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XXIV.—*On the Relationship of Ulodendron, Lindley and Hutton, to Lepidodendron, Sternberg; Bothrodendron, Lindley and Hutton; Sigillaria, Brongniart; and Rhytidodendron, Boulay.* By ROBERT KIDSTON, F.G.S.

[Plates III–VII.]

[Concluded from page 179.]

It is necessary before leaving this portion of our subject to make a few remarks on the *Ulodendroid* scars. It has been stated by some authors that the large concave *Ulodendroid* scars bore traces of leaf-scales; by others that these were never present. It is, however, now unquestionable that at one period of their development the whole area which now forms the *Ulodendroid* scar was covered with leaf-scales. This is clearly shown in Pl. IV. fig. 2 (specimen No. 3), and in another and slightly older example (specimen No. 7). It has also been stated, by those who believe that the surface of the *Ulodendroid* scars originally bore leaf-scales, that these were arranged in a system peculiar to the area of the scar. At all events in the two examples just mentioned the leaf-scars on the surface of the *Ulodendroid* scars are continuations of the ordinary leaf-spirals of the stem. The presence, then, of the leaf-scars on the *Ulodendroid* scar conclusively proves that the appendicular organ, whatever its nature may have been, cannot have been attached to the whole surface of the scar, but only to its umbilicus. Further conclusive proof of this is afforded by the Blackbraes specimen (No. 6) of *Lepidodendron Veltheimianum*. (Pl. VI. fig. 11.)

The formation of the *Ulodendroid* scar may be thus briefly described. In its earliest condition that has come under my notice the area that supports the appendicular organ is slightly elevated (Pl. IV. fig. 2). The specimen (No. 7) which shows the succeeding stage of development exhibits a clearly defined semilunar outline, limiting the upper part of the scar, but no boundary-line towards its lower part is yet visible. At this stage of progression the leaf-scars are clearly seen on the surface of the *Ulodendroid* scar, from the umbilicus downwards.

Fig. 9, Pl. V. (*Sigillaria Taylori*), shows the attached appendicular organs in a young state of growth. They are directed upwards, and consequently the pressure exerted on the bark by their leaves or bracts will be much greater on the upper part of the *Ulodendroid* scar from the acute angle the attached organ forms with the stem; and, in fact, it is on the

upper part of the Ulodendroid scar that the leaf-scars are first effaced. The continued pressure of the appendicular organ against the cortex, augmented by the increase in girth of the stem, causes the bark to swell up around its base, and thus the characteristic Ulodendroid depressions are formed. On the upper part of the Ulodendroid scar the leaves of the attached organ first obliterate all traces of the leaf-scars, and finally impress their own strap-shaped outline as radiating lines from the umbilicus. On the lower part of the scar circumstances modify the case. The space here between the attached organ and the bark is much greater than in the upper portion of the scar; hence, though the attached organ effaces the leaf-scars on the stem by its leaves or bracts pressing on its surface, they have not sufficient power to impress their outline on the Ulodendroid scar; thus the little "dots," which mark the channels through which the foliar bundles have passed are left to indicate the position of the stem-leaves. As Schimper has pointed out, there cannot remain much doubt that the appendicular organs result from a series of unequal dichotomies, which were alternately fertile and barren, the fertile probably forming deciduous cones, the barren carrying on the axis of the plant.

Of actual cases where the appendicular organ has been found *in situ* I only know of five:—first, that mentioned by Dr. Hooker*; the second the notice given by Dr. Dawson, who mentions having seen on one occasion the cones attached to the stem†; the third the specimen figured by Mr. D'Arcy Thompson‡; the fourth and fifth those shown in figures 9 and 11 of this communication. That the appendicular organs were aerial roots, as supposed by Mr. Carruthers§, has been pointed out by Dr. Williamson|| and fully corroborated by the specimens described in this paper.

* Mem. of the Geol. Survey of Great Britain, vol. ii. part 2, p. 427.

† Acadian Geol. 2nd ed. p. 456 (1868).

‡ Trans. Edinb. Geol. Soc. vol. iii. pl. (B).

§ NOTE.—The specimen on which Mr. Carruthers founded his belief that the attached organs were aerial rootlets and directed downwards, and which he figures on pl. xliii. fig. 5 of the Monthly Micr. Journ. for March 1870, is in the collection of the British Museum (Natural History). This specimen does not belong to *Ulodendron*, L. & H., but is a Halonian branch of *Lepidophloios*. On the opposite side of the specimen to that figured there is a third row of tubercles; hence it cannot be a *Ulodendron*, L. & H. Again, the leaf-scars in *Lepidophloios* are directed downwards, and the view of those he gives in fig. 6 of the same plate proves most conclusively that he has been dealing with *Lepidophloios*, and not *Ulodendron*. His fig. 5, then, is inverted; so if his specimen were placed in its true position, the tubercles would be directed upwards, which conforms with the ordinary Halonian branches of *Lepidophloios*.

|| Phil. Trans. vol. clxxii. p. 209 (1872).

That the appendicular organs were caducous cones seems most probable; but I have not seen evidence sufficiently clear to decide positively whether they were sessile or stalked. From the evidence before us, however, and taking into account the morphological significance of the attached organ, I have a strong bias in favour of the opinion that the appendicular organs were sessile cones. The view advocated by Stur that they were bulbils does not appear to me to be at all probable, and against it Schimper has stated sufficient objections*.

Before meeting with the specimens which form the subjects of figures 2 and 9, it had often been a mystery to me why we never found *Ulodendroid* scars on small stems, especially as Halonian branches of *Lepidophloios scoticus*, Kidston, about half an inch in diameter, are frequent. This difficulty is quite cleared up by an examination of the specimens nos. 3 and 18, of which the portion drawn in Pl. IV. fig. 2, is from a stem $4\frac{1}{2}$ inches broad (specimen No. 3), and that in Pl. V. fig. 9 (specimen No. 18) from another over 3 inches wide. It appears, then, that in the so-called *Ulodendra* it was only the older stems that bore lateral cones.

It has already been pointed out that plants belonging to the genus *Rhytidodendron*, Boulay, also possessed two opposite rows of *Ulodendroid* scars†. It is true that *Ulodendroid* specimens comparatively seldom show the leaf-scars well preserved, and that on some of the described species of *Ulodendron* they have not been observed; still that does not alter the fact that when well-preserved examples are examined they show leaf-scars which conform to one or other of the three genera *Lepidodendron*, *Sigillaria*, or *Rhytidodendron*, as already mentioned. But if the form of the leaf-scar is of generic value in *Lepidodendron*, *Sigillaria*, and *Rhytidodendron*, on what grounds can we ignore the value of the same character in *Ulodendron*? If, then, those plants with *Ulodendroid* scars are to be excluded from *Lepidodendron*, *Sigillaria*, and *Rhytidodendron*, it will be necessary to form three new genera for these plants—one for the *Lepidodendroid Ulodendra*, another for the *Sigillarian Ulodendra*, and a third for the *Rhytidodendroid Ulodendra*. This view, however, I am not prepared to adopt, as I think the plants find a suitable and natural place in the genera *Lepidodendron*, *Sigillaria*, and *Rhytidodendron* respectively.

Branching of Ulodendroid Stems.

The *Sigillarian* as well as the *Lepidodendroid* species of

* See *ante*, p. 135.

† See *ante*, p. 138.

the so-called genus *Ulodendron* dichotomized in a similar manner to that which occurs in *Sigillaria* and *Lepidodendron*. In the former genus the dichotomizing of the stem appears to have been much more feebly developed than in *Lepidodendron*, and, in fact, there is strong evidence to show that some *Sigillariae* did not dichotomize at all *; but in regard to other *Sigillariae* it is equally clear that they possessed a dichotomized ramification †. Of *Sigillaria Taylori*, Carr. sp., several dichotomizing examples have been found and described ‡.

The termination of these Ulodendroid stems has, however, only been twice observed—first by Hugh Miller §, who described it as having an “abrupt cactus-like termination,” and the other case is that figured in Pl. VI. fig. 10 (specimen No. 17). This example is referable to *Sigillaria Taylori*, to which species Hugh Miller’s fossil most probably belonged. I am not aware that any termination of a Ulodendroid branch of *Lepidodendron Veltheimianum* has ever been discovered. That they dichotomized in the ordinary manner has been pointed out by Tate ||. Mr. Carruthers also gives a woodcut of a specimen in a similar condition ¶. I agree with Stur in believing that *Lepidodendron Veltheimianum*, in addition to bearing lateral cones (according to Stur lateral bulbils), also bore terminal cones. Mr. C. W. Peach has shown me a large slab, which I believe to be referable to *Lepidodendron Veltheimianum*, on which are exhibited twenty-two cones attached to small terminal twigs **.

