Ibidem*, 96, 1—24.
- 1964. Организм и среда. — Наука, Москва, 1—147.

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DIFFINGIINA, NOWY PODRZĄD KORALI RUGOSA
Z POŁUDNIOWO-ZACHODNIEGO TEKSASU

Streszczenie

Diffingiina subordo n. są grupą koralii Rugosa tymczasowo włączoną do rzędu Stauriida Verrill, 1865. Cechują się rozwidleniem przynajmniej jednego (głównego) septum w kierunku osi koralu, rozwojem płytki bazalnej, od której koralit wzrastał pionowo, brakiem bruzd septalnych na powierzchni ściany zewnętrznej, skróceniem

septum przeciwległego przynajmniej we wczesnej ontogenezie, dwukształtnym tabularium oraz trabekularną mikrostrukturą septów.

Na podstawie budowy płytki bazalnej, brzegu kielicha, ściany zewnętrznej i nasad septów oraz w oparciu o kilka juwenilnych osobników reprezentowanych w kolekcji zrekonstruowano wczesne etapy tworzenia szkieletu, zakładanie aparatu septalnego i morfogenezę rozszczepiania septów oraz wydedukowano przypuszczalny sposób wzrostu koralita i stosunek polipa do brzegu kielicha. Po raz pierwszy u *Rugosa* opisano odciski przyczepów ciała do ściany kielicha.

Wszystkie taksony w obrębie podrzędu są nowymi jednostkami taksonomicznymi, ponieważ korale *Rugosa* o cechach charakterystycznych dla *Diffingiina* subordo n. nie były dotychczas nigdy opisywane bądź ilustrowane. Wydzielono monotypową rodzinę *Plerodiffiidae* fam.n. z 1 nowym gatunkiem oraz rodzinę *Diffingiidae* fam.n. podzieloną na 2 podrodziny: tymczasowo monotypową podrodzinę *Diffingiinae* subfam.n. z rodzajem *Diffingia* gen.n. i 7 nowymi gatunkami, z których 1 pozostawiono w nomenklaturze otwartej oraz podrodzinę *Turgidiffiinae* subfam.n. z rodzajem *Turgidiffia* gen.n. w którym wyróżniono 3 nowe gatunki i jeden pozostawiony w nomenklaturze otwartej reprezentujący przypuszczalnie nowy rodzaj.

Ograniczenie stratygraficznego występowania podrzędu wyłącznie do permu, wąskie zasięgi stratygraficzne przynajmniej niektórych gatunków oraz stosunkowo duża frekwencja wskazują na możliwość użycia gatunków *Diffingiina* subordo n. do celów stratygraficznych.

EXPLANATIONS OF PLATES 13—20

The cardinal septum directed down, except when stated

Plate 13

Paraduplophyllum sp.n. 2

1. Specimen USNM 197250. Locality USNM 728f, Lower Bone Spring Formation. The youngest postlarval portion of the corallite attached to the brachiopod shell, $\times 15$.

Paraduplophyllum sp.n. 1

2. Specimen USNM 197208. Locality and horizon as above. The youngest postlarval portion of the corallite attached to the brachiopod shell $\times 15$.

Diffingia collecticia sp.n.

3. Specimen USNM 197409. Locality USNM 732e, Skinner Ranch Formation, Dugout Mountain member. The smooth inner surface of the calice margin, $\times 8$.
4. Specimen USNM 197408. Locality and horizon as above. The cardinal septum in the calice splits near the middle of its length, $\times 4$.
5. Specimen USNM 197389. Holotype. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds. The cardinal septum in the calice splits near the external wall. Foundations of septa well recognizable, $\times 4$.

Diffingia valida sp.n.

6. Specimen USNM 197425. Locality USNM 705, Lenox Hills Formation. The calice margin having weak foundations of septa. The attachment scars form well distinguishable grooves (arrow) $\times 8$.
7. Specimen USNM 197418. Locality and horizon as above. The complete separation of two forks of the cardinal septum in the youngest rejuvenated calice, $\times 4$.

