AMPHIPORA AND *EURYAMPHIPORA* (STROMATOPOROIDEA) FROM THE DEVONIAN OF WESTERN CANADA

by N. R. FISCHBUCH

ABSTRACT. Subsurface diamond cores of the Devonian Swan Hills Formation of central Alberta contain well-preserved specimens of *Amphipora* Schulz and *Euryamphipora* Klovan. Three varieties of *Amphipora* are recognized in the Swan Hills material, and are referred to the species *A. angusta*, *A. pervesiculata*, and *A. ramosa*; a new species of *Euryamphipora* (*E. mollis*) and the type species *E. platyformis* also are present. *Amphipora* is placed in the Clathrodictyidae with *Euryamphipora* since they have identical tissue. 'Juvenile' forms, which may represent an early astogenetic stage, are found associated with mature *Amphipora* coenostea. The concept that some forms of *Amphipora* grew without producing a peripheral rim is rejected and the absence of this feature s considered the result of abrasion.

THE stromatoporoid genus *Amphipora*, so common in the Devonian carbonate rocks of western Canada, has aroused only passing interest among Canadian palaeontologists. Those specimens described have been referred mainly to *Amphipora ramosa* (Phillips), and have been commonly considered in conjunction with other stromatoporoids as aberrant forms. The presence and abundance of *Amphipora*, however, has been noted in several recent sedimentological studies (Edie 1961; Fischbuch 1960, 1962, 1968; Thomas and Rhodes 1961; Murray 1966; Jenik and Lerbekmo 1968; Leavitt 1968).

The Swan Hills reef complexes, which are found deep in the subsurface of the central plains of Alberta, contain exceptionally well-preserved specimens of *Amphipora* which abound in the lagoon and platform carbonates. *Amphipora* coenostea constitute up to 70 % of these rocks, are commonly oriented horizontally, and appear to have been transported over longer or shorter distances after death. The specimens used in this study were taken from diamond cores of the Devonian Swan Hills Formation which straddles the Givetian–Frasnian boundary (Fischbuch 1968, p. 523) and contains nine stages of reef growth; these have been informally designated from bottom to top as Divisions I–IX (Fischbuch 1968, p. 452). *Amphipora* and *Euryamphipora* are present in all but Division I. Three species of *Amphipora* and two species of *Euryamphipora* are recognized in the Swan Hills material; both genera are placed in the family Clathrodictyidae.

TAXONOMIC CONSIDERATIONS

The classification of *Amphipora* as a stromatoporoid has been rejected by some palaeontologists: for example, Öpik (1935, p. 3) regarded *Amphipora* as a calcareous sponge. Nicholson (1886, p. 99) also believed that it should be regarded in a separate category. Lecompte (1952) classified *Amphipora* with the dendroid stromatoporoids but cautioned that 'Dans l'état présent des observations, le genre *Amphipora* apparaît entièrement aberrant dans le groupe des Stromatoporoïdes' (1952, p. 324). Later (1956, p. F142), he removed *Amphipora* and classified it as Incertae sedis. Its relatively slender, cylindrical, growth form and consistently fibrous tissue is somewhat anomalous amidst

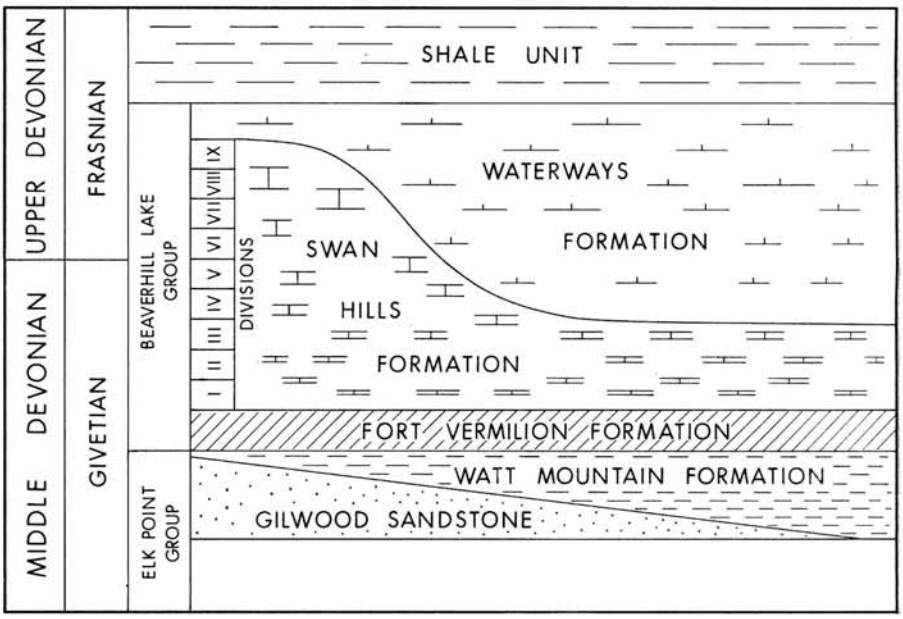
[Palaeontology, Vol. 13, Part 1, 1970, pp. 64–75, pls. 14–17.]

other genera of the Idiostromatidae and certainly anomalous compared to the families that exhibit melanospheric, cellular, compact, and flocculent tissue. Unfortunately it was not assigned originally to the Clathrodictyidae, which are typified by fibrous tissue, but rather, due to its uniformly cylindrical growth form, was conveniently placed in the

TEXT-FIG. 1. Location of Swan Hills area.

Idiostromatidae. The discovery of a tabular counterpart, *Euryamphipora*, by Klovan (1966, p. 14) sheds new light on this problem. In his description, he left little doubt that the fibrous tissue allies his genus to the family Clathrodictyidae. This, consequently, paves the way for the entry of *Amphipora* into that same family, since both genera have indistinguishable tissue. Furthermore, Birkhead (1967, pp. 31, 32), in reviewing stromatoporoid phylogeny, suggested a relationship between *Amphipora* and *Anostylostroma*. This evidence supports the inclusion of the genus *Amphipora* in the Stromatoporoidea.

Leavitt (1968, p. 325) discussed some aspects of reproduction in *Amphipora* and illustrated marginal cysts or buds and 'juvenile' coenostea (Leavitt 1968, pl. 8). Other Swan Hills limestones contain similar forms, which grade from small spherical bodies, 0·15–0·6 mm. in diameter, through incipient *Amphipora*-like stems, containing a simple



TEXT-FIG. 2. Stratigraphic position of the Swan Hills Formation.

arrangement of one or two structural elements, to mature *Amphipora* stems (Pl. 14, figs. 1–8). The outer rim in all specimens is formed by a single layer of transversely fibrous tissue. The small spheres may have been formed on the outer margins of the coenostea (Leavitt 1968, pl. 8, fig. 5). If this were so, subsequently they may have become detached, floated freely in the water, and then attached themselves to the substrate to develop into adult forms. This hypothesis, however, is conjectural, since nothing is known of the reproductive habits of stromatoporoids.

