On *Traquairia*.

BY

RINA SCOTT (MRS. D. H. SCOTT), F.L.S.

With Plates XXXIX and XL and four Figures in the Text.

THE genus *Traquairia* was named by Mr. W. Carruthers, F.R.S., after his friend, Dr. Traquair, then of Dublin, in 1872. The specimens were originally described by him before Section D, at the meeting of the British Association at Brighton, in 1872, in a paper entitled: 'On *Traquairia*, a Radiolarian Rhizopod, from the Coal Measures.'

I append a part of his description: 'A spherical spiniferous body, the hollow globular cavity is included in a clearly defined structure, probably a fenestrated shell. Beyond this, there is a considerable thickness of a spongy substance, which rises externally into numerous cones, the bases of which are in close proximity. From the apex of each cone, there proceeds a hollow echinate spine. The echinations are also hollow, and at the apparent base of the spine these echinations are produced into hollow tubes which, repeatedly branching and anastomosing and increasing in number downwards, enclose the radial hollow spines in the mass.'

I have also had a reproduction made of Mr. Carruthers's original diagram, which he kindly gave me two years ago (Text-fig. 1).

Since this paper was written, there has been a great diversity of opinion as to the real nature of *Traquairia*. Count Solms-Laubach¹ says: '*Traquairia* and *Sporocarpon* appear to me and also to Strasburger, if comparable to anything, to be like either the massulae of *Azolla* or the sporocarps which contain them.' After a description of these genera he adds that they are well worth further investigation. Dr. Schenk² and Professor Zeiller³ agree with Count Solms's view.

The subject has been dealt with in greatest detail by Professor Williamson,⁴ who produced a paper in the Transactions of the Royal Society

¹ Einleitung in die Paläophytologie, 1887, p. 188.

² Handbuch der Botanik, Bd. iv, 1890, pp. 52, 53.

³ Éléments de Paléobotanique, p. 130.

⁴ On the Organization of the Fossil Plants of the Coal Measures, Pt. x. Phil. Trans. Roy. Soc., Pt. 2, 1880, Pl. XVIII, Figs. 40, 41, 42, 45, 46, 49; Pl. XIX, Figs. 40, 44, 49, 50; Pl. XX, Figs. 85, 86, 78.

in 1880, in which some fine vigorous drawings of these objects are to be found.

Professor Williamson suggested that *Traquairia* bore more resemblance to the spore of a Cryptogam, and concluded that it was a reproductive organ of some unidentified Cryptogamic plant. Professors Haeckel and Strasburger examined his specimens and agreed with him that they were vegetable and not animal structures.

TEXT-FIG. 1. *Traquairia Carruthersii*. From Mr. Carruthers's original diagram.

This view has met with some acceptance. Dr. Hinde¹ says in one of his papers: 'The minute spherical bodies in the Coal Measures, known as *Traquairia*, have been shown by Professor Williamson to be vegetable structures.'

No new work has been done on this subject for a long time; many botanists have come to the conclusion that the *Traquairiae* are not plant structures, and do not seem to think it part of their duty to investigate them. The zoologists, however, seem to take no interest in them either. During

¹ Dr. Hinde, *Annals Nat. Hist.*, Ser. 6, vol. vi, p. 46.

the cataloguing of Dr. Scott's Collection of fossil slides, each specimen of *Traquairia* occurring was noted, and as a result of this work it has become quite clear that there is more than one species of *Traquairia* amongst the Coal Measure plants.

Two years ago I found many good specimens in the material from Burntisland, and also in that from Ostrau and the Karwin district in Moravia, in sections lent by Dr. Kubart. So that now specimens are known from the following horizons:—

Lower Carboniferous: Burntisland.

Lower Coal Measures said to be older than the English: Ostrau and Karwin, Moravia.

Lower Coal Measures: Dulesgate, Oldham, Halifax hard bed.

It seemed to be worth while to describe these new species in the hope that some biologist would be found who would take up the study of these objects, and try to decide what they really are. I hope that Dr. Kubart will also shortly add a description of his species.

Before beginning to describe the various species, I will give a rather more detailed account of Professor Williamson's work. In his notes on the catalogue of his slides now at the Natural History Museum, he says that many of the sections are serial and all show *Lepidostrobus* sporangia. In slide W. 1064¹ there are three very good *Traquairiae* in a *Lepidostrobus* sporangium, and he thought that they were three spores of a tetrad belonging to the plant.²

W. 1063 also shows a specimen in a *Lepidostrobus* sporangium. On looking at these slides it will be seen that the sporangial wall is very rotten; it is quite a usual thing to find all sorts of objects apparently in these *Lepidostrobus* sporangia. In one of Professor Williamson's own slides there is a good specimen of *Zygosporites* apparently in a sporangium, and in another a *Sporocarpon*. One constantly comes across very deceptive examples of this sort. So that the fact of finding *Traquairiae* inside a *Lepidostrobus* sporangium is not in itself satisfactory evidence that they belong to it.

