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Section IV-Controversial algal fossils

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SECTION IV—CONTROVERSIAL ALGAL FOSSILS

A. GENERAL

Two groups of what are presumed to be fossil algae, have been found in the rocks of the Cape System. The older were discovered recently and constitute the only known probable plant records from the Table Mountain Series. The second, *Spirophyton*, has long been regarded as an index fossil ranging from the Upper Bokkeveld to Middle Witteberg Series but its vegetable origin has been seriously questioned from time to time and is not now generally accepted. The subject is re-opened here because there has been a complete absence of adequate illustrations to accompany the previous discussions and also because many of the South African *spirophyton* appear to be incompatible with an invertebrate origin.

B. ALGAE?

1. cf. *Tontalia zollneri* Frenguelli

Plate XX figs. 1-4

Specimens T.D. 28a and T.D. 28b

Locality: De Doorns

Horizon: Upper Shale of Table Mountain Series

At Present: Geol. Surv. Museum Pretoria and Univ. of Witwatersrand Palaeo-botanical Collection.

The specimens figured on Plate XX are from the upper shale of the Table Mountain Sandstone at De Doorns, Western Cape Province, and are therefore probably of Upper Silurian age. They were collected by J. N. Theron of the Geological Survey and sent to me for determination. There were two small pieces of weathered, dark grey, somewhat carbonaceous shale, numbered TD. 28a and b, but these have been split further to expose fresh bedding planes.

The shale is not very fissile but on each rather uneven bedding plane a number of ramifying sinuous strands can be seen which do not appear on any vertical surface. On weathered surfaces Pl. XX figs. 1 and 2 they stand out well, being darker than the bleached matrix. They are also of slightly different texture and raised because the mineralisation is harder than that of the surrounding rock. On fresh surfaces the marks are far less conspicuous except when the rock is wet and the ramifying strands are then much lighter in colour than the matrix. The photograph on Pl. XX, fig. 4 of spec. 28b is of a fresh surface photographed under water. It represents the unweathered surface on the underside of the specimen in fig. 2 and is oriented in the same way. It can be seen that the

markings on the two surfaces do not coincide in any way although the rock is less than 1 cm in thickness. The two surfaces of specimen 28a are even less alike. The strands vary in width from 0.5 to 0.9 mm but average 1 to 1.5 mm. They increase in width from the base upwards but the increase is not constant and they may swell or decrease a little. They branch, either dichotomously or laterally, and each branch terminates bluntly. In addition a few small projections, simple or branched, can be seen. An almost constant feature of each strand is a narrow central mark in the form of a groove, a ridge or a change in colour (see Pl. XX fig. 2).

On the fresh surfaces the appearance is different for very fine grains of pyrite can be seen, under magnification, concentrated along the centre of some of the strand. Others in which the pyrite is no longer visible have a faint brown iron stain outlining each margin.

The organic origin of these markings is not at all certain but is probable. If they had been due to sun cracks in the rock and to subsequent mineralisation along them, it would be difficult to account for the shape and nature of the separate short branches but of greater significance is the fact that the strands are confined to one surface and do not run through any thickness of the rock. They have neither the appearance nor the mineral composition of dendrites and cannot be attributed to small invertebrate trails, since the fluctuating widths and the branches could not be explained. I conclude therefore that these ramifying strands are in all probability of vegetable origin and represent branched cylindrical algal thalli.

In De Doorns specimens no marked directional growth can be seen although the branching in the upper half of Pl. XX fig. 1 is suggestive. It is shown enlarged in fig. 3. The surfaces available are, however, very small. In any case a thick growth of overlapping plants would mask the growth pattern of individuals. The central mark suggests tubular algal filaments with thick walls, or alternatively a vascular strand in primitive land plants, but the former is far more probable.