The function of the axial canal remains problematic. Lecompte (1952, p. 323) rejected the contention that it is an astrorhizal tube on the basis that there is no ramification from it throughout the tissue. Several workers, however, have reported openings connecting it to the galleries. The function of the marginal vesicles is also open to question. Nicholson (1886, p. 110) suggested that they may have been used in reproduction. Some workers (Nicholson 1886, p. 110; Lecompte 1952, p. 323) also maintain that marginal vesicles are not present in all forms. Convinced that some forms grew without producing a peripheral rim, based on his observations of the Ardennes material, Lecompte (1952, pp. 329, 330) erected two species (*A. rudis*, *A. laxeperforata*) to include such coenostea.

In the many specimens from the Swan Hills Formation, however, there seems to be little doubt that absence of the outer rim is the result of abrasion. This outer envelope of tissue is relatively thin and the slightest erosion would disrupt it or remove it completely. Most coenostea have been transported some distance and a complete sequence of forms, ranging from those with the outer rim intact, to slightly broken, and finally completely removed, can be observed in the Swan Hills material (Pl. 14, figs. 9–13).

Specimens of *Amphipora* described from Canada have been referred mainly to the type species *Amphipora ramosa* (Phillips). There are, however, several distinct varieties which can be grouped as follows:

1. Those with a narrow zone of marginal vesicles, stout pillar-laminar architecture, and relatively small axial canal.
2. Those with a narrow zone of marginal vesicles, stout pillar-laminar architecture, and no axial canal.
3. Those with a wide zone of marginal vesicles, delicate pillar-laminar architecture, and relatively large axial canal.

To represent the above three types, the species *Amphipora ramosa* (Phillips), *Amphipora angusta* Lecompte, and *Amphipora pervesiculata* Lecompte respectively, were selected from over thirty described species. They usually occur closely associated with each other in the Swan Hills Formation, but generally one species is dominant in any *Amphipora*-rich bed.

Some poorly-preserved Swan Hills specimens do not portray the dark-coloured median line in the structural elements. These were not referred to the genus *Paramphipora*, proposed by Yavorsky (1955) for specimens with tissue lacking a dark-coloured median line, since the absence of this feature is probably a function of preservation. The validity of Yavorsky's genus has also been questioned by other workers (Klovan 1966, p. 14; Stearn 1966*a*, p. 109).

KEY TO LOCATION OF SPECIMENS

The locations of wells are given in an abbreviated form, e.g. the Atlantic Kaybob 4–14 well, is 4–14–64–19 W5, which should be read as Legal Subdivision 4, Section 14, Township 64, Range 19, West of the fifth Meridian. Depths are measured from the Kelly Bushing (K.B.).

The type and other specimens described in this paper have been deposited at the Geological Museum of the University of Saskatchewan under Coelenterata, Stromatoporoidea, and are numbered with the prefix GMUS Cs. Under occurrences only well numbers are given, followed by depths in feet and GMUS Cs numbers in parentheses.

Well number	*Well name and location*
1	Phillips *et al.*, Kaybob 2–5–64–19 W5
2	Atlantic Kaybob 4–14–64–19 W5
3	S.O.B.C. Snipe Lake 10–21–70–18 W5
4	Phillips *et al.*, Kaybob 10–4–64–19 W5
5	Home Regent 'A' Swan Hills 10–4–67–10 W5
6	Phillips *et al.*, Kaybob 2–9–64–19 W5
7	Pan American B.A. Swan Hills 10–32–66–10 W5
8	Pan American B.A. Swan Hills 12–19–66–10 W5
9	Imperial Goose River 4–15–67–18 W5
10	Imperial Goose River 10–15–67–18 W5

11 Canadian Superior Sakwatamau 10–4–63–15 W5
12 Canadian Kewanee Swan Hills 4–16–68–10 W5
13 California Standard S.O.B.C. Snipe Lake 10–35–70–18 W5
14 Pan American 'A–1' Sunset House 4–16–70–19 W5
15 Pan American B.A. Swan Hills 12–29–66–10 W5
16 B.A. Goose River 10–5–67–18 W5
17 Shell Virginia Hills 12–35–64–13 W5
18 Canadian Kewanee Swan Hills 4–7–69–10 W5
19 California Standard S.O.B.C. House Mountain 4–6–70–10 W5
20 Shell Swan Hills 6–34–64–13 W5
21 Pure Sakwatamau 7–7–63–14 W5
22 Pan American B.A. 'U–12' Swan Hills 4–8–66–10 W5
23 Canadian Kewanee Swan Hills 10–32–68–10 W5

SYSTEMATIC DESCRIPTIONS

Family CLATHRODICTYIDAE Kühn 1939
Genus AMPHIPORA Schulz 1883

Type species. Caunopora ramosa Phillips 1841.

Diagnosis. Coenosteum cylindrical, rod-shaped, and very rarely branching. It may or may not have an axial canal with or without irregular tabulae. Pillars and laminae cannot be distinguished but rather are commonly amalgamated to form a coarse network, which is separated from a thin outer rim by a zone of marginal vesicles. Tissue is transversely fibrous and the structural elements (amalgamated pillars and laminae) contain a dark-coloured median line. The outer rim does not have a median line and is only about half as thick as the pillar-laminar elements.

EXPLANATION OF PLATE 14

All figures × 10.

Figs. 1–8. Progressive development from possible immature to mature *Amphipora* coenostea.

Fig. 1. Concentration of small and irregular immature *Amphipora* forms composed mainly of an outer rim with little or no internal development of structural elements; well no. 10, 9335.

Figs. 2–4. Initial stage with vague internal tissue apparent in figs. 3 and 4; well no. 10, 9335.

Fig. 5. Irregular intermediate form with definite, but separate, internal skeletal elements; well no. 10, 9335.

Figs. 6–7. Development of axial canal surrounded by an intermittent network of structural elements; well no. 10, 9335.

Fig. 8. Mature, completely developed *Amphipora* coenostea; well no. 10, 9284.

Figs. 9–13. Progressive erosion of *Amphipora* coenostea.

Fig. 9. Cross-section of *Amphipora* coenosteum with outer rim broken in two places; well no. 4, 9801.

Fig. 10. Cross-section of *Amphipora* coenosteum with right side of peripheral rim removed by erosion; well no. 4, 9801.