It is true that these *Traquairiae* are usually found in association with *Lepidodendron*, but the *Lepidodendron* is always in a very rotten condition. They are generally found associated with Fungi and coprolites of insects. If one wishes to be sure that the contents of a sporangium really belong to that sporangium, it is a good rule only to judge by examples in which the sporangial wall is intact. In Text-fig. 2 will be seen an example of a sporangium with perfect walls, evidently containing its own megaspores (*Bothrodendron mundum*).

The megaspore belonging to the *Lepidostrobus* in Professor Williamson's slides is now well known. As a matter of fact *Traquairia*

¹ W. = Williamson Collection, S. = Scott Collection.

² loc. cit., Pl. XXI, Fig. 85.

occurs in all sorts of cavities in the tissues of *Lepidodendron* and other plants, and as they usually occur in groups it is very easy to find three together (see Figs. 14 and 16, Pl. XL).

TEXT-FIG. 2. *Bothrodendron* megasporangium on spirophyll. $\times 30$. S. 2561.

For some reason Mr. Carruthers's view, that *Traquairiae* were Radiolarians, was never generally accepted, yet there seems to be a good deal of evidence to prove that he was not far wrong. Perhaps one reason was that Radiolarians were always supposed to be deep-sea organisms and people did not see how this was compatible with their being associated with land plants, but Professor Sollas¹ is of opinion that the deposits in which Radiolarians occur may be of a shallow-water character, and Dr. Hinde and other observers have noticed that impressions of *Lepidodendron* occur in the same rock with Radiolarian casts. An example of this is found in the Devonian rocks of New

South Wales, where the Radiolarians are associated with *Lepidodendron australe*. This latter fact is of especial interest, as fragments of *Lepidodendron* and *Traquairia* are also so often found together in the British petrifications.

Many of the Radiolarians figured in Dr. Hinde's paper bear a striking resemblance to *Traquairia*, e.g. his Pl. IX, Fig. 1; Pl. VII, Fig. 23, is very much like another object found in the Coal Measures, *Sporocarpon elegans*.

Dr. Hinde, who has kindly written to me on the subject, says, however: 'My present opinion is that this genus is not related in any way to Radiolaria.'

Mr. Carruthers, in his paper on the subject, gave as a reason against his own arguments, that *Traquairia* had no 'central capsule', constantly found in Radiolarians. In the specimens which we now have at our disposal, every species shows a 'central capsule' (see Pls. XXXIX, XL, Figs. 9, 15, 16).

It now remains for me to describe the specimens and to record the new species.

Traquairia is a spherical organism, consisting of two parts each surrounded by a sharply defined membrane: an inner capsule, often containing spores, and an outer part, which is surrounded by a thick gelatinous envelope. In this are embedded numerous hollow spines. The apparent bases of these spines are produced into hollow anastomosing tubes, which spread over the surface of the sphere, forming a complicated network. The spines are hollow and are perforated in every direction by projecting tubular pores. Emanating from these pores are delicate threads (see Pl. XXXIX,

¹ Discussion on Dr. Hinde's paper on Devonian Radiolaria from New South Wales. Geol. Soc. Journ., vol. lv, 1899, p. 64.

Fig. 3) which appear to lose themselves in the gelatinous envelope. Sometimes the threads form a regular network in it.

The inner capsule, a definite brown membrane, can only be observed in the more perfectly preserved specimens. Spores are generally present, which appear to produce smaller spores. The *Traquairiae* occur in groups in the decayed wood of *Lepidodendron* and other plants.

The first species to be described is that figured by Williamson.¹ I propose to call it *Traquairia Carruthersii* after Mr. Carruthers, who was the first to describe these organisms.

TRAQUAIRIA CARRUTHERSII (Pl. XXXIX, Figs. 5, 6, 7; Pl. XL, Fig. 14; Text-figs. 1 and 3).

The form is spherical.

The spines appear to have been brittle. They are uniformly distributed over the sphere. They are sometimes branched and do not taper. At their apparent base they give off anastomosing tubes, which connect one spine with the other and form an elaborate network covering the surface of the sphere.

