THE BRITISH CARBONIFEROUS SPECIES OF *GIRVANELLA* (CALCAREOUS ALGAE)

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ABSTRACT. The type specimens, or topotypes, of the known species of *Girvanella* from the Lower Carboniferous rocks of Britain are redescribed. The two species found in the Girvanella Band in northern England are identical with those described by Wethered from the Avon Gorge, which occur at a very similar horizon. It is shown that the type of preservation and the amount of decay before burial affects appearances of the specimen in thin section, blurring specific characters. Various growth-forms of a species may be recognized, but such forms do not seem to be of value for stratigraphic work.

THE best-known occurrence of *Girvanella* is in the Carboniferous Limestone of northern England, where Garwood (1912, 1924) found algal nodules to be useful as horizon markers at a level which he took as the base of the D_2 zone. Though this Girvanella Band has been recorded over hundreds of square miles of north-western England, and bands have been found at a similar horizon in Derbyshire and in Northumberland, no specific names have been given by British authors to the forms occurring there, nor have their ranges in time or space been ascertained. This is due in part to the inherent difficulties of identification of such a featureless fossil, but even more to uncertainty as to the exact characters of the already named species. Garwood himself (1931) when describing a new species, *G. staminea*, from C_1 beds at Bewcastle, could only refer to the types found in the typical Girvanella Band as 'showing two sizes of threads', with a reference to his two figures of '*Girvanella sp.*' (1924). The position will be made easier in the future by the discovery of the type specimens of the species described by Wethered (1890) from the Avon Gorge, which were contained in a large collection of thin sections given by the late Judge Wethered to the University of Bristol. These were kindly put at my disposal by Professor W. F. Whittard. Though the original drawings did not show all the features which might be useful for specific identification, they were very accurate representations, and it has proved possible to pick out all the figured specimens of both species.

Perusal of Wethered's paper will show that he was chiefly concerned with the origin of oolitic granules. Already (1889) he had demonstrated that the pisoliths of the Pea Grit in the Inferior Oolite of Gloucestershire were of organic origin, and in 1890 he was concerned with both Jurassic and Carboniferous rocks, *Girvanella* being considered to be the main agent in the formation of ooliths. It seemed possible, he thought, to trace a series from clear examples of *Girvanella*, through those ooliths in which the *Girvanella* structure was in process of being destroyed, to ooliths with only a trace of organic structure, the end-member being perhaps those with a regular radial crystalline arrangement. This preoccupation with the origin of ooliths has introduced peculiar difficulties in the choice of a type specimen for *G. ducii*.

In these delicate species of *Girvanella* accurate comparisons can only be made on enlarged photographs, repeatedly checked under the microscope. A uniform enlargement of 450 diameters has been used. When whole-plate photographs are held side by

[Palaeontology, Vol. 6, Part 2, 1963, pp. 264–73, pl. 38–40.]

side, comparison is rendered easy. It becomes clear that there are a number of different growth habits among species whose internal and external diameters appear to be the same. When the eye can hardly observe these in thin section and the memory cannot retain the details while one slide is changed for another on the microscope stage, the practical value of these subtle differences almost vanishes. If more species were erected, based on those features which have become familiar to the writer through a long period of observation they would be unidentifiable by other workers, except when a full range of species was available for study. Consequently the present observations are limited to named species or figured specimens.

SYSTEMATIC DESCRIPTIONS

Girvanella wetheredii Chapman 1908 (= *G. incrustans* Wethered *non* Bornemann)

Plate 38, fig. 1; Plate 39, fig. 1

Diagnosis. Flexuous, winding, interlaced tubes, not observed to taper, wrapping around a central foreign body, perhaps also free. External diameter, measured on circular cross-sections, 0·013 mm. to 0·015 mm., internal diameter ranging between 0·006 and 0·009 mm. Closeness of packing variable; wall dark, fine-grained, thickness generally about 0·003 mm.; septa not observed. Branching occurring at a rather wide angle; sometimes the branches come off close together from the same side of the parent thread. In one case the branch bends round rapidly to grow subparallel with the others, in a manner reminiscent of *Garwoodia*.