Fig. 11. Cross-section of *Amphipora* coenosteum with only a remnant of outer rim preserved (right side of photo). Sediment has penetrated into the galleries and axial canal; well no. 4, 9801.

Fig. 12. Cross-section of *Amphipora* coenosteum with outer rim partly collapsed; well no. 6, 9884.

Fig. 13. Cross-section of *Amphipora* coenosteum with outer rim completely removed by erosion; well no. 6, 9884.

Amphipora ramosa (Phillips 1841)

Plate 15, figs. 1–5

For synonymy to 1957 see Galloway (1957, p. 442).

1957 *Amphipora ramosa* (Phillips), Yavorsky, p. 63, pl. xli, figs. 1–9 (Lower Devonian, Kuznetsk Basin, Russia).
1957 *Amphipora intexta* Yavorsky, p. 62, pl. xxxiv, figs. 5–9 (Middle Devonian, Kuznetsk Basin, Russia).
?1960 *Amphipora ramosa* (Phillips), Galloway and Ehlers, p. 98, pl. xi, figs. 1*a*, 1*b* (Middle Devonian, Michigan, U.S.A.).
1961 *Amphipora ramosa* (Phillips), Yavorsky, p. 58, pl. xxxvi, fig. 15; pl. xxxvii, figs. 1–10 (Middle Devonian, Kuznetsk Basin, Russia).
?1961 *Amphipora ramosa* (Phillips), Stearn, p. 946, pl. 107, figs. 9, 10 (Upper Devonian, Alberta, Canada).
?1963 *Amphipora ramosa* (Phillips), Stearn, p. 663, pl. 87, fig. 2 (Swan Hills Formation, Alberta, Canada).
1963 *Amphipora intexta* (Yavorsky), Stearn, p. 663, pl. 87, figs. 3, 4, 5 (Swan Hills Formation, Alberta, Canada).
1966*a* *Amphipora ramosa* (Phillips), Stearn, p. 109.
?1966 *Amphipora* sp. Klovan, p. 30, pl. x, figs. 1–6 (Cooking Lake and Leduc Formations, Alberta, Canada).
?1966*b* *Amphipora ramosa* (Phillips), Stearn, p. 63, pl. xxiv, fig. 2 (Hay River Formation, Northwest Territories, Canada).
1967 *Amphipora ramosa* (Phillips), Birkhead, p. 84, pl. 16, figs. 2*a*, 2*b* (Callaway Formation, Missouri, U.S.A.).

Diagnosis. The coenostea are cylindrical, rarely branching, and contain an axial canal. Coenosteal diameter ranges from 2·5 to 4·6 mm. (averaging 3·47 mm.). Structural elements consist of fibrous tissue.

Description. This species is represented in the Swan Hills collection by 65 rock specimens, each of which contains many coenostea. Sixteen of these specimens were used in this description.

Cross-section. An axial canal always is present, but is not as prominent as in some other species. It ranges in diameter from 0·4 to 1·1 mm., with an average of 0·66 mm. Pillars and laminae are amalgamated to form an irregular network surrounding the axial canal. The structural elements forming this network are stout, measuring 0·1–0·25 mm. (averaging 0·2 mm.) in diameter. They are composed of light-brown tissue and contain a dark-coloured, median line with fibres extending from the line toward the perimeter of the skeletal elements. Between the pillar-laminar entanglement and the outer rim is a zone of round or oval marginal vesicles, 0·1–0·3 mm. thick. The vesicles are formed by structural elements extending, at regular intervals, across the relatively open space immediately within the outer rim. The outer rim is composed of a single layer of radially fibrous tissue that does not have a dark-coloured median line and is about half as thick as the structural elements. Dissepiments, in the marginal vesicles, galleries, and axial tube, are rare.

Axial section. The structural elements of the pillar-laminar network are commonly unoriented, but rarely appear to splay upward and outward from the axial canal and toward the periphery. The elements that pass through the zone of marginal vesicles meet the outer rim at oblique angles.

Discussion. Amphipora ramosa, as here defined, always possesses an axial canal, and thus differs from *A. angusta* Lecompte, which does not have this feature. It has thicker structural elements, a narrower zone of marginal vesicles, and fewer dissepiments than *A. pervesiculata* Lecompte. Coenostea exhibiting a splay pattern of the structural elements in some axial sections, such as those referred to *A. intexta* Yavorsky, are interpreted as variants of *A. ramosa*.

Occurrence. This species is found in Divisions II–VI of the Swan Hills Formation. In Divisions II–III it is associated with *A. pervesiculata*, and *A. angusta*, and fragmented subspherical stromatoporoids, but is one of the dominant fossils in the lagoonal facies of Divisions IV–VII. *A. ramosa* occurs in the calcirudites, calcarenites, and calcilutites in the following wells: 1, 9725 (267), 9762 (268); 2, 9759·5 (269), 9749 (270); 3, 8798 (271); 4, 9778 (272), 9801 (273); 5, 8591 (274); 6, 9884 (275), 9854 (276); 7, 9071 (277), 8977 (278); 8, 8618 (279); 9, 9192 (280); 10, 9284 (281); 11, 9735 (282).

Amphipora angusta Lecompte 1952

Plate 15, figs. 6–9

1952 *Amphipora angusta* Lecompte, p. 324, pl. lxvii, fig. 2 (Middle Devonian, Dinant Basin, Belgium).

Diagnosis. The coenosteum is cylindrical and does not contain an axial canal. Coenosteal thickness ranges from 2·2 to 4·7 mm. (averaging 3·19 mm.). Structural elements consist of fibrous tissue.

Description. Description of this species is based on fourteen rock specimens, all of which contain many coenostea.

Cross-section. An axial canal is lacking in all specimens, and the central portion of the coenosteum is composed of an amalgamated pillar-laminar system. Galleries are irregular in outline but continuous open areas can be traced completely through the skeletal system. The structural elements range from 0·1 to 0·3 mm. (averaging 0·16 mm.) in diameter, and form a continuous network. This network is surrounded by a zone of marginal vesicles, 0·1–0·4 mm. (averaging 0·3 mm.) in depth. It is crossed at regular intervals by structural elements that are commonly of equal diameter to those of the interior network but rarely thin to the point of disappearance as they cross the vesicular zone. In the rare instances in which the median part of these elements has disappeared, the elements are reduced to two 'barbs', which project into the vesicular zone from opposite sides. Skeletal tissue is light brown, transversely fibrous, and contains a dark-coloured median line. The outer rim, which is about half as thick as the structural elements, is composed of one layer of radially fibrous tissue. Dissepiments are rare.

Axial section. The interior network of intertwined structural elements is generally completely amalgamated but rarely displays a vague upward splay pattern. The elements pass through the zone of marginal vesicles and join the outer rim at an oblique angle.