Diffingia coita sp.n.

8. Specimen USNM 197431. Holotype. Locality USNM 707b, Skinner Ranch Formation, top of Sullivan Peak member; a—external view and the calice margin; the upper portions of septa apparently reaching the upper limits of the calice, $\times 2$; b—calice, $\times 4$.

Diffingia divisa sp.n.

9. Specimen USNM 197453. Holotype. Locality USNM 707b, Skinner Ranch Formation, top of Sullivan Peak member; a—external view of the massive corallite, having the large basal plate and strong attachment surface; b—the calice; remainings of the rejuvenation seen upper right and lower left, $\times 4$.

Diffingia tortuosa sp.n.

10. Juvenile corallites attached to the specimen USNM 196694. Locality USNM 707g, Skinner Ranch Formation, Decie Ranch member; a—specimen "a" preserved in the stage of four protosepta; b—specimen "b" having a pair of metasepta and the minor septa at the counter septum already developed. Both. $\times 15$.

Diffingia sp.n. 1

11. Specimen USNM 197475. Locality USNM 722i, Skinner Ranch Formation, Sullivan Peak member. The partly broken calice showing the "third order" septa (?meiosepta of Weyer, 1984) developed at its margin. The cardinal septum lower right. $\times 6$.

Diffingia largifica sp.n.

12. Specimen USNM 197468 Holotype. Locality USNM 711g, Hess Formation. External view $\times 2$.

Plate 14

Turgidiffia composita sp.n.

1. Specimen USNM 197487. Locality USNM 720f, Lower Skinner Ranch Formation. The calice margin; foundations of septa are either common for both cycles or show very slight differentiation, $\times 6$.
2. Specimen USNM 197482. Locality USNM 707b, Skinner Ranch Formation, top of Sullivan Peak member. The calice margin; foundations of septa are hardly distinguishable or are lacking uppermost, $\times 6$.
3. Specimen USNM 197497. Holotype. Locality and horizon as above; a—the calice showing the axial structure well developed and several strong septal pinnacles; b—external view of the massive corallite having strong attachment surface and the basal plate comparatively wide. Both, $\times 4$.

Turgidiffia completa sp.n.

4. Specimen USNM 197507. Locality USNM 722i, Skinner Ranch Formation, Sullivan Peak member. The calice with the "additional" foundation of septum at its margin. The cardinal septum lower right, $\times 4$.
5. Specimen USNM 197500. Holotype. Locality and horizon as above. a—the calice; the strongly split cardinal septum at right, $\times 4$; b—external view of the comparatively massive corallite having the basal plate wide, $\times 4$; c—the longitudinally broken external wall showing the underdevelopment of thickness uppermost, $\times 10$; d—the "up side down" photographed specimen showing the basal plate and two strong attachment processes, $\times 6$.
6. Specimen USNM 197497. Locality USNM 721, Lower Hueco Formation External view of the long and narrow corallite having the basal plate narrow, $\times 2$.
7. Specimen USNM 197503. Locality USNM 722i, Skinner Ranch Formation, Sullivan Peak member. The moderately developed foundations of septa do not reach the smooth upper portion of the calice margin, $\times 6$.

Turgidiffia columellata sp.n.

8. Specimen USNM 197512. Holotype. Locality and horizon as above. The calice, $\times 4$.

Diffingia collecticia sp.n.

9. Specimen USNM 197401. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds; a—the calice margin; The foundations of septa underdeveloped; the attachment scars form clearly distinguishable grooves (arrow) $\times 8$; b—the attachment scars enlarged to show their structure (arrow) $\times 20$.

Plate 15

Turgidifinae gen. et sp.n.

1. Specimen 197522. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a—the calice, $\times 4$; b—the calice margin; strong, separate foundations of the counter septum and the counter-lateral minor septa and double foundations of other septa, $\times 5$; c—the external view $\times 3$; d—surface of the corallite showing waviness of growth striae, $\times 8$.