Each spine has numerous projecting tubular pores, generally arranged in about six longitudinal rows; from these pores emanate threads, which divide and branch, eventually losing themselves in the gelatinous substance enveloping the sphere. An inner capsule is present.

There are often large spores, which have a delicate membrane. Inside these are smaller thick-walled spores (see Text-fig. 3, A), which in some specimens are found

coming out of the larger spores. There is an apparent operculum in the outer capsule, but it has only been observed in one case (see Text-fig. 3, B).

Measurements :—

Diameter of the sphere without spines : from 0.32–0.48 mm.

Length of spines : about 0.2 mm.

Width of spines : from 12 μ –18 μ .

Diameter of large spores : from 36 μ –72 μ (average 40 μ).

Diameter of small spores : from 16 μ –18 μ .

¹ loc. cit.

TEXT-FIG. 3. *Traquairia Carruthersii*. A. Inner capsule and spores. $\times 170$. S. 1789. B. Operculum. $\times 200$. W. 1077.

Locality : Coal-balls from the Lower Coal Measures of Lancashire and Yorkshire.

The second species I propose to call *Traquairia Spenceri*, as it was first observed by the late Mr. Spencer and occurs in slides from his collection.

TRAQUAIRIA SPENCERI (Pl. XXXIX, Figs. 8, 9, 10 ; Pl. XL, Figs. 15, 16 ; Text-fig. 4).

The form is spherical.

The spines are much more delicate and apparently less brittle than in *T. Carruthersii*, and rapidly taper to a point. At the ends they are often curved like a shepherd's crook. At their apparent base they give a network of tubes much finer than in *T. Carruthersii*.

TEXT-FIG. 4.
Traquairia Spenceri. $\times 150$. S. 22.

Each spine has very numerous fine pores, from which emanate very fine threads. The spines are less numerous than in *T. Carruthersii*; about twenty can be counted round the circumference of the sphere seen in median section.

The inner capsule appears to have two membranes. Sometimes an operculum seems to be visible (see Text-fig. 4).

The inner capsule is filled with large spores containing smaller ones.

Measurements :—

Diameter of sphere without spines :	about 0.42 mm.
Length of spines :	from 0.18–0.24 mm.
Width of spines at base :	24 μ .
Width of gelatinous envelope :	0.1 mm.
Diameter of large spores :	from 36 μ –42 μ .
Diameter of small spores :	18 μ .

In association with *Traquairia Spenceri* I have found an object (Pl. XXXIX, Fig. 10) which might possibly be a stage in the development of *Traquairia*, perhaps the first product of germination of a spore. It appears to have one spine only, the whole object being barely one-third the size of the usual specimens. It measures 120 $\mu \times 96 \mu$. The whip-like shape of the spine strongly resembles that of *T. Spenceri*.

In the Burntisland material there are two *Traquairiae* very different in form, always occurring together. In fact, in my first investigations I always called them Form A and Form B. However, I have been unable to trace any connexion between the two, so at present they must be

described as distinct species. They occur in association with *Lepidodendron Veltheimianum*. The first very much resembles *T. Carruthersii*. I propose to call this

TRAQUAIRIA BURNTISLANDICA (Pl. XXXIX, Figs. 1, 2, 3; Pl. XL, Figs. 11, 12, 13).

The form is spherical.

The spines appear to have been brittle, as in *T. Carruthersii*. They do not branch or taper. At their apparent base they give off anastomosing tubes, which connect one spine with another and form a coarse network over the sphere. The spines are arranged in groups of 4-6. The total number of groups was probably from 24-30.

Each spine has numerous projecting tubular pores in about six longitudinal rows. From these pores emanate threads much as in *T. Carruthersii*.

The spines are enveloped in a gelatinous mass. The specimens observed are not well preserved, and the internal structure cannot be made out.

Measurements :—

Diameter of the sphere without spines : 0.36-0.42 mm.

Length of spines : about 0.24 mm.

Width of spines : 12 μ -18 μ .

In some tangential sections one sees five groups each composed of 4-6 spines cut across, and outside these seven or eight groups are seen.

Traquairia burntislandica is much the same size as *T. Carruthersii*, and differs principally in having its spines arranged in definite groups.

The second species I propose to call *Traquairia stellata*, as it has an appearance like that of a star.

TRAQUAIRIA STELLATA (Pl. XXXIX, Fig. 4).

The form is spherical.