Observations. Bornemann (1886) described the genus *Siphonema*, type species (here chosen) *S. incrustans*, from a pebble of Silurian limestone found in Pleistocene glacial drift and presumed to be from the Baltic area. This genus, as pointed out by Hinde (1887), was a synonym of *Girvanella*, so that *G. incrustans* of Wethered (1890) was invalid. Chapman (1908) noticed this and proposed the name *G. wetheredii* to replace it.

The original figures of this species were of the same specimen at different magnifications, one (1a) being reversed in reproduction. The slide in which the type specimen is contained has the locality 'B below New Rd.' engraved on the glass, and the labels read 'Carboniferous M. L. Clifton' and 'No. 1. B. Below New Rd. Dolomite'. The rock is a fragmental foraminiferal limestone, the matrix being of granular interlocking crystals of calcite whose grain size ranges between 0·01 and 0·05 mm. Scattered in the granular matrix are organic fragments ranging in size from 0·02 mm. to foraminifera 0·6 mm. across, and even larger fragments of brachiopods and gastropods. The algal growths occur around circular or slightly elliptical bodies about a millimetre in diameter, which are probably sections of Productid spines. These are hollow, with transparent fibrous walls which show a black cross under crossed nicols, and their centres are filled with matrix. A considerable amount of finely disseminated pyrite occurs in the algal growth, particularly near the nucleus, and this has invaded the material of the spine itself. Owing to the thickness of the section, the tubuli of *G. wetheredii* are difficult to make out, but they seem to have been continuous all round the nucleus, though dense structureless calcite intervenes between the nucleus and the visible threads. Similarly, tubes are difficult to discern in the outer layers. The whole gives an impression of a nodule formed by growth of various creatures around a common centre, some of which left no trace of their presence beyond a dense precipitate. Around the nodule a narrow discontinuous zone of clear calcite occurs, in continuity with a vein penetrating it, as if the nodule had shrunk slightly away from the surrounding matrix and the gap had been filled with material from solution.

One small portion of this algal nodule was figured at a higher magnification by Wethered, and is the portion in which the threads can be most clearly seen. It is figured in Plate 38, fig. 1, and is here chosen as the type specimen. The tubuli are more closely packed than in the other examples described later, and are confusedly interwoven. Probably they are cut parallel to the surface on which they grew, and they are seen to branch as they spread over it. Direct measurement on circular cross-sections of threads gives internal diameters varying from 0·006 mm. to 0·009 mm., with the average nearer the latter figure. The outer limits of the walls are extraordinarily difficult to determine owing to the slice not having been ground thin enough, but the two largest cross-sections approach 0·015 mm. in diameter while some are smaller, down to perhaps 0·012 mm. The photograph, which has not been touched up, but whose contrast has been increased by every possible means, gives an impression of clear definition not borne out when the specimen is observed by eye under the microscope.

Two other slides, both engraved with the words 'New Rd. Oolite', are almost certainly from the same bed, since they match the type slide in grain size, foraminiferal content, and especially in the algal growths being around identical nuclei. Since the slides are thinner the tubuli are more clearly seen, and an enlarged figure (Pl. 39, fig. 1) is given here. All the measurements discussed below have been taken from these two slides. In one case *G. wetheredii* occurs in contact with the nucleus, and in another it reaches the outer surface of the nodule. In all cases it seems to have had a general encrusting habit and to have taken a real part in the growth of the nodule. Layers of dense calcite devoid of tubuli are constantly present, as in the type specimen. The nucleus of one nodule is a piece of fragmental limestone with a clear crystalline matrix different from that of the rest of the section.