2. Discussion and Comparison

Tontalia zollneri from Argentina

Non-calcareous algae are far less common in fossil form than calcareous because the soft vegetative body is not easily preserved but some are known from a number of countries and are of many different ages. Very few have been described from the southern hemisphere but one from Argentina, *Tontalia zollneri* was described by Frenguelli (1952b) from the western part of the pre-Devonian Sierra de Tontal, which not only supports an organic origin but provides evidence of relationship, if not of actual specific identity, with the T.M.S. specimens.

Frenguelli stated that he knew of no similar algae of recent origin but suggested comparison with *Polysiphonia* of the Rhodophyceae. A very close parallel can be drawn between the South American and the Cape specimens.

Both had an elongate, cylindrical, tortuous thallus of comparable size branched both dichotomously and laterally. In both, the thalli were narrow at the base and broadened upwards to a rounded apex which Frenguelli suggested could be terminal sporangia. The Cape specimens fluctuated more in width than those from S. America. The distribution of thalli in both was haphazard. An important difference in form was that some of the thalli of Frenguelli's plant showed sub-regular transverse divisions which are not visible in the South African specimens. In preservation too there is a marked similarity. In both, the sinuous strands were dark in colour on a light background, both were raised above the surface, both were cylindrical and showed a concentration of iron. In *Tontalia* the central column was filled with quartz and the outer zone was carbonaceous but with an iron oxide stain. There were many small carbon particles in the matrix also.

The age of the Argentinian specimens is uncertain. They were classed by Frenguelli as probably Ordovician, being regarded as considerably older than the base of the overlying upper Devonian formation.

At the Internat. Geol. Congress in New Delhi in 1964 I was able to submit photographs of the Cape specimens to Prof. A. Amos of the Geology Department of the University of Buenos Aires who made the interesting observation that the same or very similar fossils occurred in the Furnas sandstone of Argentina in definite ecological and biogenic horizons. Since the Furnas Sandstone is regarded as the South American equivalent of the Table Mountain Sandstone the comment has an important significance. Frenguelli's specimen is No. 5307 in the Palaeobotanical Collection of the University of Buenos Aires.

From the northern hemisphere the most comparable fossil known to me is the genus *Buthotrephis*. The type specimen *B. gracilis* was described by Hall (1843) from an Ordovician limestone of New York State, and has been refigured by Banks (1961 Pl. 35) who described the plant together with another species from the Ordovician of Ontario as follows: "Thallus bush-like without any definite main axis, fasciculated from a broad attachment. Laminae (flattened branches) relatively broad, nearly constant in width, sinuately curved. Branches and lobes divided somewhat irregularly, sometimes branch dichotomously, sometimes branch laterally at moderate to wide angles. Apices of branches blunt, rounded." From this description and from the figure a number of features can be seen to be common to the Cape and American specimens. Another species *B. nidarosiensis* was described by Hoeg (1941 p. 188) from the Ordovician of Trondheim in Norway. His figure is even more like that from the Cape but the resemblance is less close than that between the two southern hemisphere fossils.

The range of *Buthotrepis* is given by Banks and Hoeg as Ordovician or Silurian. Kräusel and Weyland (1962 Pl. 30-33) have illustrated somewhat similar non-calcareous ramifying filamentous algal and psilophytic plants e.g. *Thamnocladus mosellae* and *Dawsonites jabachenis* from Lower Devonian beds in Germany but the former are smaller and the latter more stranded than the Cape specimens.

If the specimens from De Doorns are of vegetable origin as seems probable, they are the first plant fossils known from the Table Mountain Series but until better specimens are found an undisputed organic origin cannot be accepted. They have been figured and described with the object of encouraging further collecting.

C. SPIROPHYTON

Pls. XXI—XXVI

1. Brief History and Summary of the Controversy

It is probable that no single fossil or pseudo-fossil in Africa has given rise to more controversial discussions than the spiral markings known as *Spirophyton*. The arguments have centred in the origin—whether it was organic or inorganic and if the former, whether it was of animal or plant origin. Its stratigraphical value, within the Cape System of South Africa has never been questioned.