Although our knowledge of the so-called *Ulodendra* has been considerably augmented within the last few years, and to such an extent that it appears to me impossible to regard *Ulodendron*, Lindley and Hutton, as forming a true genus, still there remain many points in regard to the structure of these plants of which we at present possess only very imperfect information, and it is only by patient continued observation and collecting that we may ever hope to clear up those points which are still involved in obscurity. I for one feel very hopeful that many difficulties, not only in regard to the Ulodendroid Lycopods, but in many other branches of fossil botany, will yet be satisfactorily cleared up, only we must

* Goldenberg, ‘Flora Sarapontana fossilis,’ Heft i. p. 25, pl. B. fig. 13 (*Sig. reniformis*).

† Stur, *Culm Flora*, p. 296 (402), pl. xxv. (xlii.) (*Sigillaria Eugeni*).

‡ Thompson, *l. c.* p. 349; H. Miller, ‘Testimony of the Rocks,’ p. 464.

§ *L. c.* p. 464.

|| Tate, in Johnston’s *Nat. Hist. of the Eastern Borders*, p. 302 (1853).

¶ Monthly *Micr. Journ.* vol. iii. p. 148 (1870).

** Collected at Grange Quarry, Burntisland, Fife, in Aug. 1876 (Calceiferous-Sandstone series).

wait till specimens are discovered which may fill in the missing links, and not in the meantime supply what is at present desiderated from the fertile regions of imagination and desire.

IV. SYNONYMY AND NOTES ON THE THREE SPECIES SPECIALLY CONSIDERED IN THIS COMMUNICATION.

LYCOPODIACEÆ.

LEPIDODENDRON, Sternberg, 1820.

[Versuch eines geognostisch-botanischen Darstellung der Flora der Vorwelt, i. fasc. i. p. 25, fasc. iv. p. x.]

Lepidodendron Veltheimianum, Sternberg.

(Pl. III. fig. 1, Pl. IV. figs. 2, 3, 4, Pl. VI. fig. 11.)

Lepidodendron Veltheimianum, Bronn, Index Palæont. p. 631; Dawson, Foss. Plants of Lower Carb. and Millstone Grit, p. 8; Etheridge, Catalogue of Australian Fossils, p. 31: Grand'Eury, Flore carbon. du Dép. de la Loire, p. 138; Heer, Urwelt d. Schweiz, p. 7, fig. 2; id. Foss. Flora d. Bären Insel, p. 38, pl. viii. figs. 1, 2 a-b, 3, 4, 5 a, 6, 7, pl. ix. figs. 3, 4 (? fig. 2 a); id. Steink.-Flora d. arktischen Zone, p. 4, pl. iv. and pl. v. fig. 3; id. Flora foss. Helv. Lief. i. p. 37, pl. xviii. fig. 6 (?); Kidston, in Cadell, Trans. Ed. Geol. Soc. vol. iv. p. 335; König, Icones fossilium sectiles, pl. xviii. fig. 236; Lesquereux, Coal Flora of Pennsylv. p. 374, pl. lxii. figs. 6-8; id. Geol. Surv. of Illin. vol. ii. p. 455; Renault, Cours d. botan. foss. p. 9, pl. v. figs. 1-2 (1832); Schimper, Traité d. paléont. végét. vol. ii. p. 29; Schmalhausen, Mélanges Phys. et Chim. vol. x. p. 745, pl. i. figs. 4-7; Sternberg, Vers. i. fasc. 4, p. xii, pl. lii. fig. 3; Sterzel, Bericht d. naturwis. Gesellsch. zu Chemnitz, vol. ix. p. 215 (1884); Stur, Culm Flora, Heft i. p. 79, Heft ii. p. 375, pl. xviii. figs. 2-3, pl. xix. figs. 5, 6 (8?), 9, 10, pl. xx. figs. 1-6, pl. xxi., pl. xxii. fig. 3 (excl. figs. 1, 2); Unger, Genera et Species, p. 256; Zeiller, Végét. foss. du terr. houil. p. 110, pl. clxxii. figs. 3, 4.

Sagenaria Veltheimiana, Dawson, Quart. Journ. Geol. Soc. vol. xviii. p. 299; Ebray, Végét. foss. d. terr. d. transition, p. 19, pl. v. (in part), pls. vi., vii., and viii.; Eichwald, Lethæa Rossica, vol. i. p. 119, pl. vii. figs. 2-6; Ettingshausen, Foss. Flora d. Mähr-schles. Dachschiefers, p. 106; Feistmantel, Zeitschr. d. deutsch. geol. Gesellsch. vol. xxv. p. 528, pl. xvii. figs. 31, 32; Geinitz, Flora Hain-Ebersd. p. 51, pls. iv., v., vi. figs. 1-3; Giebel, Deutschl. Pefrefacten, p. 80; Göppert, Foss. Flora d. Uebergangsgebirges, p. 180, pls. xvii.-xx., xxiii. figs. 1-3, xxiv., and xliii. fig. 1; id. Neues Jahrb. p. 684 (1847); id. Flora d. Silur., Devon., u. unter. Kohl. p. 520, pls. xl. figs. 3-4, xli. figs. 2, 4, xlii. fig. 1, and xliii.; id. Zeitschr. d. d. geol. Gesellsch. vol. iii. p. 195; Römer, Palæontographica, vol. iii. p. 46, pl. vii. fig. 14 (1854); id. ibid. vol. v. p. 40, pl. viii. figs. 1-2 (figs. 4 & 5?) (1855); id. ibid. vol. ix. p. 10, pl. iii. fig. 6 (1862); id. Geol. v. Oberschlesien, p. 55; Schimper, Végét. foss. du terr. de trans. d. Vosges, p. 336, pls. xx., xxi., xxii., and xxvi. fig. 6; Sternberg, Vers. ii. p. 180, pl. lxviii. fig. 14.