When enlarged photographs were studied it was found that cross-sections showing truly circular interiors were more rare than had been anticipated, most sections showing irregularities due probably to partial collapse of the external mould after death. Circular cross-sections showing the thickness of the wall were even rarer, usually one side or another being in contact with and blending into the dense matrix. It was interesting to note that measurements of internal tube diameter on longitudinal sections were on the average slightly over 0·001 mm. less than those measured on circular cross-sections, while measurements of the external diameter measured in the same way were in error by nearly 0·002 mm. Presumably Wethered made his measurements on longitudinal

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EXPLANATION OF PLATE 38

Fig. 1. *Girvanella wetheredii* Chapman. Type specimen (here chosen). Branching can be seen in three places. Upper D_1, Avon section, Bristol. Geological Survey Collection, GSM. PF1923.

Fig. 2. *G. staminea* Garwood. Type specimen. Tubuli indistinct for reasons discussed in text. C_1, White Beck, Bewcastle, Cumberland. British Museum (N.H.) Collection, V43735.

Fig. 3. *G. ottonosia* Pia. Topotype. Branching visible near the centre of the photograph. Km, Avon section. Geological Survey Collection, GSM. PF2047.

sections, since he stated that the diameter was 0·01 mm. The thickness of the wall varied from rather over 0·0015 mm. to 0·003 mm., the latter being nearer the average figure.

The two slides from the Wethered collection show slightly different growth habits or types of preservation. In one the tubes remain for relatively long distances in the plane of the section. In the other, cross-sections of the walls are more obvious, and the impression of free and rapid growth parallel to the surface of the nodule is less strong. The tubes also appear to be more contorted. There is no doubt that both specimens are from the same level, perhaps from the same hand specimen, for the reasons given above. A similar range of variation in appearance can be seen in specimens from the Girvanella Band at Hull Pot, Yorkshire, in the Garwood collection in the British Museum, Natural History (Slides V43730 and 157B). The difference in appearance probably depends in part on a small variation in thickness of the thin section, but also is likely to depend on an original slight difference in the position of the threads with respect to the angle at which light fell on the algal nodule and also, perhaps, to the influence of competing organisms. In other cases, the threads are well separated and even more contorted. This is well seen in the specimen figured by Garwood in 1924 from Hull Pot in which the tubes are rendered conspicuous by a dark coating, and their contortion and the degree of separation are noteworthy. It seems likely that this specimen is conspecific with Wethered's specimens, since similar variations in degree of contortion have been described in *Girvanella problematica* itself (Wood 1957).

As stated in the introduction, *G. wetheredii* has not been positively identified since Wethered's time, though in 1932 Pia, who had made collections from the Carboniferous Limestone of England, stated that in his opinion *G. staminea* Garwood was identical with '*G. incrustans*'.

Type specimen. Figured on Plate 38, fig. 1, deposited in the Geological Survey Museum, South Kensington, GSM. PF1923.

Locality. A bed of dark nodular limestone, with argillaceous material, 9 inches thick, immediately below an oolitic bed 10 feet thick, a short distance below the junction of the road from Clifton with that along the banks of the River Avon. Upper D1 (Reynolds 1921, pp. 233–4). National Grid Reference 31/563734.

Girvanella ottonosia Pia 1937

Plate 38, fig. 3

Diagnosis. Highly contorted flexuous tubes, circular in section, forming a pellicle around a foreign body with a digitate *Ottonosia*-like outer surface. External diameter of tubes usually about 0·007 mm., internal diameter 0·004–0·005 mm., wall thickness 0·001–0·002 mm. Occasionally one tube may be as much as 0·007 mm. in internal diameter, but in general the threads are remarkably uniform in size. Branching apparently dichotomous, but contorted, usually at an angle of less than 40°.

Observations. The specimens are preserved in a fragmental limestone, consisting of crinoid ossicles and plates, broken gasteropods, polyzoa and lamellibranch shells, enclosed in a granular calcite matrix. Brachiopods are apparently absent. The matrix is of two types, one yellowish in transmitted light, probably nearly in its original state except as modified by grain growth, average grain size 0·02–0·03 mm., and a clearer more translucent portion irregularly dispersed around and among the organic fragments.

This is slightly coarser and probably represents a cavity infilling. The range of size of the organic fragments is from 0·2 mm. upwards to 7 mm., the size of the largest algal nodule. The rock was probably rapidly deposited as a mass of transported fragments in a cloud of fine silty calcite which partially filled the interstices between the fragments.