(*a*) 1842-1895—a vegetable origin assumed.

The earliest authors never doubted the vegetable origin of *Spirophyton*. According to Seward (1903) it was described first by Vanuxem in 1842 from Cauda Galli Grit of the Ithaca group, Madison County and later refigured by Hall 1863 under the name *Spirophyton Cauda-Galli* Vanuxem, being described as a *Devonian plant consisting of a slender axis bearing a thin and broad, spirally disposed "phyllome"*. This description does not altogether fit the Cape specimens but I have been unable to compare the original figure.

Dawson (1881) stated that *Spirophyton* had been found not only in the Cauda Galli grits of New York but also in Gaspe, N.Y., where it ranges from Upper Silurian to Lower Devonian. He made reference also to a plant of the same genus found by Prof. Hartt on the Rio Tapajos in Brazil in beds which had been referred to the Carboniferous but which he suspected to be of Upper Devonian age. This plant was named by Dawson, *Spirophyton brasiliense*. It is the only record known to me of *Spirophyton* in South America and I have been unable to confirm it.

It has been recorded from the Ordovician and from the Silurian of Australia but I have been unable to obtain the reference.

Dawson (1881) illustrated a specimen from the Middle Devonian of New York State which is definitely comparable with certain aspects of the South African *Spirophyton*.

In the 1st Annual Report of the Geological Commission of the Cape of Good Hope (1896), the Director Dr. Corstorphine drew attention to a peculiar alga referable to *Spirophyton Cauda-galli* of New York. He stated that one of his

geologists, Schwarz, had first drawn attention to the close similarity and considered the specimens from the two widely separated areas, to be identical.

(*b*) 1895 Invertebrate borings proposed.

Meanwhile Fuchs (1895) had suggested that the markings of the overseas specimens were due to the spiral borings of an invertebrate, probably a worm, in sand.

(*c*) 1903 Inorganic origin due to eddying water.

A number of South African plant fossils which included specimens of *Spirophyton*, was sent to Prof. Seward of Cambridge by the Director of the Geol. Commission of the Cape of Good Hope. The *Spirophyton* had been collected $\frac{1}{2}$ mile N.E. of Touws River Station on the farm Zoutkloof, 3 miles ESE of Ladismith, on the north bank of the Touws River at Letta's Kraal. The results were published in the Annals of the South African Museum in which Seward (1903, and Pl. XIV, figs. 1 and 2) figured two drawings of *Spirophyton* which until recently remained the only published illustrations of South African origin known to me. In this publication (p. 103) he expressed the opinion that the markings were merely pseudo-fossils, having an origin in the passage of an eddying current of water through a small vertical channel in the sand and stated that similar markings occurred in rocks of all ages.

(*d*) 1903 Vegetable origin reiterated in South Africa.

To this expression of opinion Dr. Rogers replied (1903 Rogers and Du Toit footnote on p. 16). "Mr. Seward concludes that *Spirophyton* was inorganic in origin, an opinion that is not concurred in by the staff of the Commission on account of the clear definition of the better specimens and the inadequate explanation offered on the supposition that they were of mechanical origin."

Most South African geologists continued to believe in an organic and preferably a vegetable origin. This was expressed by Du Toit who had perhaps a wider experience of S.A. formations than any other geologist of his time, and stated (1926, p. 198) "there could be little doubt that it is a vegetable impression, good examples having recently been obtained showing superimposed individuals spiralling in opposite directions". I have not seen any specimens exhibiting this feature since spiralling in one direction on a single surface has been consistent in all the specimens I have examined.

(*e*) 1954-1962 Modern view of worm-feeding burrows.

In the third edition of the Geology of South Africa, edited by Haughton (1954), he accepted the now current view stating that the S.A. *Spirophyton* was "identical with the N. American *Spirophyton* that characterises the Middle Devonian particularly and that is now recognized as having been produced by the burrowing worm *Taonurus*".