- Stigmaria* (?) *Veltheimiana*, Brongniart, Prodrome, p. 88; Unger, Syn. plant. foss. p. 117.
- Lepidodendron acuminatum*, Stur, Culm Flora, Heft ii. p. 397, pl. xxxix. fig. 4; Unger, Genera et Species, p. 261.
- Sagenaria acuminata*, Feistmantel, Zeitschr. d. d. geol. Gesellsch. vol. xxv. p. 533; Göppert, Flora d. Silur., Devon., u. unt. Kohlenf., p. 524; id. Zeitschr. d. d. geol. Gesellsch. vol. iii. p. 196; id. Foss. Flora d. Uebergangsgebirges, p. 185, pls. xxiii. fig. 4, xliii. figs. 8-10; id. Neues Jahrb. p. 684 (1847); Ludwig, Palæontographica, vol. xvii. p. 123, pl. xxvi. fig. 2; Römer, Geol. v. Oberschlesien, p. 55; Schimper, Végét. du terr. trans. d. Vosges, p. 338, pl. xxvi. figs. 1-5.
- Lepidodendron geniculatum*, Schimper, Traité d. paléont. végét. vol. ii. p. 33.
- Sagenaria geniculata*, Giebel, Deutschl. Petrefacten, p. 80; Göppert, Foss. Flora d. Uebergangsgebirges, p. 186; Römer, Palæontographica, vol. iii. p. 46, pl. vii. fig. 13 (1854).
- Lepidodendron patens*, Schimper, Traité d. paléont. végét. vol. ii. p. 36.
- Selaginites patens*, Brongniart, Prodrome, p. 84; id. Hist. d. végét. foss. vol. ii. pl. xxvi.; Bronn, Index palæont. p. 1132; Unger, Syn. plant. foss. p. 141; id. Genera et Species, p. 272.
- Lepidodendron glincanum*, Schimper, Traité d. paléont. végét. vol. ii. p. 34; Schmalhausen, Mém. Acad. Impér. d. Sc. d. St. Pétersbourg, 7^e sér. vol. xxxi. p. 11, pl. ii. figs. 1 and 5-15, pl. iii. figs. 1-14 (1883) (excl. other figs. and syn. *L. Volkmannianum*).
- Sagenaria glincana*, Eichwald, Lethæa Rossica, vol. i. p. 127, pl. v. figs. 21 & 22, pl. v. a, figs. 1-6 (? figs. 7-10).
- Sagenaria confluens*, Eichwald, Lethæa Rossica vol. i. p. 121, pl. vii. fig. 1 (excl. syns.).
- Lepidodendron gracile*, Römer, Palæontographica, vol. xiii. p. 213, pl. xxxv. fig. 7.
- Lepidodendron Jaschei*, Römer, Palæontographica, vol. xiii. p. 213, pl. xxxv. fig. 6; Schimper, Traité d. paléont. végét. vol. ii. p. 32.
- Sagenaria polyphylla*, Geinitz, Flora Hainichen-Ebersd. p. 53, pl. vii.
- Sagenaria aculeata*, Feistmantel, Zeitschr. d. d. geol. Gesellsch. vol. xxv. p. 531, pl. xvii. fig. 33; Göppert, Flora d. Silur., Devon., u. unt. Kohl. p. 519, pls. xxxix., xl., xli.
- Lepidodendron Sternbergii*, Heer, Foss. Flora Spitzbergens, p. 11, pls. iii. figs. 1-20, iv. figs. 3 & 4 (excl. refs.).
- Lepidodendron selaginoides*, Heer, Foss. Flora Spitzbergens, p. 14, pl. iii. fig. 21.
- Sagenaria caudata*, Geinitz, Flora Hainichen-Ebersd. p. 53, pl. iv. fig. 4; Römer, Palæontographica, vol. ix. p. 9, pl. iii. fig. 5.
- Sagenaria elliptica*, Göppert, Foss. Flora d. Uebergangsgebirges, p. 184, pl. xliii. fig. 7; Ludwig, Palæontographica, vol. xvii. p. 122, pl. xxvi. fig. 1, a, b, c, d.
- Lycopodites dilatatus*, Geinitz, Flora Hainichen-Ebersd. p. 46, pl. x. fig. 1.
- Lepidodendron ornatissimum*, Brongniart, Prodrome, p. 85; id. Hist. d. végét. foss. vol. ii. pl. xviii.; Sternberg, Vers. i. fasc. 4, p. xii.
- Lepidodendron commutatum*, Heer, Foss. Flora d. Bären Insel, p. 39, pl. vii. figs. 8-10.
- Bergeria regularis*, Schmalhausen, Bull. de l'Acad. Impér. d. Sc. d. St. Pétersbourg, vol. xxii. p. 281, pl. ii. figs. 4 & 5.
- Bergeria alternans*, Schmalhausen, Bull. de l'Acad. Impér. d. Sc. d. St. Pétersbourg, vol. xxii. p. 281, pl. ii. fig. 6.
- Kuorria acicularis*, Göppert, Foss. Flora d. Uebergangsgebirges, p. 200,

- pl. xxx. fig. 3; Heer, Foss. Flora d. Bären Insel. p. 42, pl. viii. fig. 2 d, pl. x. figs. 6 & 7.
- ? *Knorria anceps*, Eichwald, Lethæa Rossica, vol. i. p. 153, pl. xii. figs. 2 & 3.
- ? *Knorria mammillaris*, Eichwald, Lethæa Rossica, vol. i. p. 155, pl. ix. fig. 4.
- Knorria imbricata*, Geinitz, Flora Hain.-Ebersd. p. 57, pls. viii. fig. 3, ix. figs. 1-3 (excl. figs. 2 and 4).
- Flemingites pedroanus*, Carruthers, Geol. Mag. vol. vi. p. 151, pl. v. (1869).
- ? *Ptychopteris microdiscus*, Eichwald, Lethæa Rossica, vol. i. p. 106, pl. v. figs. 2 & 3.
- Ulodendron commutatum*, Lesquereux, Coal-Flora of Pennsylv. p. 401, pl. lxvi. fig. 2; Schmalhausen, Mém. de l'Acad. Impér. d. Sc. d. St. Pétersbourg, 7^e sér. vol. xxxi. p. 17, pl. iv. figs. 7 & 8; Schimper, Traité d. paléont. végét. vol. ii. p. 40, pl. lxiii.
- Ulodendron parvum*, Carruthers, Monthly Microsc. Journ. vol. iii. p. 152, pl. xlv. fig. 1.
- Ulodendron Allani*, Bronn, Index palæont. p. 1341; Buckland, Geol. and Mineral. vol. ii. p. 92, pl. lvi. fig. 6.
- Ulodendron ovale*, Carruthers, Monthly Microsc. Journ. vol. iii. p. 152, pl. xlv. fig. 1.
- Ulodendron pumilum*, Eichwald, Lethæa Rossica, vol. i. p. 144, pl. x. fig. 5.
- Ulodendron Rhodeanum*, Bronn, Index palæont. p. 1341; Unger, Syn. plant. foss. p. 135.
- Ulodendron Rhodii*, Buckland, Geol. and Mineral. vol. ii. p. 93, pl. lvi. fig. 6.
- Ulodendron ellipticum*, ? Bronn, Index palæont. p. 1341; Eichwald, Lethæa Rossica, vol. i. p. 140, pls. ix. figs. 6 & 7, x. figs. 3, 4, & 6; ? Goldenberg, Flora Sarapontana fossilis, Heft i. p. 18; ? Sternberg, Vers. ii. p. 186, pl. xlv. fig. 2; ? Unger, Syn. plant. foss. p. 135; ? id. (in part) Genera et Species, p. 264.
- Ulodendron minus*, Thompson (in part), "Notes on *Ulodendron*," Trans. Geol. Soc. Edinb. vol. iii. p. 341, pl. a. figs. 2-3.
- Ulodendron transversum*, Eichwald, Lethæa Rossica, vol. i. p. 139 (? pl. vi. fig. 13), pl. ix. fig. 8.
- Ulodendron ornatissimum*, Tate, in Johnston's Nat. Hist. of the Eastern Borders, vol. i. p. 302 (1853).
- Phytolithus parvatus*, Steinhauer (in part), Amer. Phil. Trans. vol. i. 2nd ser. p. 287, pl. vii. fig. 1 (1818).
- Vegetable Impression*, Allan, Trans. Roy. Soc. Edinb. vol. ix. p. 235, pl. xiv. (1823).
- "*Schuppenpflanzen*," Rhode, Beitr. z. Pflanzenk. d. Vorwelt, p. 16, pl. iii. figs. 1-8.

Remarks. *Lepidodendron acuminatum* appears to be only a varietal form of *Lepidodendron Veltheimianum*, with which it has already been united by Schimper.

Lepidodendron geniculatum is also merely a form of the same species.

Lepidodendron patens (*Selaginites patens*, Brongn.), from the neighbourhood of Edinburgh, is likewise to be referred to *Lepidodendron Veltheimianum*. The peculiarities of Brongniart's specimen arise from its mode of preservation,

and many specimens from the Calciferous-Sandstone series, from which horizon Brongniart's example evidently originated, show the same characters. The peculiar appearance of the fossil to which the name of *Selaginites patens* has been given is caused by the basal portions of the leaves still retaining their attachment to the stem; and in other cases I have observed a very similar appearance produced by the leaves being adpressed (probably through mechanical agency) to the branches. Although not for a moment doubting that the specimens to which I refer are similar to that figured in vol. ii. pl. xxvi. of the Hist. d. végét. foss., examples with such an extremely scaly appearance are rare; but I have two at least in which it is as well marked as in the type figure of *Lepidodendron patens*, Brongn. sp.

Schmalhausen has united *Lepidodendron glincanum*, Eichwald, and *Lepidodendron Volkmannianum*, Sternberg, with *Lepidodendron Veltheimianum*, Sternberg*.

With regard to *Lepidodendron glincanum*, I cannot find any point by which it can be separated from *Lepidodendron Veltheimianum*, and therefore include it under that name. *Lepidodendron Volkmannianum* seems an altogether distinct species, and cannot be united with *Lepidodendron Veltheimianum*.

Lepidodendron (Sagenaria) glincanum, Eichwald, Lethæa Rossica, pl. v. a, fig. 7, should perhaps be referred to *Lepidodendron Volkmannianum*.