The algae are preserved as thin coatings on polyzoa and around recrystallized lamellibranch (?) shells. The coating ranges in general from 0·3 to 0·5 mm. in thickness (maximum 1·4 mm.), and displays the digitate outer margin described by Pia. Sections parallel to the surface of the alga show that the projections are irregularly peg-like, rather than parallel-sided wrinkles. The spaces between the outgrowths were certainly present before burial; they are filled generally by the yellowish original matrix described above and occasionally by the later clear drusy grains. The algal growth must have been quite stiff and crisp to withstand transport and to retain this surface appearance. There is not sufficient evidence that the algal threads originally grew parallel to the present outer margins of the projections, though occasional portions of a section suggest this. On the other hand the interstices do not have the form of later burrows which had destroyed part of a once continuous coating. The absence of growth parallel to the margins may be due to the former presence of a living, uncalcified layer, which decayed before fossilization; certainly the whole series of outgrowths gives the impression of being an original feature.

Locality. Lower Limestone Shales, Km, Avon Gorge (Clifton Side), Bristol.

Material. Four slides from the Wethered Collection, labelled 'Lower Limestone Shales, Clifton, Bristol', or some variant of this. Figured specimen in the Geological Survey Museum, GSM. PF2047.

Girvanella staminea Garwood 1931

Plate 38, fig. 2; Plate 39, fig. 2

Diagnosis. Flexuous winding interlaced tubes, not observed to taper, wrapping around a central foreign body. External diameter, measured on circular cross-sections, 0·011–0·013 mm. internal diameter 0·006–0·008 mm. Closeness of packing variable, wall dark, fine-grained, thickness about 0·003 mm., septa not observed. Branching occurring at a wide angle.

Observations. The type specimen forms part of a single composite algal nodule, without matrix, showing a well-preserved specimen of *Garwoodia gregaria* (Nich.) enveloped by a thin layer of *Girvanella* threads. These extend in varying states of preservation nearly around the central spherical alga, being separated at intervals by thin layers and irregular blebs of clear calcite, often showing traces of organic structure. This *Girvanella* layer is in turn surrounded by another organically deposited portion which forms the outer part of the nodule. In this there are a variety of encrusting organisms, worm tubes,

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EXPLANATION OF PLATE 39

Fig. 1. *Girvanella wetheredii* Chapman. Topotype. To show growth habit. Compare tube-diameter and growth habit with *G. staminea* (below). Upper D_1, Avon section, Bristol. Geological Survey Collection, GSM. PF1925.

Fig. 2. *G. staminea* Garwood. To show tube size, branching, and general growth-habit. Compare with *G. wetheredii* (above). ? C_2, Cambeck, Spadeadam, Cumberland. British Museum (N.H.) Collection, V43734.

'bean-shaped organisms', and a few small, nearly stifled layers of *Garwoodia*. The nodule was thus formed in a period to be measured in months rather than weeks. Growth of the *Girvanella* layer, itself only an insignificant portion of the whole, was interrupted by colonization of other organisms or by boring creatures or both, which gave rise to the clear patches described above.

Though the slide is labelled 'too thick' in Garwood's handwriting, the polarization colours of the clear calcite infilling of the *Girvanella* tubes are bright, and the indefinite appearance and lack of character of the algal tubes must be ascribed to partial decay before lithifaction. The nodule must have lain on the sea floor for some time, and colonization by other creatures would affect the preservation of this specimen if only by the penetration of their basal cells. Much, if not all, of the indefinably different impression this specimen gives is to be explained in this manner.

The original diagnosis is: 'This species is distinguished from other Carboniferous species previously described by the minute size of its tubes, which measure 0·006 mm. in diameter.' It is certain that Garwood made his measurements on the bright circles which represent infilled cross-sections of the tubes, and thus give the internal diameter of the threads. All previous measurements of species of *Girvanella* had been made on the threads as seen in longitudinal sections, including the thickness of the wall. Because of the close packing of the threads in this specimen, and because of subsequent changes, longitudinal sections are always indefinite. A few cross-sections of the whole thread can be distinguished; and the measurements cited above fall into the range of variation of *G. wetheredii*, as do the measurements of internal diameter.