EXPLANATION OF PLATE 15

Figs. 1–5. *Amphipora ramosa* (Phillips). 1, Hand specimen containing numerous coenostea, ×1; well no. 11, 9735 (282). 2, Cross-section, ×50; well no. 11, 9735 (282). 3, Cross-section, ×20; well no. 11, 9735 (282). 4, Cross-section, ×10; well no. 11, 9735 (282). 5, Cross and axial section, ×10; well no. 11, 9735 (282).

Figs. 6–9. *Amphipora angusta* Lecompte. 6, Hand specimen containing numerous coenostea, ×1; well no. 6, 9915 (285). 7, Cross-section, ×10; well no. 6, 9915 (285). 8, Fibrous microstructure, ×50; well no. 6, 9915 (285). 9, Cross and axial sections, ×10; well no. 6, 9915 (285).

Discussion. The Swan Hills specimens are similar to the Belgian holotype described by Lecompte in that they lack an axial canal, but the average diameter of the Swan Hills specimens is considerably greater (3·19 mm.) compared to a diameter range of 0·5–2·0 mm. given by Lecompte. The conspicuous absence of an axial canal, however, appears sufficient to ally the Swan Hills specimens to this species. *A. angusta* has slightly thinner structural elements than, and lacks the axial canal of, *A. ramosa.* It is easily distinguished from *A. pervesiculata*, which has thinner structural elements and a relatively large axial canal and marginal vesicles.

Occurrence. This species is found in Divisions II–VII of the Swan Hills Formation. In Divisions II and III it is associated with *A. pervesiculata*, *A. ramosa*, and other stromatoporoids, but in the lagoonal facies of Divisions IV–VII the above three species of *Amphipora* occur in great abundance to the complete exclusion of other stromatoporoids. *A. angusta* occurs in the calcirudites, calcarenites, and calcilutites in the following wells: 6, 9912 (283), 9913 (284), 9915 (285); 2, 9752 (286), 9762 (287); 12, 7957 (288); 13, 8651 (289); 14, 9093 (290); 15, 8811 (291); 7, 9099 (292); 16, 9189 (293); 17, 9341 (294); 10, 9333 (295); 18, 7842 (296).

Amphipora pervesiculata Lecompte 1952

Plate 16, figs. 1–5

1952 *Amphipora pervesiculata* Lecompte, p. 331, pl. lxx, figs. 3, 4, 5 (Upper Devonian, Dinant Basin, Belgium).

?1952 *Amphipora laxeperforata* Lecompte, p. 330, pl. lxx, figs. 1, 2 (Upper Devonian, Dinant Basin, Belgium).

1957 *Amphipora pinguis* Yavorsky, p. 63, pl. xxxv, figs. 1–5 (Middle Devonian, Kuznetsk Basin, Russia).

Description. This species is represented in the Swan Hills collection by 43 rock specimens, 19 of which are used in this description, and all contain many coenostea. The cylindrical skeleton ranges from 2·0 to 4·9 mm. (averaging 3·3 mm.) in diameter.

Cross-section. A relatively large axial canal, 0·5–1·5 mm. (averaging 0·82 mm.) in diameter, is a dominant feature of all coenostea. Undifferentiated structural elements form a continuous but relatively narrow network around the axial canal. The diameter of these structural elements ranges from 0·1 to 0·24 mm. (averaging 0·13 mm.). They are slightly thinner than those of other species but appear even more so due to their reduced numbers. The conspicuous zone of marginal vesicles, 0·2–0·6 mm. wide, is crossed by structural elements which thin perceptibly, and commonly do not extend completely across the zone, but are broken to form opposing 'barbs'. In some cross-sections, most, or even all, of the marginal vesicles are joined to form a continuous open area between the outer rim and the interior skeletal system. The outer rim, 0·03–0·06 mm. in thickness, is composed of a single layer of transversely fibrous tissue, differing from the other elements which are also transversely fibrous but are thicker and contain a dark-coloured median line. Dissepiments are common in most coenostea but are especially noticeable in the large axial canal and zone of marginal vesicles.

Axial section. Structural elements are uncommon in the zone of marginal vesicles, giving the impression of an annulus between the outer rim and the pillar-laminar network.

Discussion. The Swan Hills specimens structurally are indistinguishable from the Belgian holotype described by Lecompte but have a greater over-all diameter. Considerable variation in size, however, seems to be characteristic of mature specimens of amphiporoid species. *A. pervesiculata* differs from *A. ramosa* in having a larger axial canal and a much wider zone of marginal vesicles. It is easily distinguished from *A. angusta*, which has no axial canal. *A. pinguis* Yavorsky is indistinguishable from the Swan Hills specimens in size of the coenosteum and axial canal. Width of the marginal vesicular zone was not given by Yavorsky but measures about 0·25 mm. on the illustrations, and this compares favourably with the Swan Hills specimens. *A. pinguis* is, therefore, a junior subjective synonym of *A. pervesiculata*. *A. laxeperforata* Lecompte appears to be an *A. pervesiculata* or *A. ramosa* in which the outer rim has been destroyed by abrasion.

Occurrence. This species is found in Divisions II–IX of the Swan Hills Formation. *A. pervesiculata* is associated with *A. ramosa*, *A. angusta*, fragmented subspherical, and dendroid stromatoporoids in Divisions II and III. In Divisions IV–IX it is found associated only with *A. ramosa* and *A. angusta*. It occurs in the calcirudites, calcarenites, and calcilutites in the following wells: 5, 8472·5 (297), 8409 (298); 17, 9495 (299), 9372 (300); 15, 8931 (301), 9001 (302), 8739 (303), 8813 (304); 10, 9317 (305); 4, 9737 (306), 9729 (307); 2, 9756 (308), 9764 (309); 1, 9751 (310); 14, 9104 (311); 6, 9727·5 (312); 12, 7927 (313); 3, 8716 (314); 19, 7516 (315).

Genus EURYAMPHIPORA Klovan 1966

Type species. Euryamphipora platyformis Klovan 1966.

Diagnosis. Coenosteum thin, tabular, undulating, and composed of a median zone of undifferentiated structural elements representing amalgamated pillars and laminae, which is flanked above and below by marginal vesicles. Tissue of the structural elements is transversely fibrous and contains a dark-coloured median line.

Euryamphipora platyformis Klovan 1966

Plate 17, figs. 1–5

1966 *Euryamphipora platyformis* Klovan, p. 15, pl. iii, figs. 4*a*, 4*b*; pl. iv, figs. 1–7 (Cooking Lake and Leduc Formations, Alberta, Canada).

Diagnosis. Coenostea are flat, tabular forms, ranging from 1 to 3 mm. in thickness. Astrorhizal canals, mamelons, and latilaminae are not present.

