CALCIFOLIUM (CODIACEAE) FROM THE UPPER VISÉAN OF SCOTLAND

by IAIN C. BURGESS

ABSTRACT. Two species of the algal genus *Calcifolium* Shvetzov and Birina occur in two Upper Viséan limestones in Ayrshire and Lanarkshire. At the lower horizon, that of the Hurlet Limestone, the characteristic form is *C. punctatum* Maslov; in the overlying Blackhall Limestone, the species is replaced by *C. okense* Shvetzov and Birina. Both species are easily recognized in thin sections, and the genus appears to be an accurate marker for the P_2–E_1 stratigraphical interval.

THE codiacean algal genus *Calcifolium* was first described from limestones of the Okian Series (Lower Carboniferous) of the Moscow Basin (Shvetzov and Birina 1935). It was identified in thin sections as '. . . narrow (0·1 mm.) curved strips of different lengths (0·3 to 2 mm.) with a fairly regular arrangement of round holes (diam. 0·016 mm.) close to one edge. . . .' (op. cit., quoted in Maslov 1956, p. 47). One species, *C. okense*, was erected to include such fragments and also a few which were noted as having several rows of perforations. The genus was redescribed by Maslov (1956), who assigned the 'many-rowed' fragments to a second species, *C. punctatum*, and also, from a complex branch of *C. okense*, made a reconstruction of the probable shape of the thallus (Maslov 1956, pp. 49, 50, fig. 9; Johnson 1958, fig. 2). The genus was first recognized from the Carboniferous of Great Britain in the Great Limestone (E_1) of the Alston Block and Northumberland trough (Johnson 1958). The specimens resembled *C. okense* in having only one row of perforations, but as they were of larger size, and differed in several details, they were assigned to a new species, *C. bruntonense*.

During a revision of the Upper Viséan strata in the western part of the Midland Valley of Scotland, the occurrence was noted in two limestones of algal fragments referable to *Calcifolium*. At the lower horizon, the Hurlet Limestone, *C. punctatum* is the characteristic form; in the overlying Blackhall limestone, *C. okense* is found.

SYSTEMATIC DESCRIPTION

Genus CALCIFOLIUM Shvetzov and Birina 1935

Type species. Calcifolium okense Shvetzov and Birina.

Diagnosis. The thallus consists of a tubular calcareous stem, at first rather large, then branching dichotomously into smaller tubes of constant diameter. At intervals, the stem gives rise to thin, flat, or slightly curved lateral plates, which may themselves branch to form other plates. A dichotomously branching canal system is longitudinally arranged in the stem wall, radially divergent in the lateral plates.

Remarks. Calcifolium occurs in limestone, usually where the lithology is biomicrite or biomicrosparite, in association with other algae, foraminifera, and brachiopod, crinoid,

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bryozoan, and coral debris. The alga is not normally visible in hand specimen, except where selective pyritization of the fragments has taken place. The calcite forming the thallus is very fine-grained (less than 1μ) and appears dark in thin section. It is very resistant to recrystallization, and the alga is frequently preserved when almost all the other detritus in the rock has been destroyed.

Calcifolium okense Shvetzov and Birina

Plate 21, figs. 1–5; text-fig. 1*a–c*.

Calcifolium okense (*pars*) Shvetzov and Birina 1935, pl. 4, figs. 11, 12, 14, 15 (*fide*. Maslov 1956).
Calcifolium okense Shvetzov and Birina; Maslov 1956, pl. 8, figs. 1, 3–7; pl. 9, figs. 2–5; pl. 10, figs. 1, 3–5; text-fig. 7*a*, *b*.

Diagnosis. Calcifolium, in which a single series of canals lies close to the inner surface of the tubular stem, and close to one side of each lateral plate. Dimensions as in Table 1.