Nevertheless, other better-preserved material from north Cumberland contained in the Garwood collection seems to show that a species with slightly slimmer threads than *G. wetheredii* is characteristic of this horizon in Cumberland. The specimen figured on Plate 39, fig. 2 is from Cambeck, Spadeadam, north Cumberland, and is said by Garwood to come from a horizon in C_2. Reference to Garwood's map (1931) will show that this locality is only just above the Main Algal Series, from which the type specimen of *G. staminea* was obtained. In the Cambeck specimen well-preserved *Girvanella* threads closely envelop a *Garwoodia* nodule, and are enclosed in a fine-grained bioclastic limestone containing occasional tiny rounded quartz grains. They closely resemble the type specimen in appearance, growth, habit, and even in the ecological niche they have chosen to inhabit. The preservation is good, the threads are clear, and branching can be seen.

Comparison with the figures of *G. wetheredii* shows that the average diameter of the threads is slightly less, though the growth-habit is similar. Such a difference may be due to a differing environment, but it seems more probable that there was a real, though by now almost inappreciable, distinction between the C_1 and C_2 species and that characteristic of the upper part of the D_1 and base of the D_2 zones.

Type specimen. Figured on Plate 38, fig. 2, deposited in the British Museum (N.H.), V43735.

Locality and horizon. 'Main Reef', Main Algal Series; White Beck, Bewcastle, Cumberland; C_1.

Girvanella ducii Wethered 1890

Plate 40, figs. 1–2

Diagnosis. Gently flexuous tubes, generally loosely interwoven or not in contact, sometimes closely wrapped around a foreign body. External diameter, measured on circular cross-sections, ranging from 0·026 to 0·033 mm., average 0·029 mm., internal diameter ranging from 0·015 to 0·020 mm., average 0·018 mm. Wall dark, fine-grained, thickness generally about 0·006 mm., branching irregularly dichotomous, at a varying angle. No cell-walls observed.

Observations. The original figures of *G. ducii* were from three different thin sections and two localities. I here choose the original of Wethered's figure 2*a* as the type; this specimen is figured on Plate 40, fig. 1. It occurs in a fragmental limestone, in which the majority of organic fragments have a pellicle of algal or inorganic radial fibrous coating up to 0·1 mm. thick. The fragments are often rounded and range in size from 0·05 mm. to nearly 1 mm. in diameter, the latter being rare. The average grain size is about 0·4 mm. Some foraminifera, in particular, have no precipitated layer around them. The fragments are closely packed, but rarely in contact, and the matrix is transparent and granular, with an average grain size of about 0·01 mm. The minute nodule containing *G. ducii* is the largest fragment in the slide, measuring 2·8 mm. in longest diameter. The margins are dark and composed of fine-grained 'algal dust' in which threads of *G. ducii* occur, while the centre is occupied by clear calcite similar to the matrix and containing similar murky ooliths and organic fragments. In the clear calcite near the centre, tubuli of *G. ducii* are common, and are not so closely packed as in the less transparent margins. There is no suggestion of a concentric arrangement of the threads, but this may be due to the nodule being irregular in shape and excentrically cut. This suggestion is supported by the presence of ooliths in the apparent centre of the nodule. Branching is not seen in this specimen.

Wethered stated that the diameter of the tubuli was 0·02 mm. Measurement on his figure 2*a* gives a diameter of 0·03 mm. for the external diameter of the larger cross-sections, a figure which is substantiated by the present measurements (see above). It is, however, particularly noticeable that the threads seem to be of greater external diameter when they are not touching, and are surrounded by clear calcite. This fact has not affected the measurements given in the diagnosis above, since it happens that only one cross-section occurs in this region, but it is very noticeable when measurements are made on longitudinal sections of threads. These measurements in the dense closely packed regions average 0·027 mm. for external diameters, while in the clear area with loosely packed threads, the average is slightly above 0·030 mm., with a maximum of 0·035 mm. In each case the threads were measured at the point of greatest diameter and greatest interior brightness, this being presumed to indicate nearness to a median section. The difference is probably due in the main to the outermost boundaries of the walls being easily visible in the areas of clear calcite, while they are taken to be part of the matrix in the more crowded regions.