Plerodiffia eaglebuttensis sp.n.

All specimens derived from the USNM locality 721,
Lower Hueco Formation

2. Specimen USNM 197546. The calice; the cardinal septum (upwards) splits adaxially, $\times 10$.
3. Specimen USNM 197551. The external wall removed to show the simultaneous insertion of the minor septa, $\times 6$.
4. Specimen USNM 197527. External view of the corallite having strong attachment processes at its lower portion and the basal plate wide, $\times 2$.
5. Specimen USNM 197544. The juvenile corallite attached to the mature one; a—side view showing relation of the axial septum (Ax) to the surface of the mature corallite; b—top view; domination of the cardinal septum part of the axial septum; the counter septum is already diminished. Both, $\times 15$.
6. Specimen USNM 197550. External view of the juvenile corallite attached to the mature one showing its slightly widened basal plate and its growth perpendicular to the substrate, $\times 15$.
7. Specimen USNM 197525. Holotype. External view of the massive corallite having strong attachment processes in its lower portion and the basal plate wide, $\times 2$.
8. Specimen USNM 197543. The cardinal septum upwards; a—the calice floor; the left alar septum (A) splits, $\times 10$; b—relation of the split and not split parts of two alar septa (A) to themselves and to the last tabula, $\times 15$.

Plate 16

Diffingia collecticia sp.n.

1. Specimen USNM 197392. Locality USNM 728e, Lower Bone Spring Formation. Transverse sections; a—relation of the major and minor septa to the widely split cardinal septum and to the external wall; b—remains of the growth lines of the inner part of the external wall and their relation to septa. Both, $\times 50$.
2. Specimen USNM 197388. Locality and horizon as above. Transverse section. Relation of the major and minor septa to the widely split cardinal septum, $\times 50$.
3. Specimen USNM 197389. Holotype. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds. Transverse section. Split of the cardinal septum and two adjacent major septa, $\times 50$.

Plate 17

Diffingia valida sp.n.

1. Specimen USNM 197413. Holotype. Locality USNM 701, Neal Ranch Formation. Transverse section; a—relation of the remains of the growth lines of the external wall to the counter septum (middle) and the counter-lateral minor septa, $\times 40$; b—just right of the previous one; remains of the growth lines of the external wall are convex towards the minor septa, but concave towards the major septum (middle), $\times 50$.
2. Specimen USNM 197417. Locality USNM 705, Lenox Hills Formation. Transverse section. The dark coloured stylolitic structure of the peripheral parts of septa, $\times 50$.

Diffingia tortuosa sp.n.

3. Specimen USNM 197436. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds. Transverse section; a—relation of bases of septa to the external wall and the dark coloured stylolitic structures, $\times 50$; b—left part of the figure "a" enlarged to show the beginning of formation of the minor septum (left), $\times 100$; c—right part of the figure "a" enlarged to show the minor septum having its own middle line well developed, but being outlined together with the adjacent major septum to form a common foundation, $\times 100$.

Plate 18

Diffingia largifica sp.n.

1. Specimen USNM 197468. Holotype. Locality USNM 711g, Hess Formation. Transverse section; a—relation of septa to the external wall, $\times 50$; b, c—two middle septa of the figure "a" enlarged to show their basal widening, diagenetic alterations, and the possibly trabecular microstructure, $\times 100$.

Turgidiffia composita sp.n.

2. Specimen USNM 197483. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds. Transverse section of the widely split counter-lateral septum $\times 200$.

Plerodiffia eaglebuttensis sp.n.

3. Specimen USNM 197536. Locality USNM 721, Lower Hueco Formation Transverse section of the distinctly split cardinal septum, $\times 80$.
4. Specimen USNM 197525. Holotype. Locality and horizon as above. Transverse section of the distinctly split counter-lateral septum, $\times 80$.
5. Specimen USNM 197532. Locality and horizon as above. Transverse section. The T-shaped cardinal septum, $\times 50$.

Plate 19

Plerodiffia eaglebuttensis sp.n.