Description. This species is represented in the Swan Hills collection by nine specimens.

EXPLANATION OF PLATE 16

Figs. 1–5. *Amphipora pervesiculata* Lecompte. 1, Hand specimen containing numerous coenostea, × 1; well no. 5, 8472·5 (297). 2, Cross-section, × 10; well no. 10, 9317 (305). 3, Cross-section showing fibrous microstructure, × 50; well no. 5, 8472·5 (297). 4, Cross-section, × 20; well no. 5, 8472·5 (297). 5, Axial section showing a vague upward splay pattern of the structural elements, × 10; well no. 5, 8472·5 (297).

Figs. 6–10. *Euryamphipora mollis* sp. nov. 6, Hand specimen containing tabular coenostea of *Euryamphipora mollis* sp. nov. associated with *Amphipora* and dendroid stromatoporoids, × 1; well no. 6, 9924 (325). 7, Vertical section of *E. mollis* showing fibrous microstructure and zone of marginal vesicles crossed by dissepiments, × 50; well no. 6, 9924·5 (325). 8, Tangential section showing cross-sections of structural elements, × 50; well no. 6, 9924·5 (325). 9, Vertical section, × 10; well no. 6, 9924·5 (325). 10, Tangential section, × 10; well no. 6, 9924·5 (325).

Vertical section. The upper and lower surfaces of the coenosteum are bordered by a thin (0·05 mm.) layer of transversely fibrous tissue, which does not contain a dark-coloured median line. In some coenostea, the upper layer has been disrupted or removed by erosion allowing sediment or algal (?) material to accumulate directly on the pillar-laminar network (Pl. 17, fig. 1). The pillar-laminar entanglement occupies the median portion of the skeleton, and its elements range from 0·1 to 0·2 mm. in diameter. They are composed of light-brown, transversely fibrous tissue and contain a dark-coloured median line. The interior network is joined, at regular intervals, to the outer layer of tissue by vertical elements (pillars?), forming a continuous row of marginal vesicles 0·25–0·35 mm. in thickness. Dissepiments are rare.

Tangential section. Where sections cut the median zone, the skeletal elements not uncommonly are crudely oriented in subparallel rows at right angles to each other, forming a coarse, screen-like pattern. This differs from the sheet-like laminae of other stromatoporoids, which are pierced only by foramina and vacuoles. Tangential sections through the relatively open marginal vesicle zone reveal the structural elements as discrete dots, 0·1–0·15 mm. in diameter, which are joined by dissepiments.

Discussion. The Swan Hills specimens are closely similar to the holotype described by Klovan from the Upper Devonian Redwater reef complex, although they have a slightly thinner outer layer of tissue. This difference, however, is negligible and not of specific significance. *E. platyformis* differs from *E. mollis*, which has more dissepiments, thinner structural elements, and larger marginal vesicles.

Occurrence. E. platyformis is found in Divisions II–VII of the Swan Hills Formation, where it is associated with *Amphipora*, fragmented brachiopods, and disarticulated ostracode carapaces. It occurs in growth position and in the calcarenites and calcirudites in the following wells: 20, 9447 (316), 9644 (317); 21, 9408 (318); 22, 8613 (319), 8616 (320); 23, 8247 (321), 8249 (322); 8, 8777 (323); 12, 7910 (324).

Euryamphipora mollis sp. nov.

Plate 16, figs. 6–10

Holotype. 6, 9924·5 (325).

Diagnosis. Coenostea have a tabular growth habit and occur singly or in superposed layers of several coenostea, which encrust and over-ride each other giving the whole mass a latilaminar aspect. Some coenostea persist laterally for only short distances and have the appearance of large 'cysts' formed on the underlying coenosteum. These, in turn, are engulfed by the coenosteum above, which may have similar 'cysts' on its upper surface.

Description. Euryamphipora mollis is represented in the Swan Hills collection by six specimens.

Vertical section. Coenosteum consists of a median pillar-laminar system, 1–1·5 mm. thick, in which pillars cannot be distinguished from laminae. These structural elements range from 0·1 to 0·15 mm. in diameter, are transversely fibrous, and contain a dark-coloured median line. The median zone of undifferentiated structural elements is flanked above and below by a zone of marginal vesicles, 0·4–0·8 mm. in thickness, which is crossed at regular intervals by vertical or oblique structural elements. These elements

thin perceptibly and commonly do not extend across the zone, but are broken completely to form opposing 'barbs'. The coenosteum is covered by a thin layer of transversely fibrous tissue, 0·04–0·08 mm. in thickness. Where coenostea are superposed, the line of contact can be traced by a dark-coloured median line, identical to that in the interior elements. Dissepiments are common, especially in the marginal vesicles, where they curve and branch outward, linking the median skeletal system to the outer, covering layer.

Tangential section. Structural elements in the median zone are represented by discrete, irregular masses of fibrous tissue surrounded by continuous gallery space, which is interrupted only by dissepiments. Where sections cut the zone of marginal vesicles, widely spaced skeletal elements are represented by dots, 0·1 mm. or less in diameter, not uncommonly joined by dissepiments.

Discussion. E. mollis differs from the only other species of *Euryamphipora*, *E. platyformis*, in having more dissepiments, a more delicate pillar-laminar system, and a larger zone of marginal vesicles. It has a slightly 'knotted' structure reminiscent of *Hammatostroma nodosum*, described by Klovan from the Redwater reef complex, but the laminae in the latter species are much more closely spaced than the units described here as individual coenostea. The genera *Euryamphipora* and *Hammatostroma* have similar fibrous microstructure but differ markedly in laminar spacing (or coenosteal thickness). They eventually may be found to be related to a common ancestor.

Occurrence. This species is found in Divisions II and III of the Swan Hills Formation, where it is associated with *Amphipora*, *Euryamphipora platyformis*, subspherical stromatoporoids, and ostracode carapaces. It occurs in growth position and in the calcarenites and calcirudites in the following wells: 6, 9924·5 (325), 9902·5 (326), 9926 (327); 5, 8640 (328); 22, 8614 (329); 2, 9770 (330).

Acknowledgements. This paper is a portion of a doctoral dissertation written at the University of Saskatchewan under the direction of Drs. W. G. E. Caldwell and W. K. Braun. The writer gratefully acknowledges their guidance and criticism.

REFERENCES

BIRKHEAD, P. K. 1967. Stromatoporoidea of Missouri. *Bull. Am. Paleont.* **52,** no. 234, 23–110.

EDIE, R. W. 1961. Devonian reef reservoir, Swan Hills oilfield, Alberta. *Can. Mining and Met. Bull.* **54,** no. 590, 447–54.