The second specimen figured by Wethered (fig. 2*b*) shows rather indistinct tubuli

EXPLANATION OF PLATE 40

Figs. 1–2. *Girvanella ducii.* Wethered. 1, Type specimen (here chosen). Tubes winding loosely in a fine-grained limestone with cavity infillings. Upper D_1, Avon section, Bristol. Geological Survey Collection, GSM. PF1924. 2, Specimen from Girvanella Band, Yorkshire, to show growth-habit and tube diameter identical with the Bristol specimen. Base of D_2, Hull Pot, Pen-y-Ghent, Yorkshire. British Museum (N.H.) Collection, V44935.

partly enveloping a compound nucleus. The internal diameter of the tubuli is between 0·017 mm. and 0·020 mm., and they are surrounded by a dense structureless 'algal dust'. The largest diameter of the whole granule is 0·7 mm. The chief interest of this specimen is that it shows that *G. ducii* could grow concentrically around a nucleus and envelop it, as do other species of *Girvanella*. The tubes are markedly less flexuous than in *G. wetheredii*, and they lie at one side of the nodule only. This may well be due to attrition before fossilization.

The original of Wethered's figure 2*c* came from Tortworth Park, Gloucestershire, and is an algal aggregate enclosed in radially disposed calcite crystals. It occurs in an oolitic limestone in which every organic fragment is covered with a thin layer of radiating crystals; the matrix is entirely recrystallized. It is clear that the fragment of *Girvanella* is detrital and had been rounded before being incorporated into the sediment. Unfortunately no circular cross-section of the threads is visible. However, there is no doubt that the tubuli are markedly thinner than in the type specimen, measuring only 0·016 mm. in external diameter on longitudinal sections, and they must belong to another species. The internal diameter measured in the same way varies from 0·008 to 0·010 mm.

The choice of a type specimen is not entirely straightforward. On p. 272 of Wethered's paper a measured section of the New Road Oolite is given, six beds being listed. Concerning the topmost bed, he stated 'a form of *Girvanella* was here discovered to which I propose to give the name of *Girvanella Ducii*, for reasons to be presently explained. It consists of an aggregation of tubules similar to those represented in Pl. XI. figs. 2*a* and *b*; but in this instance the outlines are to a large extent obliterated by mineral changes. . . .' On page 273 he wrote, when describing bed 3, 'In this bed we again meet with the organism I propose to call *Girvanella Ducii*, occurring in loose aggregations as represented in fig. 2*a*.' At first sight it seems difficult to come to any other conclusion than that the type specimen must be that first mentioned by Wethered, unfigured and undescribed. However, when one considers his interest in the origin of ooliths, and the fact that the measured section was described in logical order from above downwards, it becomes apparent that *Girvanella ducii* was here referred to as an agent in oolith formation, without any intention of making a type specimen from among the tubules of Bed 1.

The specimen figured by Garwood (1924, pl. xix, fig. 2) from the Girvanella Band at Hull Pot, Penyghent, is undoubtedly *G. ducii*. A similar specimen from the same locality (B.M.N.H. slide V44935) is identical with the type specimen in dimensions, growth habit, and branching. It is made up of a lax aggregation of tubes forming a small part of a typical 'algal' nodule, 15 mm. long, which shows a series of irregular concentric layers around a fragment of a brachiopod shell. The whole is contained within a fragmental foraminiferal and crinoidal limestone.