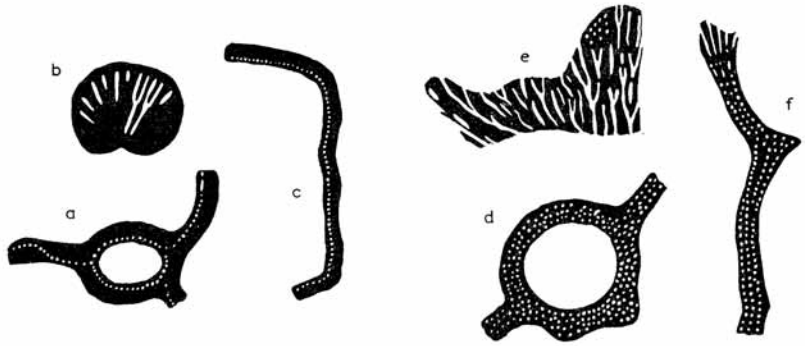
TABLE 1. Dimensions of *Calcifolium spp.* from the West of Scotland, the Moscow Basin, and Northern England.

	This paper		Maslov 1956		Johnson 1958
	okense	*punctatum*	*okense*	*punctatum*	*bruntonense*
Diameter of stem-tube	300–400 μ	500–1,200 μ	300–400 μ	..	1,000 μ
Thickness of stem wall	100–180 μ	100–250 μ	70–100 μ	..	100–200 μ
Diameter of stem wall canals	20–25 μ	10–25 μ	..	..	40 μ
Thickness of lateral plates	60–170 μ	80–140 μ	70–100 μ	100 μ	100–150 μ
Maximum length of individual plates	3 mm.	4 mm.	..	..	2 mm.
Diameter of canals in plates	15–30 μ	10–25 μ	16 μ	20 μ	20–50 μ
Angle of branching of canals	20–40°	20–30°	10–25°	10–45°	15°
Distance between canals	10–30 μ	10–30 μ	0–40 μ	0–40 μ	15–20 μ

Description. The stem wall is pierced by a single series of longitudinal canals, which are close to the inner surface of the tube, except where they branch and cross over into the bases of the lateral plates. These plates have an irregularly oblong triangular shape, or are semi-discoidal or oval. Within the plates the canals diverge radially, branching dichotomously, usually at an acute angle. They are always arranged close to one side of the plate and branch approximately in one plane. In transverse sections, the plates appear as dark, almost opaque strips with nearly circular, light-coloured specks—sections across canals—close to one edge of the strip. In oblique sections of the plates, the canals have the appearance of oval or oblong light-coloured strips. The plates often form lamellar branches in which the canals are arranged on the same side as those in the initial plate. As a result of repeated branching, very complex branches may be formed.

Remarks. The dimensions of *Calcifolium* from the Blackhall Limestone are given in Table 1, where they are compared with those of other described specimens. Although they cover a wider size range than that given by Maslov for the typical *C. okense*, it is believed that all the Scottish material is conspecific, since the extreme variants occur in

the same microsection. Also, several of Maslov's figured specimens (Maslov 1956; pl. 8, figs. 4, 5) exceed the sizes which he gives in the text of his paper. Apart from the central stem, the size range of the Scottish specimens almost includes that of *C. bruntonense* Johnson. The diameter of the central stem is, however, very close to that of the type material of *C. okense*, and the average size of the fragments is closer to that of *C. okense* than *C. bruntonense*. For this reason, they are assigned to the former species. It is of interest to note that *C. bruntonense* occurs abundantly in the Great Limestone



TEXT-FIG. 1. Diagrammatic representation of sections of *Calcifolium okense* (*a*, *b*, *c*) and *C. punctatum* (*d*, *e*, *f*) approximately ×25; *a*, *d*, stem cross-sections; *b*, *e*, plate tangential sections; *c*, *f*, plate cross-sections.

of N. England (Johnson 1958) and this limestone is usually equated with the Top Hosie Limestone of the Scottish succession—a higher horizon than the Blackhall Limestone. It may be that records of *Calcifolium* with a single series of canals from lower limestones in N. England (Short 1954) in fact indicate the presence of the smaller form *C. okense*.

The probable form of the thallus of *C. okense* is discussed in some detail by Maslov (op. cit.). The Scottish specimens are generally too broken up to give any further information. The structure must have been of some rigidity, for several plates have attached foraminifera, usually growing on the side farthest from the perforations.