Lepidodendron (Sagenaria) aculeatum, Feistmantel and Göppert, *Lepidodendron Sternbergii* and *Lepidodendron selaginoides*, Heer, and *Lepidodendron (Sagenaria) caudatum*, Geinitz and Römer†, are all, I believe, referable to *Lepidodendron Veltheimianum*.

Lepidodendron Jaschei and *Lepidodendron gracile*, Römert‡, are both young conditions of *Lepidodendron Veltheimianum*.

The transverse bars that occur on the leaf-scars of *Lepidodendron gracile* have most probably been produced by shrinkage, and are frequently present on other species of *Lepidodendron*.

Bergeria regularis and *Bergeria alternans*, Schmalhausen†, only appear to represent different conditions of preservation of *Lepidodendron Veltheimianum*.

The core which lifted out of an impression of *Lepidodendron Veltheimianum* in my own collection agrees so entirely

* Mém. de l'Acad. d. Sc. de St. Pétersbourg, 7^e sér. vol. xxxi. no. 13, p. 11.

† For figures specially referred to see synonyms given on pp. 243-245.

with *Knorria acicularis* that I have no hesitation in referring that fossil to this species.

The explanation of how *Knorria* is formed will be learnt from an examination of the internal structure of *Lepidodendron*. As far as the present example of *Knorria acicularis* is concerned, the more delicate tissue surrounding the central vascular bundle appears to have decayed, and the bundle thus freed has probably floated out of the cortical cylinder, which subsequently became filled with sediment. Pressure now acting on the cortical cylinder has forced the mud which filled its interior up the small channels through which the foliar vascular bundles passed to the leaves; the bark next appears to have decayed, leaving the impression of its outer surface on the surrounding matrix. The preservation of the casts of the vascular-bundle channels has been assisted by the decayed bark remaining around them in the form of a fine powder, and so helping to prevent their obliteration by subsequent pressure or infiltration. In this manner were formed the little acicular points (the casts of the channels through which the foliar vascular bundles passed) which characterize *Knorria acicularis*, Göppert. Some specimens of *Knorria imbricata* appear to be formed by a partial decay of the outer surface of the bark before fossilization took place.

It is impossible to correlate the various named species of *Knorria* with the plants to which they really belong, as any species of *Lepidodendron* might produce one or more species of *Knorria*, according to the conditions which attended its mineralization*. *Lepidophloios* and the Clathrarian *Sigillaria* might also form *Knorria*-like fossils.

The type of *Flemingites pedroanus*, Carruthers, is in the collection of the British Museum. I have failed to see any character in which it differs from *Lepidodendron Veltheimianum*.

The figure given by Mr. T. Allan of a vegetable impression found in the quarry of Craigleith is a good example of *Lepidodendron Veltheimianum* showing the Ulodendroid scars†. This example was subsequently named *Ulodendron Allani* by Buckland and *Lepidodendron ornatissimum* by Brongniart. Lindley and Hutton mention Allan's figure as syno-

* There is in my collection a core, which lifts out of an impression of typical *Lepidodendron Veltheimianum*, and is identical with the figure of *Lepidodendron tetragonum* as given by Geinitz in his 'Darstellung der Flora des Hainichen-Ebersdorfer und des Flohaer Kohlenbassins,' pl. iii, fig. 2. My example came from the Calciferous-Sandstone series, Water of Leith, between Slateford and Colinton, Midlothian.

† Trans. Roy. Soc. Edinb. vol. ix. pl. xiv.

nymous with their *Ulodendron minus*; but this is a mistake, for Allan's specimen shows the *Lepidodendroid* leaf-scar, whereas Lindley and Hutton's plant belongs to the *Sigillarian* section of *Ulodendron*. The plate of *Ulodendron minus*, L. & H., would not at first lead one to this view; but from an examination of the counterpart of their fossil, all that is now preserved of their type*, I have been led to this conclusion. *Ulodendron majus*, L. & H., is only an older and larger example of their *Ulodendron minus*; hence its supposed identity with Rhode's pl. iii. fig. 1 is also erroneous. *Lepidodendron ornatissimum* and Rhode's pl. iii. figs. 1-8 are both referable to *Lepidodendron Veltheimianum*. Here must likewise be placed Eichwald's figures of *Ulodendron ellipticum*, which all appear to represent more or less imperfectly-preserved specimens of *Lepidodendron Veltheimianum*; his pl. x. fig. 6 †, in addition to exhibiting the leaf-scars of this *Lepidodendron*, shows also on other parts of the same fossil scars so preserved that they might be named with all propriety "*Knorria*." It is questionable whether most of the other figures which by different authors have been referred to *Ulodendron ellipticum* really belong to this plant.

Ulodendron transversum, Eichwald ‡, pl. ix. fig. 8, is another example, and a very interesting one, of the *Ulodendroid* condition of *Lepidodendron Veltheimianum*. In this figure are seen the characteristic leaf-scars, a *Knorria* condition, a decorticated state of the stem, and, finally, the large *Ulodendroid* scar. Eichwald's fig. 13, pl. vi., also probably belongs to this species, but the actual proof that it does so is not shown in the figure, which represents merely a *Knorria* condition of *Lepidodendron*.

Similar remarks to those just made on Eichwald's fig. 8, pl. ix., may also be applied to his *Ulodendron pumilum* ‡, pl. x. fig. 5. The large *Ulodendroid* scar appears to have been partly covered by the matrix, and consequently looks smaller than in some other examples, but does not seem to be specifically distinct from them. It is identical with his *Ulodendron transversum*, with which the leaf-scars agree in all particulars.

It is probable that the *Ptychopteris microdiscus* of the same author is only a badly-preserved specimen of *Lepidodendron Veltheimianum*. There is little evidence to support the view that this fossil is a fern-stem.

* In the "Hutton Collection," Newcastle-on-Tyne.

† For full reference see synonyms to *Lep. Veltheimianum*, p. 245.

‡ This is not the same species as that subsequently named *U. pumilum* by Mr. Carruthers.

Under *Pachyphlæus tetragonus*, Göppert* appears to have included portions of different plants. His fig. 5 cannot be distinguished from a *Ulodendroid* scar of *Lepidodendron Veltheimianum*, but, his other figures do not seem to belong to this plant.

Some writers have proposed the union of *Lepidodendron corrugatum*, Dawson, with *Lepidodendron Veltheimianum*; and "so closely does the last species resemble *Lepidodendron corrugatum*, that Schimper and other palæobotanists conversant with the protean forms of this species, and knowing ours only by imperfect figures, may well be excused for regarding them as identical" †. As mentioned in the above quotation, some figures of *Lepidodendron corrugatum* are scarcely distinguishable from *Lepidodendron Veltheimianum*; but, through the kindness of Sir Wm. Dawson, who has forwarded me a series of specimens representing his plant at different stages of growth, I have been able to compare them with well-preserved examples of *Lepidodendron Veltheimianum*, and feel convinced that *Lepidodendron Veltheimianum*, Sternberg, and *Lepidodendron corrugatum*, Dawson, cannot be united.

The three figures given by Stur in his 'Culm Flora,' pl. xxxix. figs. 1 a, 1 b, and 2, do not belong to this species, but to *Sigillaria Taylori*, Carruthers, sp.

Localities and Horizons.

SCOTLAND—Carboniferous-Limestone Series.

Ayrshire: Spittal Hill, Craigie Range, 3½ miles S.E. of Kilmarnock (*Rev. D. Landsborough*).

Lanarkshire: Shale above Calderwood Cement-stone, East Kilbride (*A. Patton*); Possil Ironstone, Keppock Hill, near Glasgow (*J. Bennie*); Carluke (*collection of British Museum*).

Linlithgowshire: Roof of Easter Main Coal, Bo'ness (*H. M. Cadell*); Shale above Ironstone, No. 6 Pit, Grange, Bo'ness (*H. M. Cadell*); Brown Ironstone, Bo'ness (*H. M. Cadell*); Blaes, 20 feet above Lower Ironstone, No. 6 Pit, Grange, Bo'ness (*H. M. Cadell*).

Midlothian: Cowden, near Dalkeith (*D. Grieve*); Burghlee Pitt, near Loanhead.

Stirlingshire: Todholes, Bannockburn, about 400 yards above Bridge on Denny Road; Raploch Quarry, near Stirling (*G. Macdougall*).

* Syst. fil. foss. p. 468, pl. xliii.