The fact that Wethered gave an incorrect diameter for the tubuli of *G. ducii* might well have led to confusion, but fortunately no other species has been named from Carboniferous rocks with a tube diameter of 29 μ. Indeed most authors, including Maslov (1956), quote diameters of around 20 μ for the specimens they ascribe to *G. ducii*. The growth-habit of the specimens from the Urals, and those figured by Dangeard (1948) from Belgium is closely similar to that of typical *G. ducii*, and the difference in external diameters requires explanation. Part of the difference may be explained by other workers measuring tube diameter on longitudinal sections, rather than on cross-sections and a part may be due to grain growth in the matrix of the limestone, whereby the outer part of the calcareous envelope has been taken over and incorporated in the crystals around.

G. liebusi Paul is stated to have a tube diameter of 20 μ. It is interesting to note, in view of the remarks given above concerning the preservation of *G. ducii*, that Paul (1938) stated that his species with elongated weakly curved threads did not build nodules, and thus is separated from other forms of *Girvanella*, though the threads were individually identical with those of *Girvanella* so that a generic distinction was not possible. Later in 1938 he added that this alga was found in a coarsely crystalline limestone with foraminifera, a habitat that algae usually avoid. In this respect too it is similar to *G. ducii* and the limestone figured does not look any coarser than the beds in which *G. ducii* usually occurs. In view of these facts, and the incorrect magnification given by Paul for the type figure (the true magnification is around 25 diameters) it is possible that *G. liebusi* is synonomous with *G. ducii*.

Both Dangeard (1948) and Maslov (1935) mention the occurrence of cell walls transverse to the tubes, in specimens they consider to belong to this species and Dangeard gives a fine photograph of these. Similar features are occasionally seen in specimens from Britain, but observation is very difficult at the magnifications that have to be employed, and the present author has not been able to feel certain that they are not simply the boundaries of the relatively more clear crystals filling the interior of the tubes.

Though this form has frequently been referred to by other authors, for example Pia (1932, 1937) and Johnson (1945), the original incorrect statement concerning the tube diameter necessitates a re-examination of the evidence in each case.

Type specimen. Figured on Plate 40, fig. 1, deposited in the Geological Survey Museum, GSM. PF1924.

Locality. A bed of blue limestone with some oolitic spherules, 2·5 feet thick, lying immediately below the thin dark limestone with *G. wetheredii*. Upper D_1.

Girvanella nicholsoni (Wethered) 1886

This appears to be a rare species, and there is nothing new to add to the description given by Wood (1941).

NOTE ON THE 'GENUS' *GIRVANELLA*

Johnson (1946) considered the present author's use of the generic name *Girvanella* for so coarse a species as *G. nicholsoni* 'unfortunate'. There can be no doubt that the various species included above in one genus are not congeneric. *G. ottonosia* Pia, for instance, with strongly contorted minute tubuli and peculiar growth habit is very different from *G. ducii* Wethered. The latter does, however, have many characters in common with *G. problematica* Nich. and Eth., the type species. At some time in the future it will be necessary to split off the forms with highly contorted minute threads as a separate genus, and at that time the form with very wide tubuli now called *G. nicholsoni* could conveniently and logically resume the name *Mitcheldeania*, at present suppressed as a synonym.

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Manuscript received 8 August 1962

1

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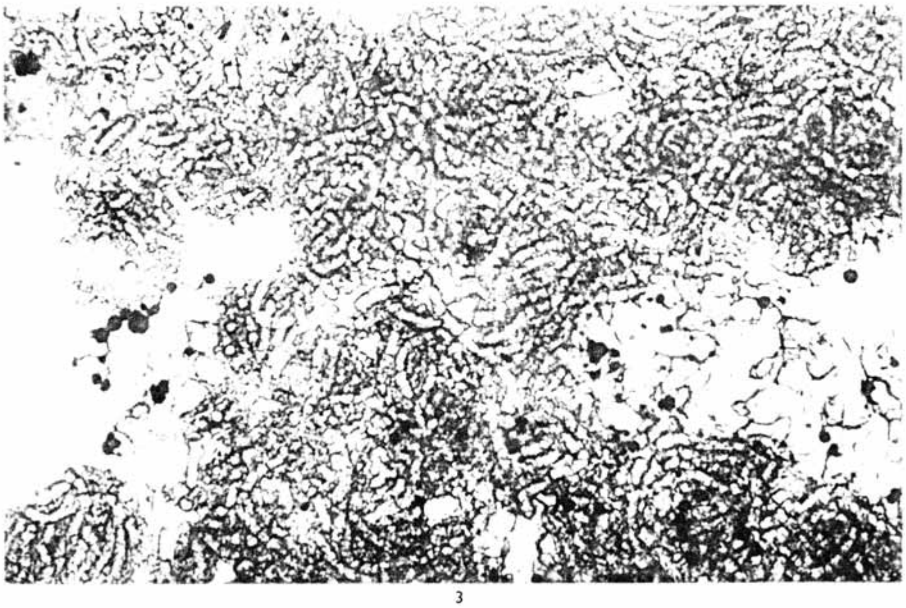