The arms or spines are much fewer and broader at the base than in *T. Carruthersii* or in *T. burntislandica*. The general appearance of a radial section is something like a starfish in form. The number of arms is about twenty-four, uniformly distributed round the sphere. The arms are pointed, widening out at the base, so that the base of one almost joins the base of the next. They appear to be chambered, the chambers sometimes forming a single series, while in other cases they are further divided by longitudinal septa. They are deeply embedded in the gelatinous mass. One cannot feel at all sure that these chambers may not be due to disorganization. Tubes are given out from the base of the arms, but the structure is so imperfectly preserved that little can be said on this point.

The surface of the sphere is covered by a finer network than *T. Carruthersii* and *T. burntislandica*. The inner capsule is preserved in some specimens, but none of those observed contain spores.

Measurements :—

Width of sphere without arms : 0.216 mm.—0.252 mm.

Length of arm : 120 μ .

Width of arm at base : 108 μ .

The most characteristic feature in the organisms described is the very complicated structure of the outer envelope with its elaborate system of anastomosing tubes connected with prominent spines, which are themselves very complex organs.

Nothing parallel to this is known in the vegetable world.

The presence in well-preserved specimens of an inner capsule containing spores, in the interior of which smaller spores are produced, reminds one of Radiolarians, though some previous authors have seen an analogy on this point with the massulae of *Azolla*.

The spores, however, are not always confined to the inner capsule.

The inner capsule and spores are features common to another fossil genus, *Sporocarpon*. In *S. elegans* there are spines also. But on the whole the outer envelope of *Sporocarpon* is less complicated, and often has a more cellular appearance than that of *Traquairia*.

On the other hand, *Sporocarpon elegans* with its long spines is very much like a Radiolarian. The organisms of both genera urgently need further investigation.

Professor Dendy, F.R.S., in a discussion at the Linnean Society, suggested that *Traquairia* might belong to an extinct group of *Protozoa* allied to the Radiolarians.

My thanks are due to Dr. Smith-Woodward, F.R.S., Mr. Carruthers, F.R.S., Dr. Hinde, F.R.S., and Professor Judd, F.R.S., for help in connexion with this paper.

EXPLANATION OF FIGURES IN PLATES XXXIX AND XL.

Illustrating Mrs. D. H. Scott's paper on *Traquairia*.

PLATE XXXIX. Drawings.

Fig. 1. *Traquairia burntislandica*. Portion of the periphery showing hollow spines. $\times 280$. Pettycur, Burntisland. S. 990.

Fig. 2. *T. burntislandica*. Portion of the periphery showing hollow spines and tubular pores. $\times 280$. Pettycur, Burntisland. S. 986.

- Fig. 3. *T. burntislandica*. Section near the surface, showing anastomosing tubes, which connect the spines. $\times 280$. Pettycur, Burntisland. S. 990.
- Fig. 4. *T. stellata*. Nearly radial section, showing five complete 'arms' and inner capsule; at 6 sections of 'arms'. $\times 100$. Pettycur, Burntisland. S. 977.
- Fig. 5. *T. Carruthersii*. Transverse section near the middle, showing spines and place of attachment of spines. $\times 100$. Dulesgate. S. 923.
- Fig. 6. *T. Carruthersii*. Section near top, showing spines in section. Dulesgate. S. 923.
- Fig. 7. *T. Carruthersii*. Section near surface, showing spines in section. $\times 100$. Dulesgate. S. 923.
- Fig. 8. *T. Spenceri*. Spores from Fig. 9 more magnified. $\times 280$. Halifax. S. 22.
- Fig. 9. *T. Spenceri*. Section through middle, showing spines in section. Inner capsule containing spores. $\times 100$. Halifax. S. 22.
- Fig. 10. *T. Spenceri*. Possible young stage with one spine developed. $\times 100$. Halifax. S. 22.

PLATE XL. Photographs.

- Fig. 11. *T. burntislandica*. Section, nearly median, showing inner capsule. $\times 100$. Pettycur, Burntisland. S. 986.
- Fig. 12. *T. burntislandica* not quite median. $\times 100$. S. 990.
- Fig. 13. *T. burntislandica*. Section near the top, showing spines in section. $\times 100$. S. 990.
- Fig. 14. *T. Carruthersii*. Shows a large group. $\times 25$. Dulesgate. S. 923.
- Fig. 15. *T. Spenceri*. Section median, showing inner capsule with spores. $\times 100$. Halifax. S. 22.
- Fig. 16. *T. Spenceri*. Showing numerous sections *in situ* in wood of *Lepidodendron*. $\times 25$. S. 22.

1.

2

3.

A.

B.

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5.

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7.

8.

9.

10.

Scott, Rina. 1911. "On Traquairia." *Annals of botany* 25, 459–467.
<https://doi.org/10.1093/oxfordjournals.aob.a089336>.

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