† Dawson, Foss. Plants of Lower Carbon. and Millstone-Grit Formations of Canada, p. 21.

SCOTLAND—Calciferous-Sandstone Series.

Berwickshire : Shore, Cove, Cockburnspath (*J. Bennie*) ;
Cliff, Cove, Cockburnspath (*J. Bennie*).

Fife : Kilmundy Limestone Quarry, Burntisland (*J. Bennie*) ; Kilmundy Sandstone Quarry, Burntisland (*J. Bennie*) ; Grange Quarry, Burntisland ; Dod-head Quarry, 1 mile N.E. of Burntisland (*J. Bennie*) ; Pettycur, Fife.

Haddingtonshire : Long-Craig Bay, 1½ mile west of Dunbar.

Linlithgow : Shore, E. and W. of Society, Hopetoun, Queensferry (*J. Bennie*) ; Shore, Dalmeny, E. of Newhall Pier (*J. Bennie*) ; Dalmeny (*Dr. Macfarlane*) ; Shore, near Long-Craig Pier, Dalmeny (*J. Bennie*).

Midlothian : Raw Camps, near Midcalder ; Juniper Green (*T. Henderson*) ; Shore, Wardie ; Craigleith Quarry (*T. Allan*) ; Addiewell, West Calder ; Burdiehouse, near Edinburgh ; Granton (*J. Gaul*) ; Water of Leith, Spylaw House, Colinton (*J. Bennie*) ; Hailes Quarry, near Edinburgh ; Woodhall, Water of Leith, near Juniper Green (*J. Bennie*) ; Straiton Oil Works, near Loanhead ; Shale over shell-bed, Railway-cutting, 300 yards N. of canal, Murchiston, Edinburgh (*J. Bennie*) ; Railway-cutting, Water of Leith, between Slateford and Colinton (*J. Bennie*) ; Straiton Brick-works, near Loanhead, West Calder.

ENGLAND—From Rocks of Calciferous-Sandstone Age*.

Northumberland : Chirden Burn, near Hope House, North Tynedale, specimen loose in drift (*H. Miller*) ; Alnwick Moor (*G. Tate*) ; Yate Burn, 2 miles S.S.W. of High Long House ; Chattlehope Burn, 2 miles S.W. of Chattlehope House, Rede Water (*T. Rhodes*) ; near Chillingham (*Mus. N. H. Soc. of Northumberland, Durham, and Newcastle-on-Tyne*).

* The Calciferous Sandstones of the border counties are now looked upon by the Geological Survey as being the equivalent of part of the Carboniferous Limestone of Derbyshire and Yorkshire. The Scottish "Carboniferous-Limestone series" represents the Yoredale rocks of the North of England.

England.

Scotland.

Lower Carboniferous.

Yoredale rocks	Carboniferous-Limestone series.
Carboniferous Limestones of Yorkshire and Derbyshire.	{ Calciferous-Sandstone series.

Devonian.

Devonian (Old Red Sandstone) Old Red Sandstone.

SIGILLARIA, Brongniart, 1822.

[Sur la classification et la distribution des végétaux fossiles, p. 9.]

Section *Clathrarice*.*Sigillaria discophora*, König, sp.

(Pl. IV. fig. 5; Pl. V. fig. 8; Pl. VII. figs. 12, 13.)

Lepidodendron discophorum, Bronn, Index palæont. p. 650; König. Icones fossilium sectiles, pl. xvi. fig. 194 (1825).*Ulodendron majus*, Bronn, Index palæont. p. 1341; Carruthers, Monthly Micr. Journ. vol. iii. p. 153, pl. xliii. fig. 4 (1870); Giebel, Deutschl. Petrefacten, p. 82; Goldenberg, Flora sarapontana fossilis, Heft i. p. 18; Lesquereux, Geol. Survey of Illin. vol. iv. p. 435; id. Geol. of Pennsylv. vol. ii. p. 875; id. Coal Flora of Pennsylv. p. 401 (? pl. lxvi. fig. 3) (excl. refer. Steinhauer); Lindley & Hutton, Foss. Flora, vol. i. pl. v. (excl. refer.); Renault, Cours d. botan. foss. p. 50, pl. xi. fig. 3 (1882); Röhl, Foss. Flora d. Steink. Form. Westph. p. 138; Schimper, Traité d. paléont. végét. vol. ii. p. 41 (syn. and refer. in part); Sternberg, Vers. ii. p. 185; Unger, Syn. plant. foss. p. 134; id. Genera et Species, p. 263.*Ulodendron minus*, Bronn, Index palæont. p. 1341; Carruthers, Monthly Micr. Journ. p. 225, pl. xxxi. (1869); id. ibid. vol. iii. p. 153 (1870); Eichwald, Urwelt Russlands, Heft i. p. 82; Giebel, Deutschl. Petrefacten, p. 82 (excl. syn.); Goldenberg, Flora sarapontana fossilis, Heft i. p. 18; Lindley & Hutton, Foss. Flora, vol. i. pl. iv. (excl. refer.); Lesquereux, Coal Flora of Pennsylv. p. 403 (? pl. lxvi. fig. 1); Renault, Cours d. botan. foss. p. 50, pl. xi. fig. 2 (1882); Röhl, Foss. Flora d. Steink. Form. Westph. p. 139 (excl. syn.); Schimper, Traité d. paléont. végét. vol. ii. p. 42 (syn. in part); Sternberg, Vers. ii. p. 185, pl. xlv. fig. 5; Unger, Syn. plant. foss. p. 135 (excl. refer. Allan & Brongt.); id. Genera et Species, p. 263 (excl. refer. Allan & Brongt.); Zeiller, Végét. foss. du terr. houil. p. 115.*Bothrodendron punctatum*, Bronn, Index palæont. p. 173; Goldenberg, Flora Sarapontana fossilis, Heft i. p. 18; Lindley & Hutton, Foss. Flora, vol. ii. pls. lxxx. & lxxxi.; Morris, Trans. Geol. Soc. 2nd ser. vol. v. p. 489; Renault, Cours d. botan. foss. p. 52, pl. xi. fig. 4 (1882).*Ulodendron punctatum*, Schimper, Traité d. paléont. végét. vol. ii. p. 42.*Ulodendron Lindleyanum*, Lesquereux, Geol. of Pennsylv. p. 875 (1858); Sternberg, Vers. ii. p. 185, pl. xlv. fig. 4; Unger, Syn. plant. foss. p. 135; id. Genera et Species, p. 263.*Ulodendron ellipticum*, Röhl, Foss. Flora d. Steink. Form. Westph. p. 139, pl. xxiii. fig. 3 (? fig. 4).*Ulodendron Stokesii*, Buckland, Geol. & Mineral. vol. ii. p. 93, pl. lvi. fig. 5; Carruthers, Monthly Micr. Journ. vol. iii. p. 152, pl. xlv. fig. 3.? *Ulodendron Conybearii*, Buckland, Geol. & Mineral. vol. ii. p. 94, pl. lvi. fig. 6'.?? *Ulodendron transversum*, Carruthers, Monthly Micr. Journ. vol. iii. p. 153, pl. xlv. fig. 2.*Ulodendron pumilum*, Carruthers, Monthly Micr. Journ. vol. iii. p. 152, pl. xliii. fig. 2.

- Ulodendron Lucasii*, Buckland, Geol. & Mineral. vol. ii. p. 93, pl. lvi. fig. 4.
- Lepidophloios parvus*, Dawson, Acad. Geol. 2nd ed. p. 470, fig. 170 *g* (1868); id. Quart. Journ. Geol. Soc. vol. xxii. p. 163, pl. xi. fig. 50; id. Canad. Natur. vol. viii. p. 453; id. Quart. Journ. Geol. Soc. vol. xxx. p. 216; id. Foss. Plants of Lower Carb. & Millstone Grit of Canada, p. 38.
- Lepidophloios tetragonus*, Dawson, Acad. Geol. 2nd ed. p. 490, fig. 170 *d* (1868); id. Quart. Journ. Geol. Soc. vol. xxii. p. 164, pl. x. fig. 49; id. Canad. Natur. vol. viii. p. 453; id. Foss. Plants of Lower Carb. & Millstone Grit of Canada, p. 37.
- Lepidodendron salebrosum*, Wood, Trans. Amer. Phil. Soc. vol. xiii. p. 345, pl. viii. fig. 6.
- Halonnia disticha*, Morris, Trans. Geol. Soc. 2nd ser. vol. v. p. 489, pl. xxxviii. fig. 1.
- Sigillaria Preuliana*, Römer, Palæontographica, vol. ix. p. 42, pl. xii. fig. 7 (1862).
- Sigillaria perplexa*, Wood, Trans. Amer. Phil. Soc. vol. xiii. p. 345, pl. viii. fig. 7.
- Sigillaria Menardi*, Lesquereux, Geol. Survey of Illin. vol. ii. p. 450, pl. xliii.