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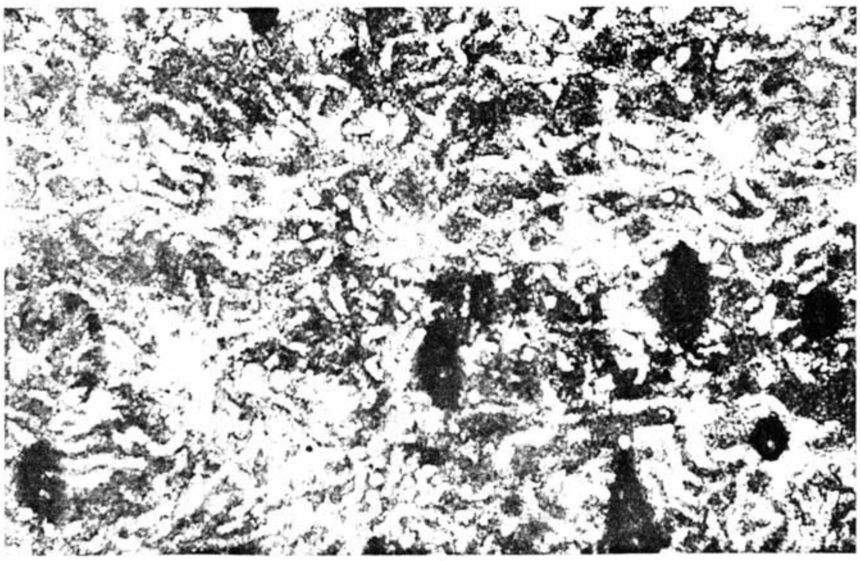

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WOOD, *Girvanella*

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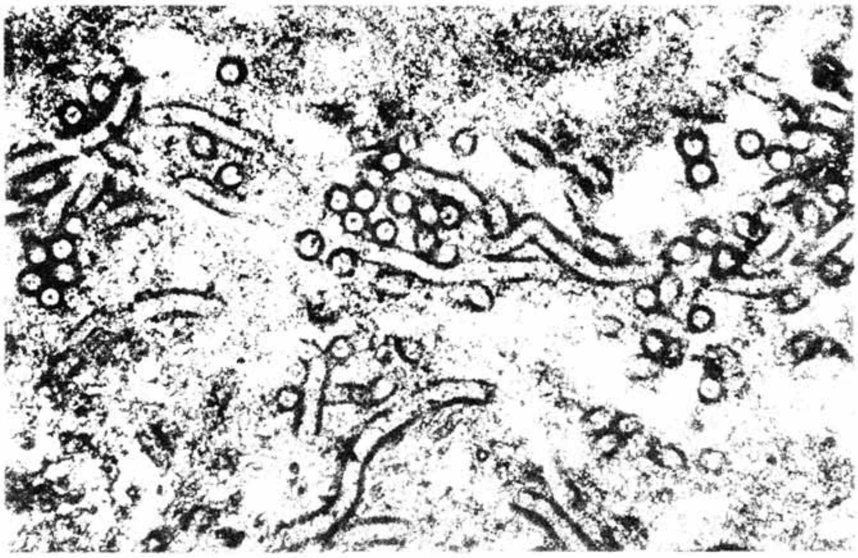

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