An animal origin is supported also by Hantzschel (1962 p. 220) who states emphatically that *Spirophyton* is a synonym of *Zoophycus* Massalongo 1855 and that it consists of feeding burrows formed possibly by worms. The illustration provided was a reproduction of the drawing by Dawson (1881).

(*f*) Plant origin still favoured in South Africa.

Meanwhile several South African geologists working in the Cape fold belt are still strongly in favour of plant origin. It is absurd that so marked a difference of opinion should have remained after a lapse of seventy years and it is probably due to the extreme scarcity of illustrations of *Spirophyton* not only in South Africa but throughout the world. It is possible that different authors may have been describing quite different objects. For this reason brief descriptions of the various forms of the fossil to which this name has been applied in South Africa, together with a series of photographs should serve a useful purpose especially since as far as can be ascertained *Spirophyton* has a greater development in South African Devonian rocks than elsewhere. It is only by these means that it will be possible to assess the validity of the views expressed by the various authors.

2. *Spirophyton* in South Africa

Stratigraphical occurrence and environment

It used to be believed that *Spirophyton* was confined to the Witteberg Series, being particularly common in the Main Witteberg quartzite. It is now known to be equally and possibly more common in the upper part of the Bokkeveld Series where it occurs in both sandstones and shales. Swart (1950) recorded that in the Wuppertal district of the western Cape, *Spirophyton* was actually more common in the 3rd Bokkeveld shale than in the Witteberg. In this area the Witteberg follows the 6th Bokkeveld shale conformably so that the fossils range from a marine through possibly brackish to what has been accepted as a fresh water environment. The presence of occasional trails and of fragments of land plants associated with certain specimens of *Spirophyton*, implies a shallow water or even a littoral zone and normally an arenaceous or sandy site was preferred.

Biological associations

Spirophyton normally occurs in large numbers and as a separate community in any particular area, but sometimes tracks of worms or other invertebrates cross the surface. Pl. XXI is the best example of this known to me but it is obvious that the worm? tracks are smooth and differ in diameter from the spiral strands. They cross the *Spirophyton* at random.

In a specimen recently presented to this University by Dr. A. J. Bruwer from his farm Mymering in the Ladismith district, there are several fragments of poorly preserved lycopod stems in the sandy matrix between specimens of *Spirophyton*. Both the plant debris and invertebrate trails are compatible with a littoral zone but appear to be in no way related to the spiral fossils.

Mineral Matrix

The preference of the organisms? for a quartz sand, and therefore a clear water environment has been mentioned already but large quantities of silvery mica are common in the matrix at many of the horizons on which *Spirophyton* occurs. In addition, red iron oxide is often conspicuous. It tends to concentrate in the fossils sometimes producing the impression of reddish rosettes on the white quartzite. It is uncertain whether this is due to easier porosity in the vicinity of the fossils or to an affinity or attraction between the organic matter and the iron-bearing solutions. In a number of cases a marked black colouration is a feature of *Spirophyton*. Unfortunately it has not been possible to test such specimens chemically and it is not known whether the black colour is due to manganese or iron oxides or to carbon. The latter, of course, would provide valuable confirmation of a plant origin. Seward (1931 p. 104) mentioned one specimen of Spirophyton from the Lower Carboniferous rocks of Scotland and now in Geol. Surv. Museum which has abundant carbon associated with the markings.

Appearance in the field

The spiral markings, in South Africa at least, are most commonly visible on bedding planes where they often occur in very close association. In diameter there is considerable variation which is apparent in the accompanying plates but in any particular area or horizon there is usually a marked uniformity in size. In thickness they rarely exceed 2 cm and consequently a number of individuals may overlap on a single surface. Statements have been made to the effect that *Spirophyton* occurred through several inches of rock but in all those I have examined, wherever the markings occur on both upper and lower surfaces of a rock specimen they represent different individuals and the positions do not coincide.