Description. Leaf-scars rhomboidal, contiguous, their transverse diameter slightly greater than their vertical diameter, placed on slightly elevated cushions, whose size but little exceeds that of the leaf-scar. Upper and lower angles of leaf-scar rounded, lateral angles sharp and prominent. Vascular impressions situated towards the upper part of the leaf-scar; central punctiform, the two lateral lunate. Certain branches bear two opposite vertical rows of large (*Ulodendroid*) scars, those of one row alternating in position with those of the corresponding vertical row. Large scars more or less oval, usually touching each other. Bark generally fissured longitudinally, especially in older examples. Decorticated branches also exhibit longitudinal fissures and show on their surface small "dots" arranged in quincuncial order. Leaves single-nerved, grass-like. Fructification (sessile?) cones attached to the vertical rows of large scars.

Remarks. I have found associated with this species peculiar (sessile?) cones (at least I have never seen them attached to stems or twigs), which I believe to be the fructification of this species. They appear to differ from the cones of *Lepidodendron*, and are the same as those figured by Brongniart (Hist. d. végét. foss. vol. ii. pl. xxii. figs. 2, 3, and 8*).

As far as known to me, the ramification of this species has not been observed, nor yet the termination of the branches.

This species was first figured as a *Lepidodendron*, without any description, by König, about 1825. Bronn is the only

* On the fructification of *Sigillaria*, see Zeiller, Ann. des Sci. nat. 6^e sér. Bot. vol. xix. p. 256.

author, as far as I am aware, who takes any notice of König's plate, which is very characteristic of the species. A plaster cast of the specimen he figured is preserved in the collection of the British Museum; it measures $6\frac{1}{2}$ inches long and 3 inches wide, and bears two perfect *Ulodendroid* scars and a portion of a third one. These are about two inches in diameter. The rhomboidal leaf-scars are seen in the figure, and a separate drawing of them is also given, but they show no trace of the vascular-bundle "dots."

This, like all König's figures, is extremely characteristic of the species, and is one of the best representations of the plant with which I am acquainted.

Lindley and Hutton's *Ulodendron majus* agrees in all respects with this figure, which evidently must have been unknown to the authors of the 'Fossil Flora,' as they make no reference to it. In regard to Lindley and Hutton's plate, the leaf-scars appear to be a little roughly drawn, their upper angle being too acute and the boundary-lines of the lower portion of the leaf-scar too convex. Their reference to Rhode's pl. iii. fig. 1 must be excluded, as Rhode's figure belongs to *Lepidodendron Veltheimianum* and not to their *Ulodendron majus*.

From the examination of numerous specimens, many of which were in exquisite preservation, there can remain no doubt that *Ulodendron minus*, L. & H., is only a slightly younger stem of *Ulodendron majus*, L. & H. The reference they give to Allan's plate of the *Ulodendron* from Craigleith Quarry, as synonymous with their *Ulodendron minus*, must also be cancelled, as Allan's plant is likewise *Lepidodendron Veltheimianum*, Sternberg. I have carefully examined the counterpart of the type of *Ulodendron minus*, L. & H., which is now all that is known to exist of the fossil, and am assured by the shape of the leaf-scars that it is Sigillarian, they being in fact of the same form as that described by Römer in *Sigillaria Preuiana*; but this point will be more fully discussed presently*. The figure of *Ulodendron minus*, given by Lesquereux in the 'Coal Flora of Pennsylvania,' and which appears to be inverted, is not very satisfactory, but is probably Lindley and Hutton's plant. The same author gives an excellent figure of *Sigillaria discophora*, König, sp., in the Geol. Survey of Illinois, vol. ii. p. 450, pl. xliii., under the name of *Sigillaria Menardi*, where the character of the leaf-scar is clearly shown. The specimen he figures has been a comparatively old stem, but is very characteristic of the species. In fact Lesquereux here notices the Sigillarian nature of his

* See p. 256.

fossil, and places it in the correct genus, but perhaps not under the right species, though I am by no means sure that *Sigillaria Menardi*, Brongniart (Hist. d. végét. foss. pl. clviii. fig. 5, not fig. 6), does not belong to *Sigillaria discophora*.

It is a little uncertain if the figure given as *Ulodendron majus* by Lesquereux in his 'Coal Flora,' pl. lxvi. figs. 3 & 3 a, belongs to Lindley and Hutton's plant. The explanation of the figures is, I am afraid, inaccurate, if they belong to the species under which he has placed them. He appears to have had under consideration two distinct plants. Perhaps his fig. 3 a is the *Bothrodendron punctatum*, Zeiller *, which is not, however, the *Bothrodendron punctatum* of Lindley and Hutton†. The *Bothrodendron punctatum*, Lindley and Hutton, is only a decorticated condition of their *Ulodendron majus* and *U. minus*. The plant which Zeiller has figured and identified as Lindley and Hutton's *Bothrodendron punctatum* is a closely allied species to *Rhytidodendron minutifolium*, Boulay ‡, and it is interesting to find the large Ulodendroid scars also occurring in Boulay's genus *Rhytidodendron*.

Ulodendron punctatum, Sternberg, Vers. ii. p. 186, pl. xlv. fig. 1.—As this specimen is decorticated it is impossible to determine the species to which it should be referred, though, from the closeness of the foliar vascular bundles to each other, it probably belongs to the Sigillarian group of *Ulodendron*. Even in decorticated conditions of the so-called *Ulodendra*, if the little "dots" of the foliar-vascular bundles are shown, there can be made in many cases a probable determination as to whether the specimen belongs to the Lepidodendroid or Sigillarian group of *Ulodendron*, for on the Lepidodendroid members the leaf-scars are larger than on the Sigillarian, and consequently the foliar-vascular-bundle "dots" on decorticated stems of Sigillarian *Ulodendra* stand nearer to each other than they do on Lepidodendroid *Ulodendra*. This is not, however, in all cases a secure generic test, and in no case will it lead to a specific determination. When the little "dots" are not shown, it is impossible even to say to which genus a Ulodendroid fossil belongs.

Ulodendron ellipticum, Sternberg, Vers. ii. p. 186, pl. xlv. fig. 2, does not admit of any satisfactory allocation. *Ulodendron ellipticum*, Röhl (l. c.), pl. xxiii. fig. 3, appears to be referable to *Sigillaria discophora*; but his fig. 4 of the same

* Ann. des Scienc. nat. 6^e sér. Botan. vol. xiii. p. 218, pl. ix. figs. 1-3, and Végét. foss. du terr. houil. p. 116.

† See *antè*, pp. 138 and 174.

‡ Boulay, Terr. houil. du nord de la France et ses végét. foss. p. 39, pl. iii. figs. 1, 1 bis.

plate is too indifferently preserved to speak of with any certainty. Neither can any definite identification be made of *Ulodendron Lindleyana*, Röhl (*l.c.*), p. 138, pl. xxiii. figs. 1, 2. Nor can one speak with more certainty as to the specific designation of *Ulodendron Schlegelii*, Eichwald, 'Lethæa Rossica,' vol. i. p. 138, and 'Urwelt Russlands,' Heft i. p. 81, pl. iii. fig. 4.

Ulodendron transversum, Carruthers (*l.c.*) (not Eichwald) (which does not, in the few characters that the fossil shows, appear to differ from *Ulodendron Schlegelii* and *Ulodendron Conybearii*, Buckland), is also probably to be referred to *Sigillaria discophora*. Of course, in discussing the nature of *Ulodendron*, absolutely nothing for the elucidation of its true affinities can be learnt from such examples as those just mentioned, though, if at all possible, one is naturally anxious to correlate them with the species of which they are decorticated examples.