1. Specimen USNM 197540. Locality USNM 721, Lower Hueco Formation Transverse section; a—relation of the peripheral parts of septa to the external wall, $\times 50$; b—the inner, thickened end of the left septum shown on the fig. "a" enlarged to demonstrate its trabecular microstructure, $\times 200$.
2. Specimen USNM 197533. Locality and horizon as above. The distinctly split cardinal septum having two forks equally developed, $\times 50$.

Diffingia collecticia sp.n.

3. Specimen USNM 197387. Holotype. Locality USNM 705a, Skinner Ranch Formation, base of Scacchinella beds; a, b—transverse section, ephebic stage, $\times 10$.

Diffingia valida sp.n.

4. Specimen USNM 197413. Holotype. Locality USNM 701, Neal Ranch Formation: Transverse sections; a—neanic stage, $\times 15$; b—ephebic stage, $\times 10$.

Diffingia divisa sp.n.

5. Specimen USNM 197453. Holotype. Locality USNM 707b, Skinner Ranch Formation, top of Sullivan Peak member. Transverse section, early ephebic stage, $\times 10$.

Plate 20

Diffingia tortuosa sp.n.

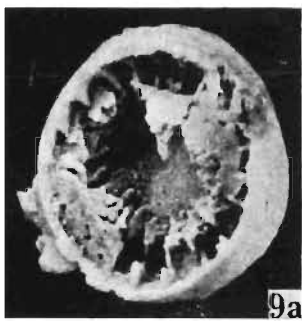
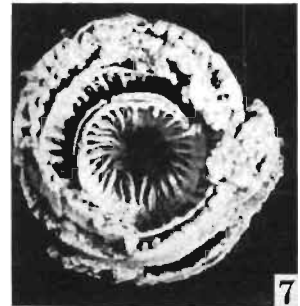
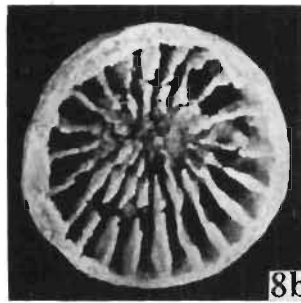
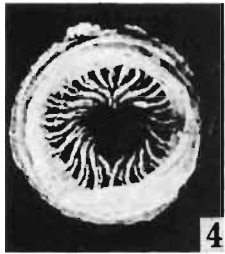
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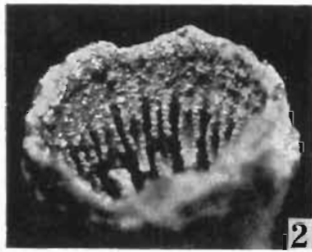
Diffingia largifica sp.n.

2. Specimen USNM 197469. Holotype. Locality USNM 711g, Hess Formation. Transverse sections; a—neanic stage, $\times 15$; b—d—early to late ephebic stage, $\times 10$.

Turgidiffia columellata sp.n.

3. Specimen USNM 197512. Holotype. Locality USNM 7221, Skinner Ranch Formation, Sullivan Peak member; a, b—transverse sections, ephebic stage, $\times 10$.







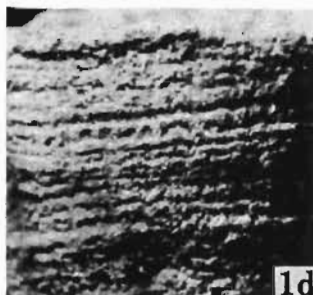
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1b