In the field *Spirophyton* may occur through several feet of sediments but the individual specimens replace one another continuously and probably represent a reef on which the organisms grew over a comparatively long period under uniform conditions.

Geographical distribution and historical record of the fossil

Since the Bokkeveld and Witteberg Series of the Cape System occur only in the fold belt bordering the Karroo System on the west and southern margins, the fossils are confined to this area but the complex folding results in many outcrops.

The earliest specimen was brought to the museum by a Dr. Watson, from the Ladismith district where many fine specimens are still to be found. In the second report of the Geological Commission of the Cape of Good Hope the Chief Geologist, Corstorphine (1897 p. 19), remarked that the curious spiral markings which occur throughout a considerable thickness of the Witteberg Series were possibly not of organic origin but that their presence throughout the

sandstones was of great assistance in recognising the group. Meanwhile one of his assistant geologists, Schwarz (1897a p. 20), recorded that in the Worcester and Robertson districts, south of the Langebergen he found the sandstones in many places "crowded with *Spirophyton*", especially along the upper reaches of Sarah's River and also where the Breede River cuts through the beds at Roodeberg where beautiful impressions occur.

In the intensely folded area the quartzites of T.M.S. and Witteberg were very alike but *Spirophyton* in the latter could be used to distinguish them. Schwarz had compared them with the fossils described from the Devonian of New York and was convinced that they were identical and of a algal origin.

Later from the Robertson-Lady Grey district Schwarz (1897b) recorded *Spirophyton* in the rugged hills of the Elandsberg extending from six miles from Lady Grey to Robertson and occurring in the southern part of the town of Swellendam.

Rogers and Schwarz (1897 p. 64) stated that *Spirophyton* was found throughout a considerable thickness "probably more than half" of the Witteberg Series and appeared to have a wide distribution. Rogers and Schwarz (1898) reported it from two lines of high hills north of Caledon which are capped with Witteberg Sandstone. The fossil was found also in great abundance at Storms Vlei and in the Bredasdorp area west of Salt River Vlei where an inlier of Witteberg protrudes through younger beds. In 1899 Schwarz recorded (p. 35) *Spirophyton* beautifully preserved in Elands Kloof Mountains between Prince Albert on the east and Buffels River on the west at the contact of the Bokkeveld and Witteberg.

Schwarz (1903) found it on the road between Prince Albert and Klaarstroom on the farm Roosendal and also to the east of Kando's Poort.

Schwarz (1905 p. 282) again recorded *Spirophyton* from both upper Bokkeveld and Witteberg beds in the Laingsburg area and commented that geologists favoured a plant origin but palaeontologists mainly supported an animal one.

Following the fold belt eastwards Haughton (1935) found numerous *Spirophyton* in micaceous shales of the Bokkeveld beds at the west end of the farm Springbok Vlakte in the country east of Steytlerville but could not find it (Haughton 1928) in either Bokkeveld or Witteberg of the area described in the Port Elizabeth Sheet, where younger sediments mask many of the outcrops. Further inland Mountain (1946) had found the fossil to be common on the Grahamstown-Port Elizabeth road at West Hill and 3 miles S.E. of Grahamstown. Finally at the eastern extremity of the Cape System where the beds disappear into the Indian ocean Mountain 1962 reported *Spirophyton* in the country immediately inland from Port Alfred (the Kowie) presumably in Upper Bokkeveld beds.

There are undoubtedly many other South African occurrences of *Spirophyton* not recorded here but those mentioned serve to indicate its frequency as a zone fossil of upper Bokkeveld and lower to middle Witteberg from Wuppertal in the north-west along the whole fold belt to Port Alfred in the east. Unfortunately none of the survey records included photographs of this very familiar

fossil. Some of the original specimens can be located in museums but many are without exact localities.