Calcifolium punctatum Maslov

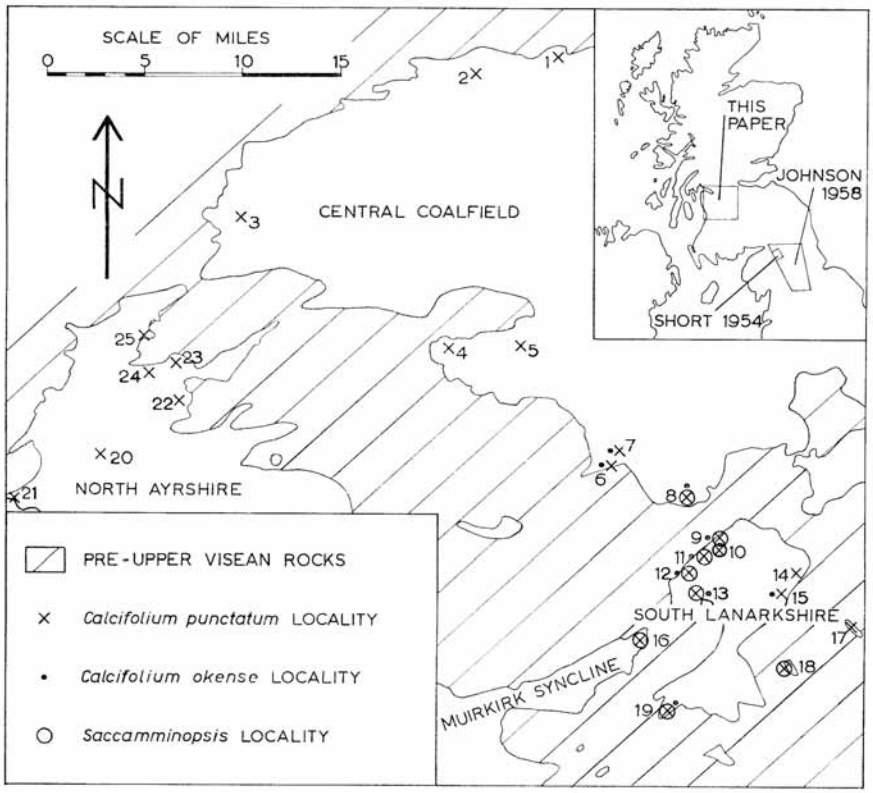
Plate 22, figs. 1–5; text-fig. 1*d–f*.

Calcifolium okense Shvetzov and Birina 1935 *pars*.
Calcifolium punctatum Maslov 1956, plate 8, fig. 2; plate 9, fig. 1; plate 10, fig. 2; text-fig. 8.

EXPLANATION OF PLATE 21

Figs. 1–5. *Calcifolium okense* ×28. 1. Cross-section of complex branch; Hawthorn Lst., Bankend quarry (text-fig. 2, locality 13). (Slide no. PS2998), Geological Survey Collection, Edinburgh.)
2. Cross-section of stem, with lateral plates; Hawthorn (Wee) Lst., River Nethan (loc. 11). (PS2996.)
3, 4. Cross- and tangential-sections of lateral branches; Blackhall Lst., Avon Water (loc. 6). (PS3001.)
5. Cross-section of plate, with attached foraminifer (top right); Blackhall Lst., Avon Water (loc. 7). (PS3002.)

Diagnosis. Calcifolium, in which the canal system takes the form of a network which may completely fill the thickness of the stem wall and the lateral plates. Dimensions are as in Table 1.



TEXT-FIG. 2. Sketch-map of the western part of the Midland Valley of Scotland, showing areal distribution of Upper Viséan strata and fossil localities: 1, Corrieburn; 2, Baldow Glen; 3, Bridge of Weir; 4, Thorntonhall; 5, Calderwood Glen; 6, 7, Avon Water; 8, Birkwood Burn; 9, 10, 11, 12, River Nethan; 13, Bankend; 14, Ponfeigh Burn; 15, Craig Burn; 16, Glenbuck; 17, Limefield; 18, Wedder Law; 19, Kennox Water; 20, Blairmill; 21, Ardrossan; 22, Nettlehirst; 23, Hessilhead; 24, Broadstone; 25, Roebank Glen.