1c



1d



2



3



4



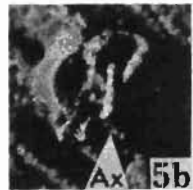
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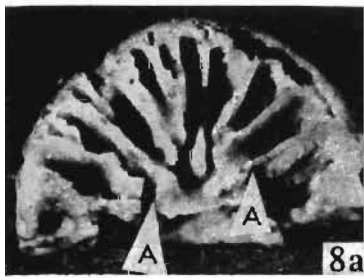
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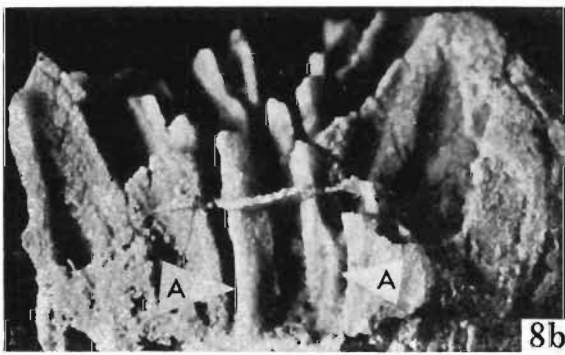
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5b



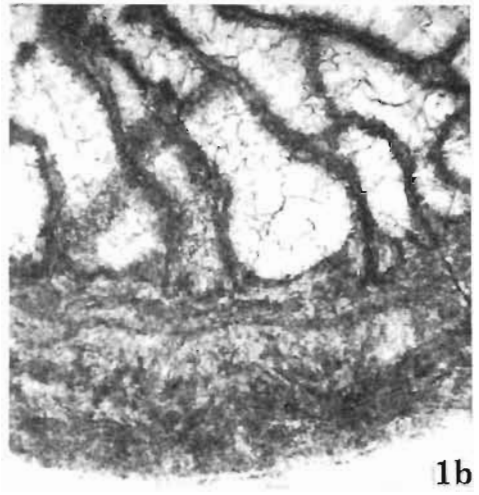
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8b