The small figure which Buckland gives of his *Ulodendron Lucasii* is not all that could be desired for a satisfactory determination; but from the form of the few leaf-scars, as shown in his figure, there is little reason to doubt that this species should also be placed under *Sigillaria discophora*.

I am unable to discover any point by which *Ulodendron pumilum*, Carruthers, can be distinguished from *Sigillaria discophora*. The specimen from which Mr. Carruthers's figure is taken is in the collection of the British Museum, and shows very well the Sigillarian form of the leaf-scars. This fossil is somewhat smaller in all its parts than König's example, but this difference is entirely dependent on age. A figure agreeing in all essentials with that of Mr. Carruthers, and which I also refer to *Sigillaria discophora*, had previously been published by Dawson in his 'Acadian Geology,' 2nd ed. fig. 170 G, p. 455 (1868), under the name of *Lepidophloios parvus*. What I believe to be only an older state of *Lepidophloios parvus* is the *Lepidophloios tetragonus*, also figured by Dawson on p. 455 of the same work, and in the Quart. Journ. Geol. Soc. vol. xxii. pl. x. fig. 49 (see Pl. VII. fig. 13 a*).

Halonia disticha, Morris (*l.c.*), must also be united with *Sigillaria discophora*. Specimens preserved "in the round," similar to his figure, are by no means uncommon. The presence of only two rows of large scars on his fossil is sufficient to remove it from *Halonia* (= *Lepidophloios*), and the other characters of the specimen show its true place to be here.

Geinitz, in his Verst. d. Steinkf. in Sachsen, p. 38, appears to have misunderstood the true nature of Lindley and Hutton's

* See also *ante*, p. 178.

genus *Bothrodendron*, for, under the name of *Halonia punctata*, he includes different plants.

Lepidodendron salebrosum and *Sigillaria perplexa*, Wood, are only fragments of *Sigillaria discophora*.

Both in *Sigillaria perplexa* and in the figure given under the name of *Sigillaria Menardi* by Lesquereux, the longitudinal clefts which appear in the bark of old examples are well seen. A similar vertical splitting of the bark also takes place in the succeeding species (*Sigillaria Taylora*, Carruthers, sp.), and has already been pointed out as occurring in *Lepidodendron Veltheimianum*.

One of the most interesting figures of this species has been given by Römer in the 'Palæontographica,' vol. ix. pl. xii. fig. 7, under the name of *Sigillaria Preuiana*. He says of his plant, on p. 42 :—"The leaf-cushions stand, as in *Lepidodendron*, in oblique rows; they are rhomboidal or six-sided, as long as broad, slightly elevated, and show above the middle a round scar, on each side of which are two semilunar scars. The leaf-scar is almost as large as the leaf-cushion." I have seen many well-preserved specimens of *Sigillaria discophora* with the leaf-scars identical with those described by Römer as occurring in his *Sigillaria Preuiana*, and were it not for the presence of the large Ulodendroid scars on these specimens they could not have been distinguished from Römer's plant. Hence, as *Sigillaria Preuiana* agrees in all the characters that it shows with undoubted specimens of *Sigillaria discophora* we have no course left but to unite these two species. Portions of some of those examples of *Sigillaria discophora*, to which I have referred, might be broken off from those parts where the large scars do not occur and would be undistinguishable from *Sigillaria Preuiana*, Römer. I am also strongly inclined to think that *Lepidodendron pustulatum*, Boulay*, is not specifically distinct from *Sigillaria discophora*, König, sp. *Sigillaria discophora* appears to be restricted to the Coal-measures.

Localities and Horizons.

SCOTLAND—Coal-measures.

Ayrshire: Bonnington Pit, Kilmarnock (*Rev. D. Landsborough*).

Clackmannanshire: Devonside, Tillicoultry (*T. Mitchell*); Furnace Bank Colliery, Old Sauchie.

Lanarkshire: "Airdrie Coal Field" (*Hunterian Museum, Glasgow*); near Carluke (*collection of British Museum*); Shotts (*ditto*); Shettleston (*R. Dunlop*).

Perthshire: Blairingone Colliery, $1\frac{3}{4}$ mile S.E. of Dollar.

* Boulay, Le terr. houil. du nord de la France et ses végét. foss. p. 37, pl. ii. figs. 2, 2 bis. Lille, 1876.

ENGLAND—Coal-measures.

Durham: High Main Seam, South Shields (*Type of U. minus*, *Hutton collection*).

Northumberland: Bensham Seam, Jarrow (*Type of U. majus*, *Hutton collection*).

Shropshire: Coalbrookdale (*Type of Halonia disticha*, *Prof. Morris*).

Staffordshire: Longton (*J. Ward*); Low Moor (*collection of British Museum*).

Worcestershire: Bewdley (*collection of British Museum*).

Yorkshire: Boldshaw, Bradford Moor, Bradford (*collection of British Museum*); Wakefield (*ditto*).

Sigillaria Taylora, Carruthers. (Pl. IV. figs. 6, 6 a;
Pl. V. fig. 9; Pl. VI. figs. 10, 10 b, c, d.)

Ulodendron Taylora, Carruthers, *Monthly Micr. Journ.* vol. iii. p. 152, pl. xliii. fig. 1 (1870).

Ulodendron minus, Thompson, "On *Ulodendron* and *Halonia*," *Trans. Edinb. Geol. Soc.* vol. iii. p. 341, pl. (B).

Lepidodendron Veltheimianum, Stur (in part), *Culm Flora*, pl. xxxix. figs. 1, 2.

Sigillaria, sp., Kidston in Cadell, *Trans. Edinb. Geol. Soc.* vol. iv. p. 335.

Description. Branches dichotomizing; leaf-scars small, rhomboidal, contiguous, their transverse and vertical diameters being almost equal. Leaf-scars placed on slightly elevated cushions, whose size little exceeds that of the leaf-scar; upper and lower angles of leaf-scar rounded, lateral angles sharp, but scarcely produced. Vascular impression situated towards the upper part of the leaf-scar. Certain branches bear two opposite vertical rows of large (*Ulodendroid*) scars, those of one row alternating in position with those of the corresponding vertical row. Large scars circular, occasionally oval, usually separated by a slight interval, but sometimes touching each other. Bark generally fissured by longitudinal clefts. Large scar-bearing branches ending in a truncated apex. Decorticated specimens also exhibit the longitudinal fissures and show on their surface small "dots" arranged in quincuncial order. Leaves single-nerved, lanceolate. Fructification (sessile?) cones attached to the vertical rows of large scars.

Remarks. This species is much smaller in all its parts than *Sigillaria discophora*, nor do its branches appear to have attained the same magnitude as those of the last-mentioned species. The leaf-scars also are more truly rhomboidal.

The form of the leaf-scars is not well shown in the type specimen of this species, but they are better shown in the three other figures of this plant, which have been given under the

names of *Ulodendron minus* and *Lepidodendron Veltheimianum*.

It is difficult to understand how Dr. Stur has included his two figures of *Sigillaria Taylora* under *Lepidodendron Veltheimianum*, as no state of preservation or age could account for the leaf-scars of *Lepidodendron Veltheimianum* becoming so altered as to assume the form and arrangement shown in his 'Culm Flora,' pl. xxxix. figs. 1, 2. His fig. 1 shows an older condition of *Sigillaria Taylora* than his fig. 2. The right-hand upper corner of this last-mentioned figure indicates clearly the Sigillarian form of the leaf-scar, and how close the affinities of this species are with *Sigillaria discophora*. Mr. D'Arcy Thompson has figured an example of this species (*Ulodendron minus*, l. c.) with the lower portion of the appendicular organ attached. The Clathrarian form of the leaf-scars is well shown in his figure, but even better on his specimen, which he has kindly lent me for examination.

I have already given a description of an example of this species (No. 18), collected by Dr. Macfarlane, which shows the appendicular organs in a young condition, attached to the stem (Pl. V. fig. 9).

This species is restricted to the Lower Carboniferous (Carboniferous-Limestone series and Calciferous-Sandstone series).

Localities.

SCOTLAND—From the Carboniferous-Limestone Series.

Linlithgowshire: Blaes, 20 ft. above Parrot Seam, No. 6 Pit, Grange, Bo'ness (*H. M. Cadell*); Silver-Mine Quarry, Linlithgow (*H. M. Cadell*); Bathgate (*type of species in the collection of the British Museum*).

From the Calciferous-Sandstone Series.