Description. The stem wall is pierced by a network of longitudinal canals, which in larger specimens is confined to the inner half of the wall, but which in smaller specimens fills the wall completely. Within the lateral plates the canals diverge radially, and branch dichotomously at an acute angle, forming a network throughout the thickness of the plate. In transverse sections, the plates appear as dark, often ragged strips, with the

canals arranged in two or three rows, or distributed irregularly throughout the thickness of the plate. Repeated branching of the plates frequently takes place, forming complex structures.

Remarks. The specimens from the Hurlet Limestone closely resemble those described by Maslov in size and form (Table 1). The thallus generally appears to be more irregular in shape than that of *C. okense*. The canals also lack the regularity of those in *C. okense*, and in some specimens give the appearance of forming an anastomosis within the lateral plates. In one specimen (Plate 22, fig. 1) *C. punctatum* grew attached to a corallite of *Lithostrotiom junceum*, a feature never observed in *C. okense*.

STRATIGRAPHICAL DISTRIBUTION

The Upper Viséan strata are a series of alternating marine and non-marine beds, which rest unconformably and with internal overlap on Clyde Plateau Lavas and older rocks. Their stratigraphy has in the past been the subject of many investigations (summarized by Macgregor 1930) due partly to their former economic importance and partly to the wealth of fossils which are found in many of the limestones.

The stratigraphical sequences in North Ayrshire and South Lanarkshire (text-fig. 3) are comparable both in lithology and thickness. The limestones are generally thick, and yield a prolific macrofauna. In the Central Coalfield basin, the sequence is much thicker, but individual limestones tend to be thinner and less fossiliferous. The change in facies coincides closely with the gap in exposures caused by the ridge of older rocks separating the Central Coalfield from the basins to the south (text-fig. 2). Thus while the correlation of the marine horizons between North Ayrshire and South Lanarkshire is well established (Richey 1946) that between these areas and the Central Coalfield is more difficult, and has in the past been a controversial subject (Carruthers and Richey 1915; Macnair 1915).

In the Central Coalfield basin, *Calcifolium punctatum* occurs abundantly in the Hurlet Limestone in most exposures, except those around Paisley and Howwood, in which district the limestone is crinoidal. In the region between Lesmahagow and Carluke, it is commonly found in association with *Saccamminopsis fusulinaformis* (M'Coy). In the Coalburn–Douglas district, *C. punctatum* and *S. fusulinaformis* are again found together in the *Productus giganteus* Limestone. Traced south-westwards into the Muirkirk syncline, this limestone becomes first shaly, then sandy. *C. punctatum* is not found there, being confined to those exposures where the lithology of the limestone is biomicrite or

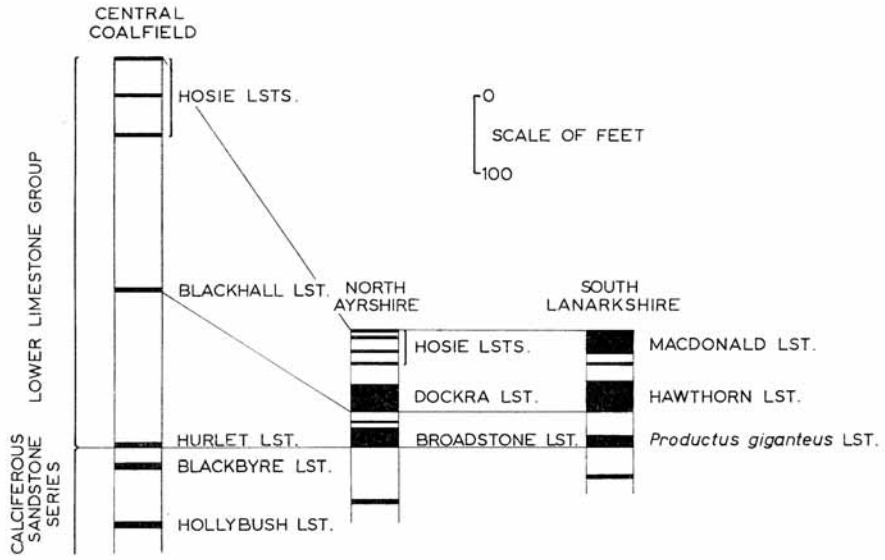
EXPLANATION OF PLATE 22

Figs. 1–5. *Calcifolium punctatum* × 28. 1. Cross-section of alga, initially encircling a corallite of *Lithostrotion junceum* then giving rise to a complex branch; *Productus giganteus* (Big) Lst., River Nethan (text-fig. 2, locality 12). (Slide no. PS2995, Geological Survey Collection, Edinburgh.)