1a



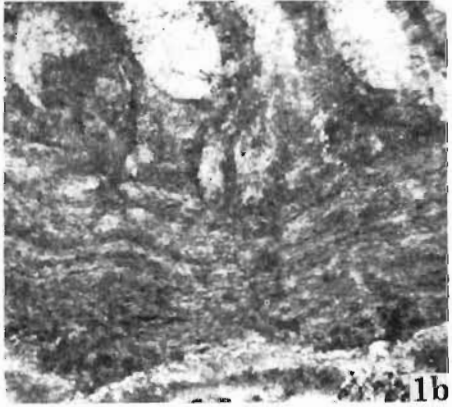
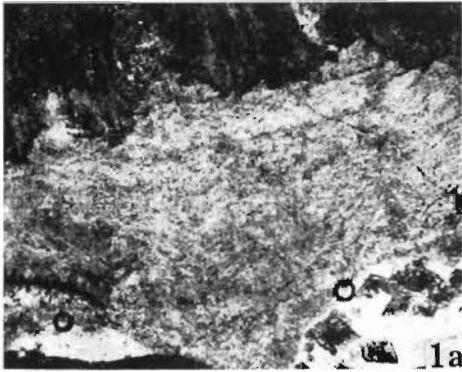
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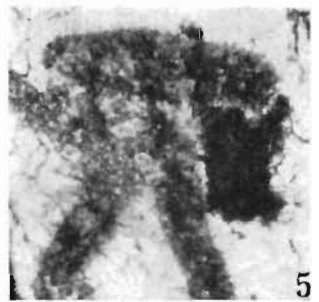
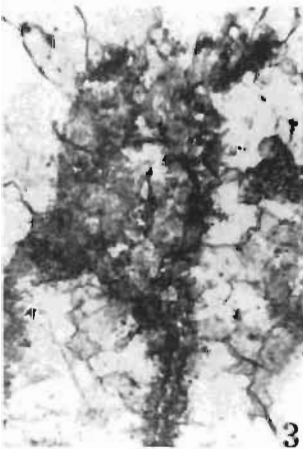
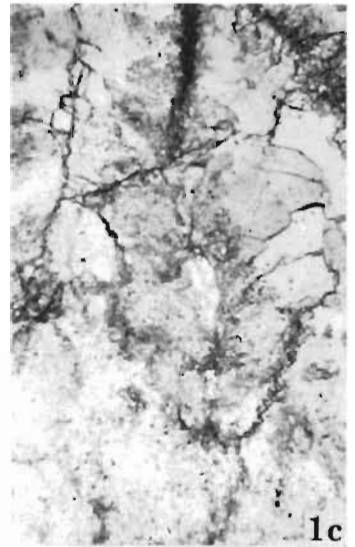
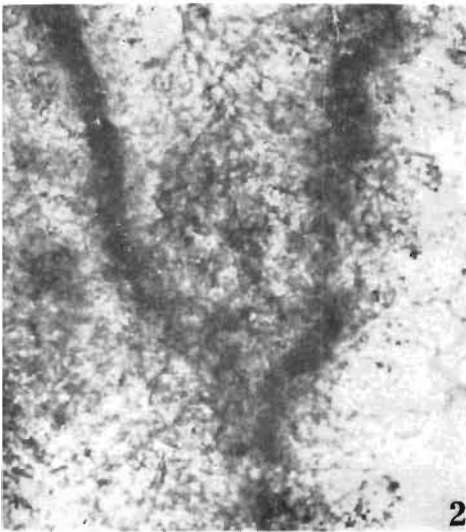
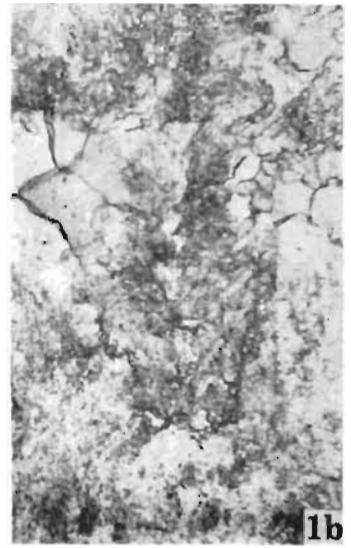
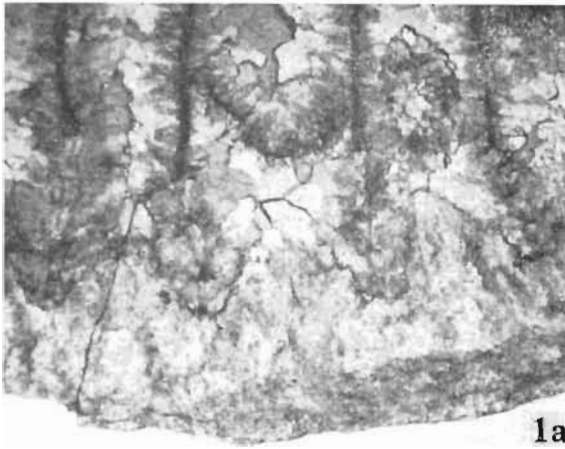


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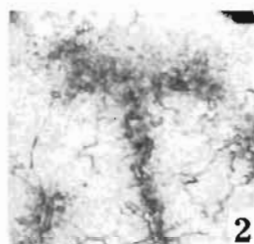




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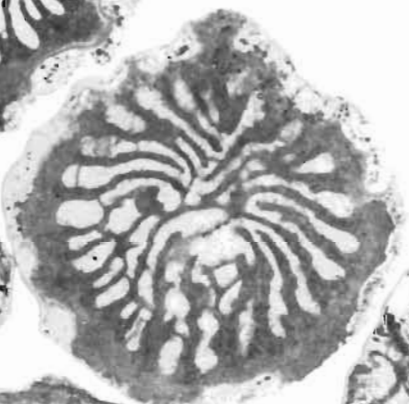
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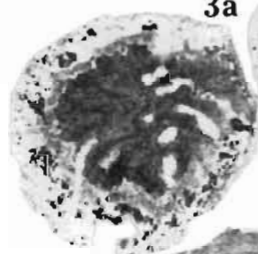
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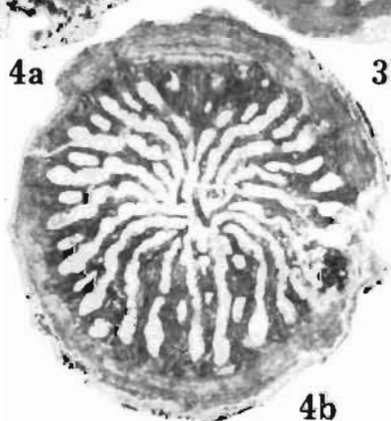
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3b