FISCHBUCH, N. R. 1960. Stromatoporoids of the Kaybob reef, Alberta. *Jour. Alta. Soc. Petrol. Geol.* **8,** 113–31.

—— 1962. Stromatoporoid zones of the Kaybob reef, Alberta. Ibid. **10,** 62–72.

—— 1968. Stratigraphy, Devonian Swan Hills reef complexes of central Alberta. *Bull. Can. Petrol. Geol.* **16,** 446–587.

GALLOWAY, J. J. 1957. Structure and classification of the Stromatoporoidea. *Bull. Am. Paleont.* **37,** no. 164, 345–480.

EXPLANATION OF PLATE 17

Figs. 1–5. *Euryamphipora platyformis* Klovan. 1, Vertical section showing tabular growth habit, ×10; well no. 20, 9644 (317). 2, Tangential section showing orientation of skeletal elements in subparallel rows, ×10; well no. 22, 8616 (320). 3, Tangential section cutting median pillar-laminar entanglement and zone of marginal vesicles, ×10; well no. 22, 8616 (320). 4, Vertical section showing marginal vesicle, ×50; well no. 22, 8613 (319). 5, Tangential section showing fibrous microstructure, ×50; well no. 22, 8613 (319).

GALLOWAY, J. J. and EHLERS, G. M. 1960. Some Middle Devonian stromatoporoids from Michigan and south-western Ontario, including the types described by Alexander Winchell and A. W. Grabau. *Contr. Mus. Paleont. Univ. Mich.* **15,** no. 4, 39–120.

—— and ST. JEAN, J. JR. 1957. Middle Devonian Stromatoporoidea of Indiana, Kentucky, and Ohio. *Bull. Am. Paleont.* **37,** no. 162, 29–308.

JENIK, A. J. and LERBEKMO, J. F. 1968. Facies and geometry of Swan Hills reef Member of Beaverhill Lake Formation (Upper Devonian), Goose River field, Alberta, Canada. *Bull. Am. Assoc. Petrol. Geol.* **52,** 21–56.

KLOVAN, J. E. 1966. Upper Devonian stromatoporoids from the Redwater reef complex, Alberta, Canda. *Bull. geol. Surv. Can.* **133,** 1–33.

LEAVITT, E. M. 1968. Petrology, palaeontology, Carson Creek North reef complex, Alberta. *Bull. Can. Petroleum Geol.* **16,** 298–413.

LECOMPTE, M. 1952. Les stromatoporoïdes du Dévonien moyen et supérieur du Bassin de Dinant. *Mém. Inst. r. Sci. Nat. Belg.* **117,** 216–369.

—— 1956. Stromatoporoidea. In MOORE, R. C. (ed.), *Treatise on invertebrate paleontology*. Part F, F107–44, Univ. Kansas Press and Geol. Soc. Amer.

MCCOY, F. 1884. *A synopsis of the characters of the Carboniferous limestone of Ireland.* Univ. Press, Dublin.

MURRAY, J. W. 1966. An oil-producing reef-fringed carbonate bank in the Upper Devonian Swan Hills Member, Judy Creek, Alberta. *Bull. Can. Petroleum Geol.* **14,** 1–103.

NICHOLSON, H. A. 1886, 1892. A monograph of the British stromatoporoids. *Palaeontographical Soc. London.* Pts. 1, 4, 39, 46, 1–234.

ÖPIK, A. 1935. *Amphipora ramosa* (Phillips) in the marine Devonian of Estonia. *Ann. Nat. Soc. Tartu Univ.* **41,** 1–8.

PHILLIPS, J. 1841. *Figures and descriptions of the Palaeozoic fossils of Cornwall, Devon, and West-Somerset.* Longman, Brown, Green, and Longmans, London.

RIPPER, E. A. 1937. A note on the occurrence of *Amphipora ramosa* (Phillips) in western Australia. *R. Soc. West. Aust. Jour.* **23,** 37–41.

SCHULZ, E. 1883. Die Eifelkalkemunde von Hillesheim. Nebst einem palaeontolog Anhang. *Jb. preuss. geol. Landesanst. Berg Akad. für 1882,* 160–247.

STEARN, C. W. 1961. Devonian stromatoporoids from the Canadian Rocky Mountains. *J. Paleont.* **35,** 923–48.

—— 1963. Some stromatoporoids from the Beaverhill Lake Formation (Devonian) of the Swan Hills area, Alberta. Ibid. **37,** 651–68.

—— 1966*a*. The microstructure of stromatoporoids. *Palaeontology*, **9,** 74–124.

—— 1966*b*. Upper Devonian stromatoporoids from southern Northwest Territories and northern Alberta. *Bull. geol. Surv. Can.* **133,** 35–68.

THOMAS, G. E. and RHODES, H. S. 1961. Devonian limestone bank-atoll reservoirs of the Swan Hills area, Alberta. *Jour. Alta. Soc. Petrol. Geol.* **9,** 29–38.