2. Tangential section of lateral plate with canals infilled with pyrites; *Productus giganteus* Lst., Coal Burn, Glenbuck (loc. 16). (PS2994.)
3. Cross-section of lateral branch; Broadstone Lst., Broadstone quarry (loc. 24). (PS2999.)
4. Cross-section of stem, with remnant of lateral plate (top left); *Productus giganteus* (Big) Lst., River Nethan (loc. 9). (PS2997.)
5. Cross-section of part of stem (bottom left) with longitudinal sections of lateral branches; Broadstone Lst., Nettlehirst quarry (loc. 22). (PS3000.)

biomicrosparite. The Broadstone Limestone of North Ayrshire also contains abundant *C. punctatum* at many localities.

Calcifolium okense is found over a more restricted area. In the Central Coalfield basin, it occurs in a 1-foot band just above the base of the Blackhall Limestone, in the region around Strathaven and Birkwood, frequently in association with a small encrusting form of *Girvanella*, with tubes about 3–4 μ in internal diameter. Elsewhere, the lower part of the limestone is shaly, or is a silty ostracod limestone. *Calcifolium* has not been recorded in



TEXT-FIG. 3. Generalized stratigraphical sequences in the Central Coalfield, North Ayrshire and South Lanarkshire, approximately to scale, showing main limestones and proposed correlations.

these facies. In the Coalburn–Douglas district *C. okense* occurs near the base of the Hawthorn Limestone at Bankend (again in association with small *Girvanella*) and in a 1-foot band above the base of the equivalent 'Wee' Limestone at several localities in the River Nethan. In the Muirkirk syncline the lower part of the Hawthorn is shaly in the Glenbuck region and becomes sandy to the south-west. *C. okense* has not been found at any exposures in this area. In North Ayrshire, the equivalent Dockra Limestone (Richey 1946) has been sampled at many exposures, but *Calcifolium* has not been found.

None of the other limestones in the west of Scotland has been proved to contain *Calcifolium*. This probably reflects more an absence of the specific environmental conditions required by these algae than a genuine stratigraphical control on their distribution, as elsewhere the two species have a much wider range (Short, 1954). Within this region, however, each species is confined to its own horizon, and on this basis the correlations shown in text-fig. 3 are proposed. Both limestone horizons are of P_2 age (Currie 1954). In the north of England, the genus was first recorded by Johnson, as 'Organism α',

in 1949 (Johnson 1958), from the Great Limestone (E_1) (which material he later assigned to a new species, *C. bruntonense* Johnson 1958). *Calcifolium punctatum* has not been recorded as such from the North of England. However, Short in an unpublished thesis (1954) records this species as '*Algae* β', from the Yoredales of the Alston Block. He gives the range of '*Algae* β' as Jew Limestone to Five Yard Limestone, with a maximum in the Tynebottom Limestone. He also records a form with a single row of punctations which he assigns to '*Algae* α' Johnson, ranging from Five Yard to Great Limestone.

C. punctatum thus ranges from high P_1 or basal P_2 (there is still some disagreement as to the base of P_2 in the Yoredales) up into P_2, to be replaced by *C. okense* and *C. bruntonense* which extend up into basal E_1.

In Russia (Maslov 1956), the genus *Calcifolium* is common in the upper part of the Okian series (P_2) and extends into the base of the Serpukhovian series (E_1, Ramsbottom 1957), only *C. punctatum* being present in the lowest beds and only *C. okense* in the Serpukhovian.

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REFERENCES

CARRUTHERS, R. G. and RICHEY, J. E. 1915. The Lower Limestones of Renfrewshire and North Ayrshire: a comparison and correlation. *Trans. geol. Soc. Glasg.* **15,** 249–64.

CURRIE, E. D. 1954. Scottish Carboniferous goniatites. *Trans. roy. Soc. Edinb.* **62,** 527–99.

JOHNSON, G. A. L. 1958. Biostromes in the Namurian Great Limestone of Northern England. *Palaeontology*, **1,** 147–57.