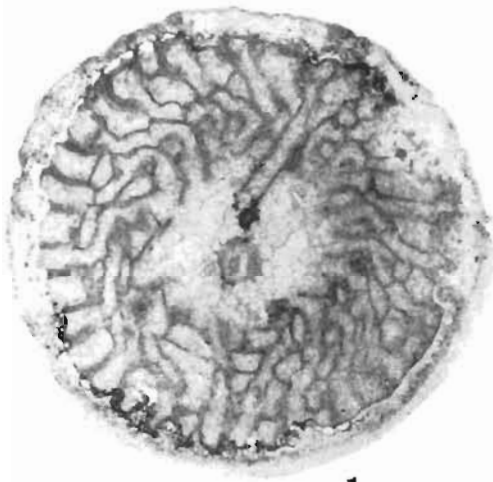
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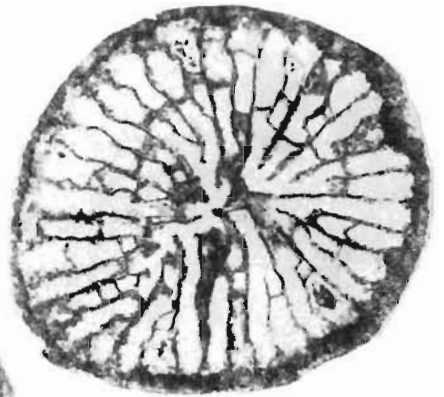
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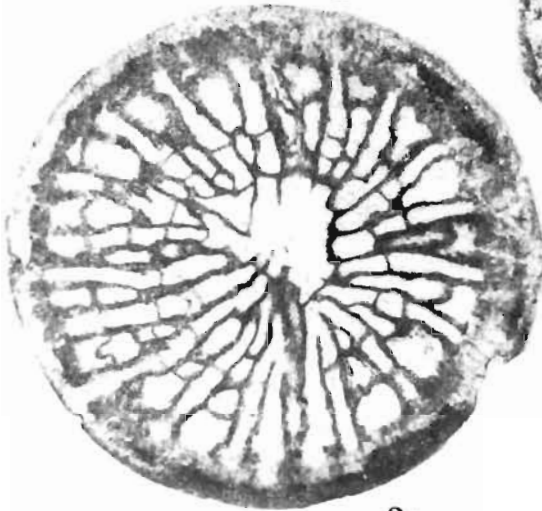
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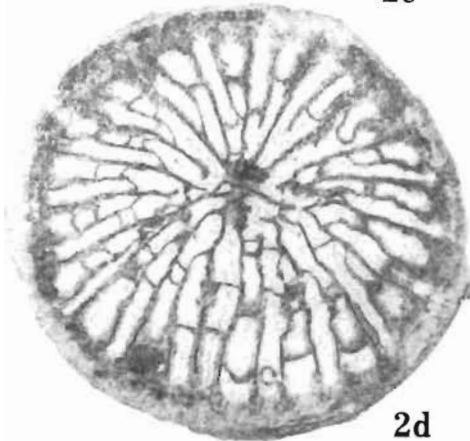
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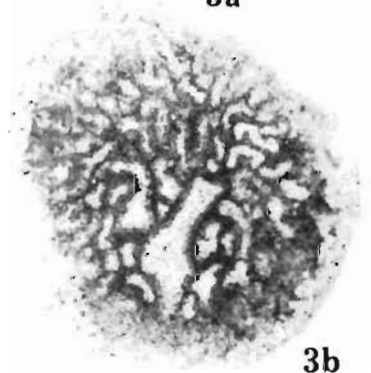
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