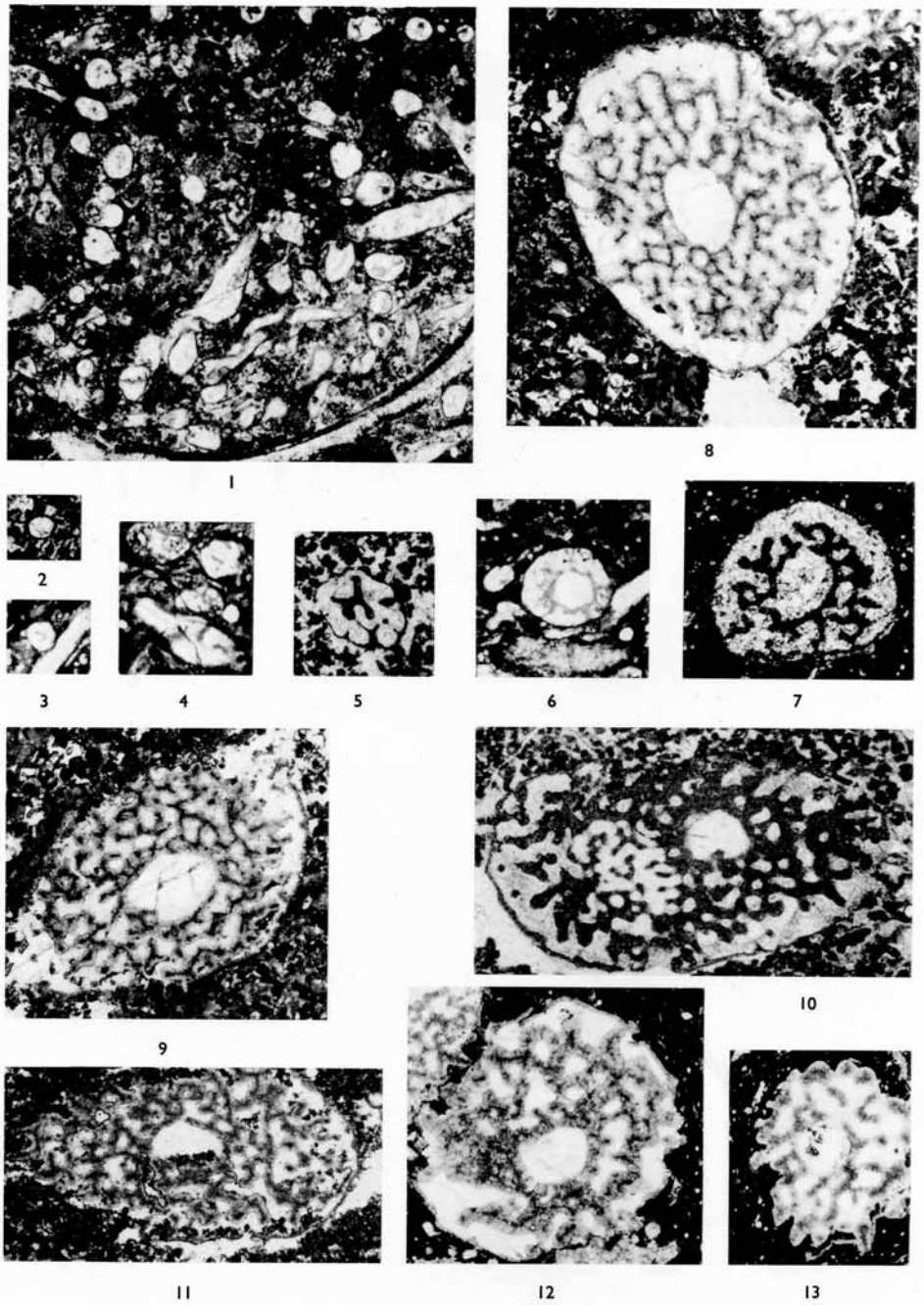
YAVORSKY, V. I. 1955. Stromatoporoidea Sovetskogo Soyuza, pt. 1. *Trudȳ Vses. Nauchno-issled. geol. Inst.*, Minist. geol. Okhr. Nedr., n. ser. **8,** 173 pp.

—— 1957. Stromatoporoidea Sovetskogo Soyuza, pt. 2. Ibid. **18,** 78 pp.

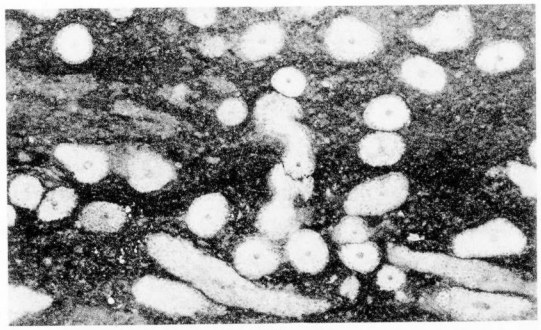
—— 1961. Stromatoporoidea Sovetskogo Soyuza, pt. 3. Ibid. **44,** 64 pp.