I propose to describe briefly below, and to illustrate, four forms of the spiral fossils, which for the purpose of this discussion will be termed *Spirophyton* A-D, and then to summarise the findings.

3. Description of the Specimens Illustrated

(*a*) *Spirophyton Type A* Pl. XXII figs. 1 and 2, and Pl. XXIV figs. 3 and 4

Type A appears to be the most common form. The fossils are usually crowded together and often overlap closely on a bedding plane. They vary somewhat in diameter but on any particular surface they are of approximately the same size. Each is round in plan, often bun-shaped, and consists of a compact form with a central column (either raised or hollow according to the aspect) surrounded by a dense mass of "strands" with a cyclic spiral to the left. The margin is usually a well defined circle for the strands curve downwards and their ends are rarely visible. The individual strands are approximately of the same length and each resembles an evenly twisted cord spiralling upwards to the left (see upper right hand side of fig. 1). Strands may overlap one another without losing their form or identity.

Sometimes only a portion of a *Spirophyton* is preserved. Plate XXIV, figs. 3 and 4 are believed to be portions of vertical sections of Type A. In each case they lie on bedding planes but it is suggested that the living plant may have been severed and only the vertical column and one side of spiralling strands has been preserved in a recumbent position. In fig. 4 part of a silica cast can be seen at the top of the vertical column, the straight smooth nature of which contrasts strongly with the much narrower, twisted strands which coil upwards and outwards from it.

(*b*) *Spirophyton Type B* Pl. XXIII figs. 1-3

Type B is less common. It is normally much larger and does not occur in closely packed associations like Type A but as well spaced individuals. Occasionally one may be seen on the same plane as a number of Type A *Spirophyton*. Type B is often black in colour and contrasts strongly with the white quartzite.

In the "B" form the strands are grouped into elongated tapering units, each of approximately twelve spiralled strands giving the whole fossil a flower-like appearance. Pl. XXIII fig. 1 is a photograph taken by Theron of a bedding plane in Witteberg quartzite on which a large specimen 18 inches in diameter is preserved. I am indebted to him for allowing me to reproduce it. The scale is indicated roughly by the tuft of grass in the top left hand corner.

The specimen on Pl. XXIII fig. 2 illustrates a portion of one of these forms. The dark point on the left indicates that the separation into groups was not confined to a single plane for it represents the emergence of the terminal portion from a lower level.

The general spiral is less apparent in form B than in A but the spiralling of individual strands is consistent and can be seen on the right hand side of fig. 2.

The dark colouring in both these specimens is possibly carbon.

In his thesis Theron (1962) expressed the view that form B represented an older plant which had opened and that what I have called type A was a closed bud-like form. I think it is more probable that they represent different species of related organisms.

(*c*) *Spirophyton Type C* Pl. XXIV figs. 1 and 2

This form is still less common than B. and differs from it considerably. The circular form is absent and instead a group of cylindrical and feather-like branches fan upwards from a point which may correspond to the central column of forms A and B. Each branch consists of a number of short spiralling strands spreading upwards and outwards and possibly densely packed around a central column which is not visible.

At a lower level on the right hand side of Pl. XXIV fig. 1, several other groups can be seen emerging, suggesting that the vertical depth of each group was small.

In both the specimens illustrated the organic portions have a shiny black colouration which may be carbonaceous.

(*d*) *Spirophyton Type D* Pl. XXV figs. 1 and 2

This is a form similar to that illustrated by Seward (1903 Pl. XIV figs. 1 and 2) which led him to believe that the markings were due to eddying currents of water. On the right hand side of Seward's fig. 1 the spiralling of several individual strands can be seen and on the present specimen in fig. 1 they are faintly preserved although not clearly in the photograph.