MACGREGOR, M. 1930. Scottish Carboniferous stratigraphy: an introduction to the study of the Carboniferous rocks of Scotland. *Trans. geol. Soc. Glasg.* **18,** 442–558.

MACNAIR, P. 1915. The Hurlet sequence in North Ayrshire. *Trans. geol. Soc. Glasg.* **15,** 200–48.

MASLOV, B. P. 1956. Calcareous algae of the U.S.S.R. *Trans. inst. geol. Science*, **160,** 1–301.

RAMSBOTTOM, W. H. C. 1957. Namurian goniatites in the U.S.S.R. *Geol. Mag.*, **94,** 305–11.

RICHEY, J. E. 1946. The Lower Limestone Group near Drumclog, Lanarkshire. *Trans. geol. Soc. Glasg.*, **21,** 49–60.

SHVETZOV, M. S. and BIRINA, L. M., 1935. On the petrology and origin of the Oka Limestones. *Trans. Moscow Geol. Trust*, **10.**

SHORT, K. C. 1954. The Geology of the Pennine Escarpment from Croglinwater to Ardale. Ph.D. thesis, University of Nottingham.

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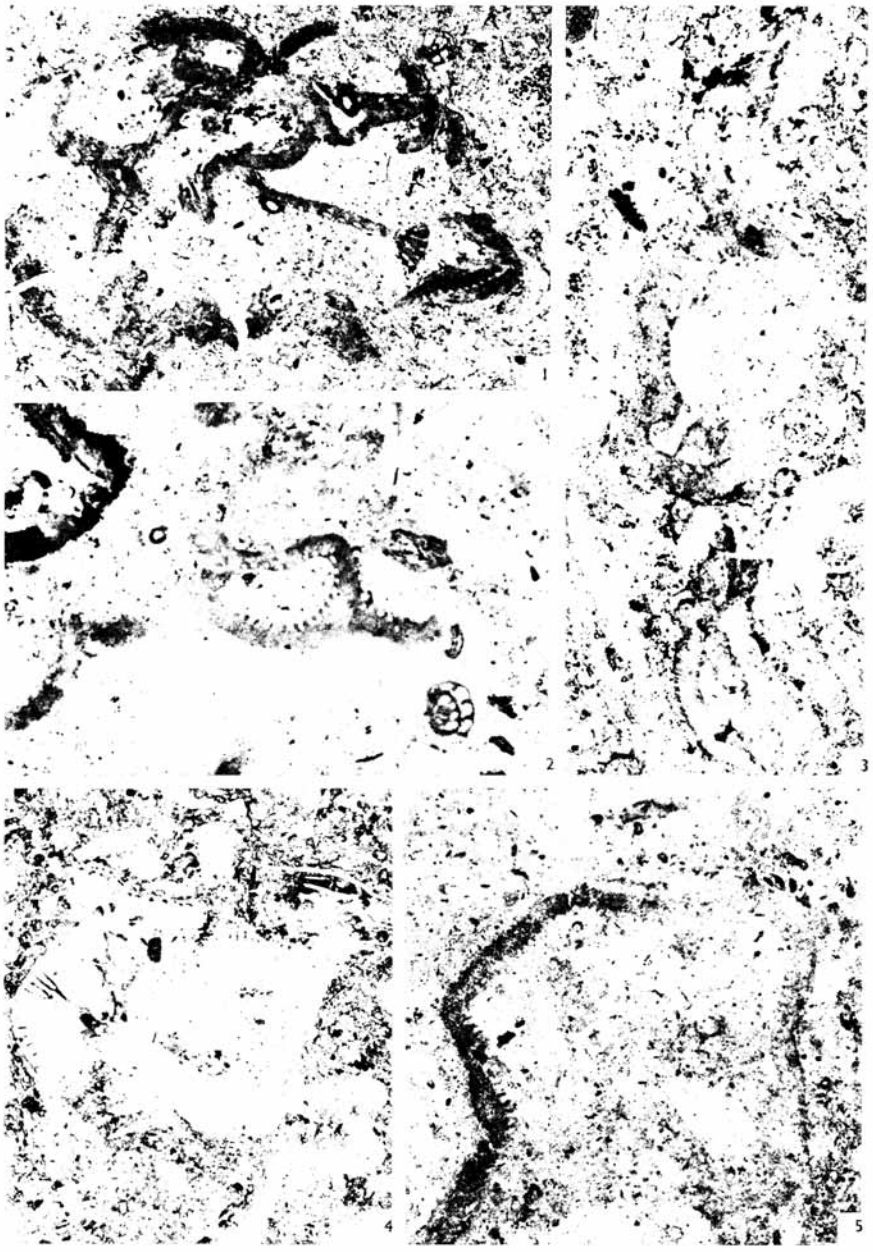
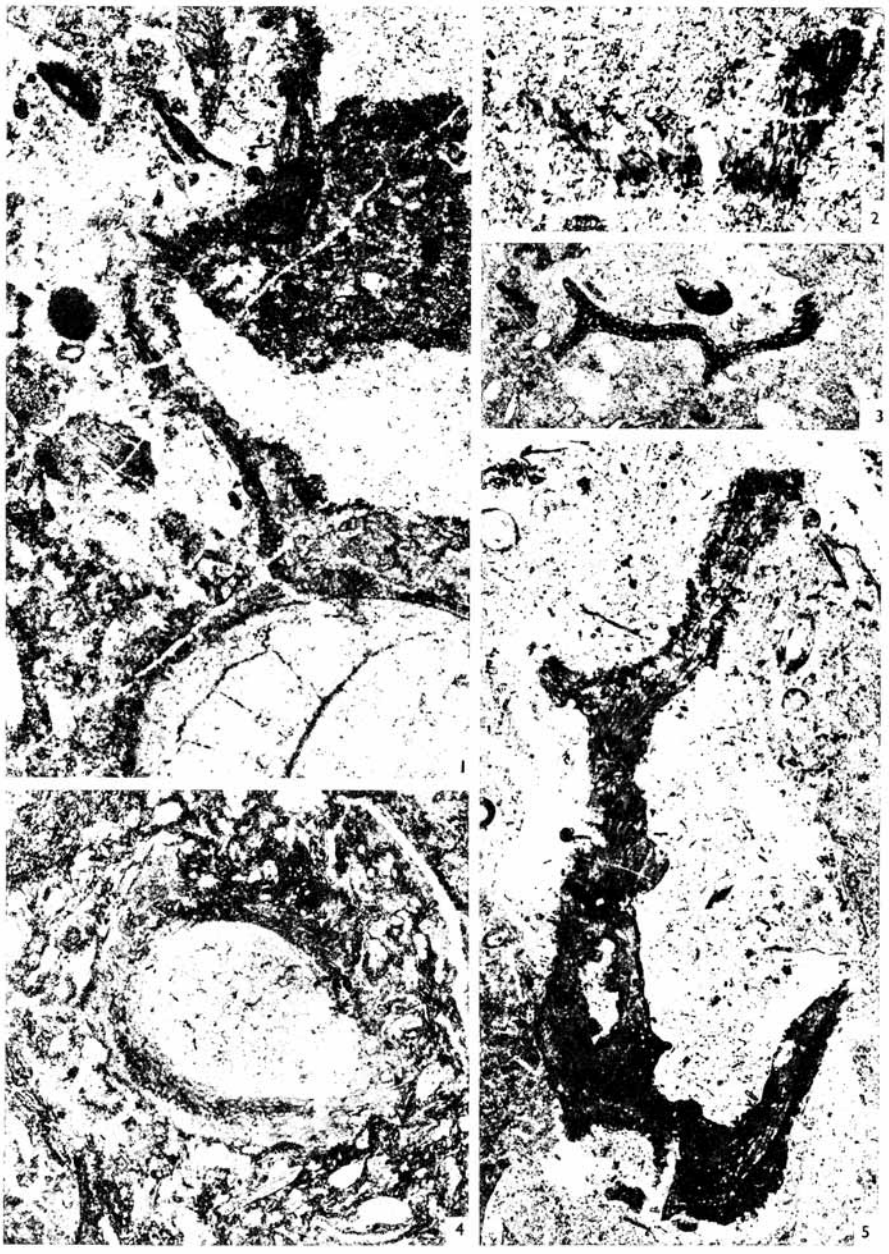


BURGESS, *Calcifolium*



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