N. R. FISCHBUCH
33 Fernie Place S.E.
Calgary 27
Alberta, Canada

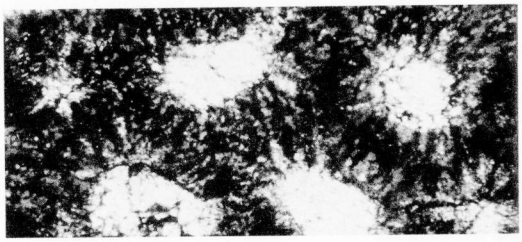
Final typescript received 15 July 1969



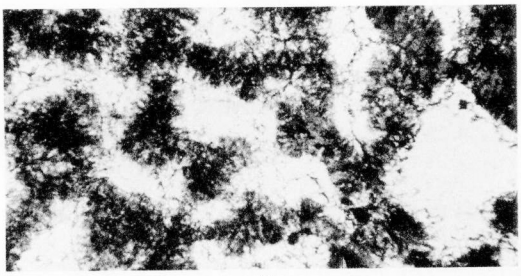
FISCHBUCH, *Amphipora*



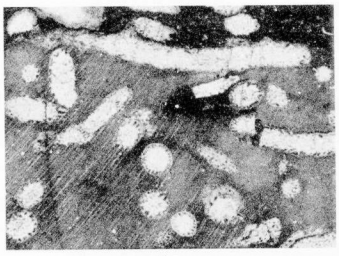
1



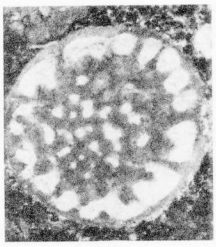
2



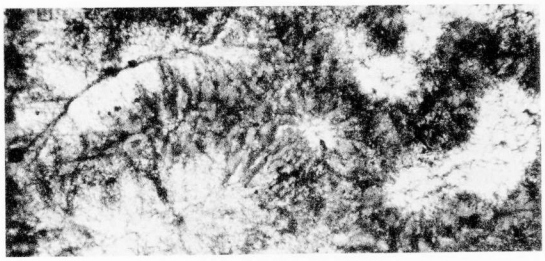
3



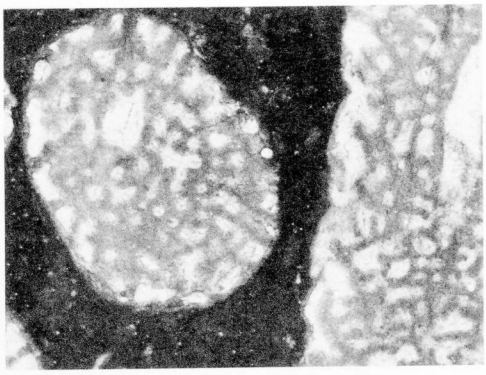
6



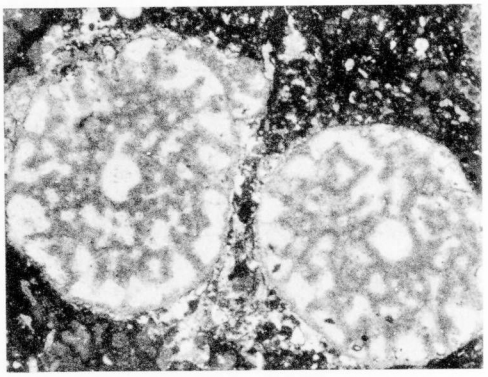
7



8



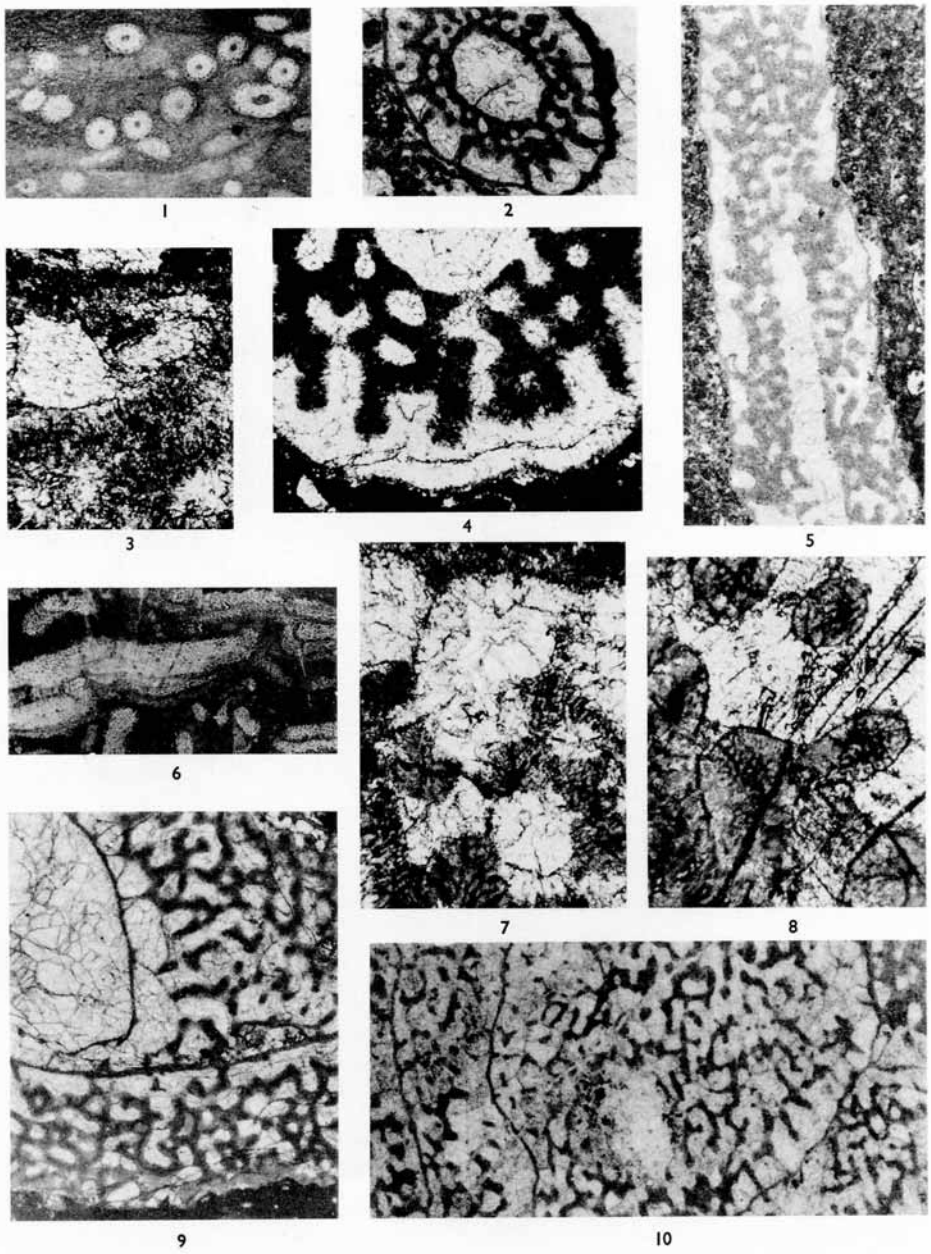
4



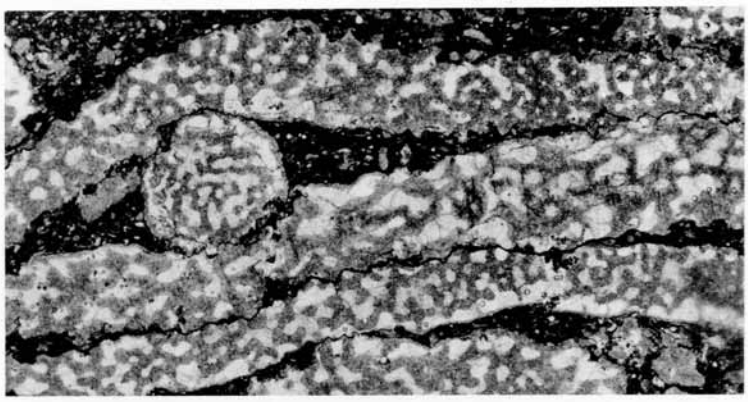
5

9

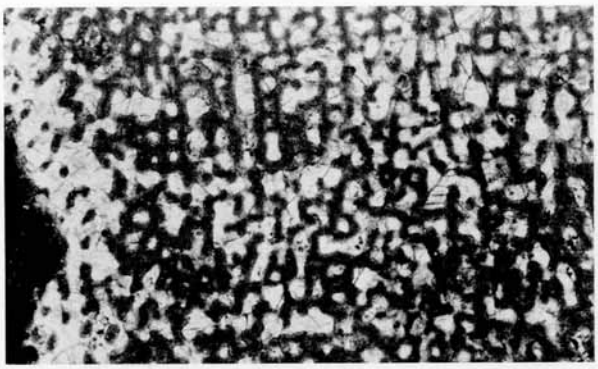
FISCHBUCH, *Amphipora*



FISCHBUCH, *Amphipora* and *Euryamphipora*

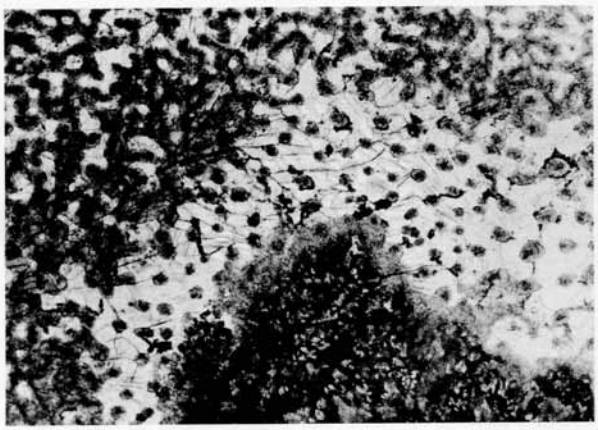


1



2

4



3

5

FISCHBUCH, *Euryamphipora*