These D forms usually cover a larger area than any of the convex "bun-like" A forms. They always lack clear outlines and definition. For this reason it seems probable that the large, almost formless, markings represent dead or dehydrated specimens which have possibly been detached and stranded in an alien environment and exposed until they became a flaccid and dried gelatinous film with little bulk or substance, spread out on loose sand before being buried. It is possible that Pl. XXIV fig. 1 illustrates a stage intermediate between those 'A' types on Pl. XXII and Pl. XXIV fig. 2 in which the D type has been flattened and lost its clear marginal outlines and individual spiral strands are no longer visible. Against this view the much larger areas covered by most D. forms may be indicative of a more spreading and flatter species.

4. Summary of Discussion on Origin of Spirophyton

(*a*) The preservation of forms A, B and C with well defined outlines and details of structure is completely incompatible with an inorganic or mechanical origin and an organic origin is now generally accepted.

(*b*) Despite the statements by Seward (1903) and others that similar markings occurred throughout geological time, the particular fossils described here appear to have a limited distribution both in time and space which implies that they were caused by organisms with a limited evolutionary span and with restricted environmental requirements. These are characteristic of Lower Palaeozoic but especially of Middle Devonian rocks formed in shallow water or possibly in a littoral zone preferably with a sandy base. The South African occurrences imply a transition from marine through brackish to fresh water.

(*c*) The four forms described here as *Spirophyton* Types A-D differing in size and shape all have in common a tendency to colonize, often forming a close association of individuals. This is particularly marked in the A form and suggests that they were preserved where they were growing, on sand banks and probably with some form of anchorage.

(*d*) The four types all exhibit a well developed spiral form which suggests a generic relationship.

(*e*) In considering an animal origin the forms must have been due either directly to the preservation of soft bodied organisms i.e. *body fossils* or be the result of some animal activity such as boring i.e. *trace fossils*. In the first case an Anthozoan origin is probably the only one which could be considered and in fact forms like B do suggest the modern sea anemones in shape, size and form but these animals are apparently unknown in fossil form. In any case the individual spiralling strands cannot be explained and the food problem of probably thousands of immobile organisms of not inconsiderable size, on a single sand bank would be considerable, since unlike coral reefs, signs of other life associated with them are very rare.

In the second case—where the markings are attributed to burrows or food storage canals the dual spiralling is even more difficult to explain. The mechanical problems produced by inter-winding and spiral canals would be insupportable unless each burrow had a strong casing and even then, very close contact would create a sponge within a confined space. The very close packing militates also against a collection of food storage canals. Food is stored to be used and in the extensive horizons of Form A, the tightly spiral strands are preserved intact.

(*f*) On the other hand if a plant origin were considered, a close association of colonies of algae is quite acceptable. The known distribution of *Spirophyton* in horizontal lenses of some considerable areal extent, and forming beds a couple of feet in thickness is compatible with an algal reef. Although, as far as I know, nothing resembling the collective Devonian *Spirophyton* has been recorded on modern algal reefs, single spiral forms of living algae are known e.g. *Spirulina princeps*, one of the Cyanophyceae (Tilden 1935). It is possible that the individual spiral strands were each encased in a thin membrane so that the form could be preserved. Fragments of *Spirophyton* are often preserved with the details of their structure undamaged. This would be difficult to explain if a composite

series of burrows had been fractured but a torn portion of seaweed could remain intact and, in fact, might represent a common form of vegetative reproduction.

The loss of form and bulk, similar to that which is apparent in specimens like Type D, can often be seen in dried-out films of previously bulky gelatinous seaweeds. The shapes of forms like *Spirophyton A* were probably protected by a coating of sand and mica particles while they were living or while still in growth positions. In fact specimens occur in which the accumulating sand layers terminate against the bun-shaped fossil.

(*g*) In the absence of actual animal or plant tissue no observations can be conclusive but they are at least suggestive and seem to support the original choice of the name *Spirophyton* implying a spiral plant rather than the alternative and so-called synonym of *Zoophycus*.

(*h*) Algal reef zones play an important role in many South African formations and throughout the world the considerable contribution of algae in rock-forming processes is being recognized increasingly.