Midlothian: Camps Lime Quarry, near Midcalder (*R. F. B. Bishop*); Straiton, near Loanhead; Addiewell; West Calder; Midcalder.

I conclude by thanking the friends who have so kindly and willingly submitted to me for examination many specimens, which have been of the greatest use while drawing up these notes.

EXPLANATION OF THE PLATES.

PLATE III.

Fig. 1. *Lepidodendron Veltheimianum*, Sternberg. From Burghlee, Loanhead, Midlothian. Calciferous-Sandstone series. Natural size. (Specimen No. 1.)

PLATE IV.

- Fig. 2. Lepidodendron Veltheimianum*, Sternberg. From the Oil Shales, West Calder, Midlothian. Specimen in the collection of the Addiewell Oil Co., Addiewell, Midlothian. Calciferous-Sandstone series. Natural size. (Specimen No. 3.)
- Fig. 3. Lepidodendron Veltheimianum*, Sternberg. From Dalmeny, Linlithgowshire. Calciferous-Sandstone series. Natural size. Specimen collected by Dr. Macfarlane, Edinburgh. (Specimen No. 4.)
- Fig. 4. Lepidodendron Veltheimianum*, Sternberg. From West Calder, Midlothian. Calciferous-Sandstone series. Natural size. (Specimen No. 5.)
- Fig. 5. Sigillaria discophora*, König, sp. From Furnace-Bank Pit, Old Sauchie, Clackmannanshire. Coal-measures. Natural size. (Specimen No. 15.) 5 *a*. A few leaf-scars from fig. 5, enlarged.
- Fig. 6. Sigillaria Taylora*, Carruthers, sp. From Camps Lime Quarry, Midcalder, Midlothian. Calciferous-Sandstone series. Natural size. (Specimen No. 16.) Collected by the late R. F. B. Bishop, Esq., Edinburgh. 6 *a*. A few leaf-scars from fig. 6, enlarged.
- Fig. 7. Sigillaria Brardii*, Brongniart. A few leaf-scars copied from Brongniart (*Hist. d. végét. foss.* pl. clviii. fig. 4.).

PLATE V.

- Fig. 8. Sigillaria discophora*, König, sp. From "Coal-measures, British." Specimen in the collection of the Geological Survey of Great Britain, Museum of Practical Geology, London. Natural size. (Specimen No. 13.)
- Fig. 9. Sigillaria Taylora*, Carruthers, sp. From Calciferous-Sandstone series. Natural size. (Specimen No. 18.)

PLATE VI.

- Fig. 10. Sigillaria Taylora*, Carruthers, sp. From the Oil Shales, near Addiewell, Midlothian. Calciferous-Sandstone series. $\frac{1}{4}$ natural size. (Specimen No. 17.) In the collection of the Addiewell Oil Co. 10 *b*. Small portion of stem, natural size, marked *b* on fig. 10. 10 *c*. Ulodendroid scar marked *c* on fig. 10, natural size. 10 *d*. Small portion of stem, marked *d* fig. 10, showing the *Bothrodendron*-condition of the plant.
- Fig. 11. Lepidodendron Veltheimianum*, Sternberg. From Blackbraes, West Calder, Midlothian. Calciferous-Sandstone series. $\frac{1}{4}$ natural size. (Specimen No. 6.) Collected by J. Linn, Esq. 11 *a*. A few of the leaf-scars, marked *a*, fig. 11, natural size. 11 *b*. Profile view of appendicular organ, which fits into the depressed Ulodendroid scar of fig. 11, natural size. 11 *c*. Basal view of appendicular organ, natural size.

PLATE VII.

- Fig. 12. Sigillaria discophora*, König, sp. From Devonside, Tillicoultry, Clackmannanshire. Coal-measures. Natural size. (Specimen No. 12.) Collected by Mr. T. Mitchell, Tillicoultry. 12 *a*. A few leaf-scales from part marked *a*, fig. 12, enlarged. 12 *b*. A few leaf-scars from part marked *b*, fig. 12, to show variation in form of leaf-scar, enlarged.

- Fig. 13. *Sigillaria discophora*, König, sp. From Furnace-Bank Pit, Old Sauchie, Clackmannanshire. Coal-measures. (Specimen No. 14.) $\frac{1}{4}$ natural size. 13 *a*. A few leaf-scars, natural size. 13 *b*. Small portion of fig. 13, showing *Bathrodendron*-condition, natural size.
- Fig. 14. *Lepidophloios scoticus*, Kidston. From West Calder, Midlothian. Calciferous-Sandstone series. *a*, articulating leaf-surface; *g*, downward-directed cortical cushion.
- Fig. 15. *Lepidodendron aculeatum*, Sternberg. Leaf-scar, to show its various parts: *a*, vascular scar or impression; *b*, vascular-bundle impression; *cc*, the "field;" *dd*, oval pits; *e*, "ligule" depression; *f*, medial line.

XXV.—*Chilomonas paramæcium*. By SARA GWENDOLEN FOULKE*.

[Plate IX. B. figs. 1-6.]

SINCE its discovery by Ehrenberg this form has been carefully studied by Bütschli, Stein, and Kent, the two latter giving the first entirely accurate diagnosis of its character.

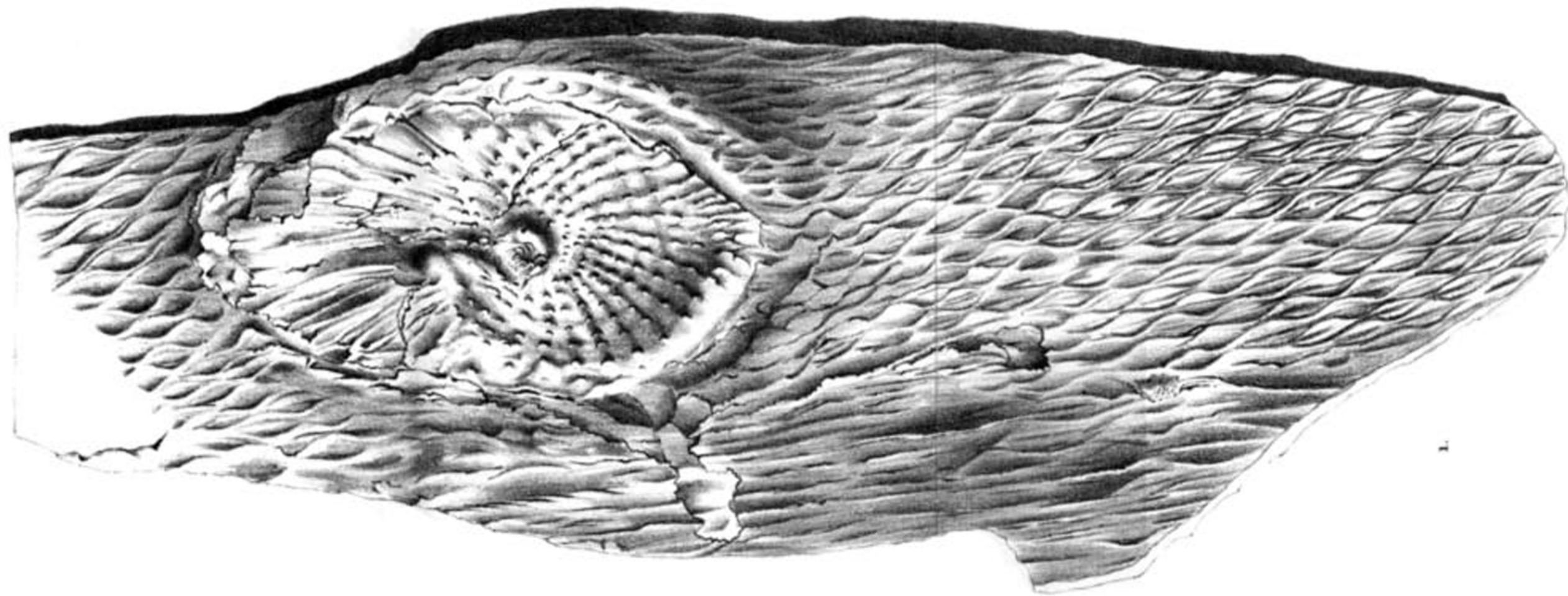
According to Kent *Chilomonas* is classified as follows:—Order Flagellata-Eustomata; Family Chilomonadidæ; Genus *Chilomonas*.

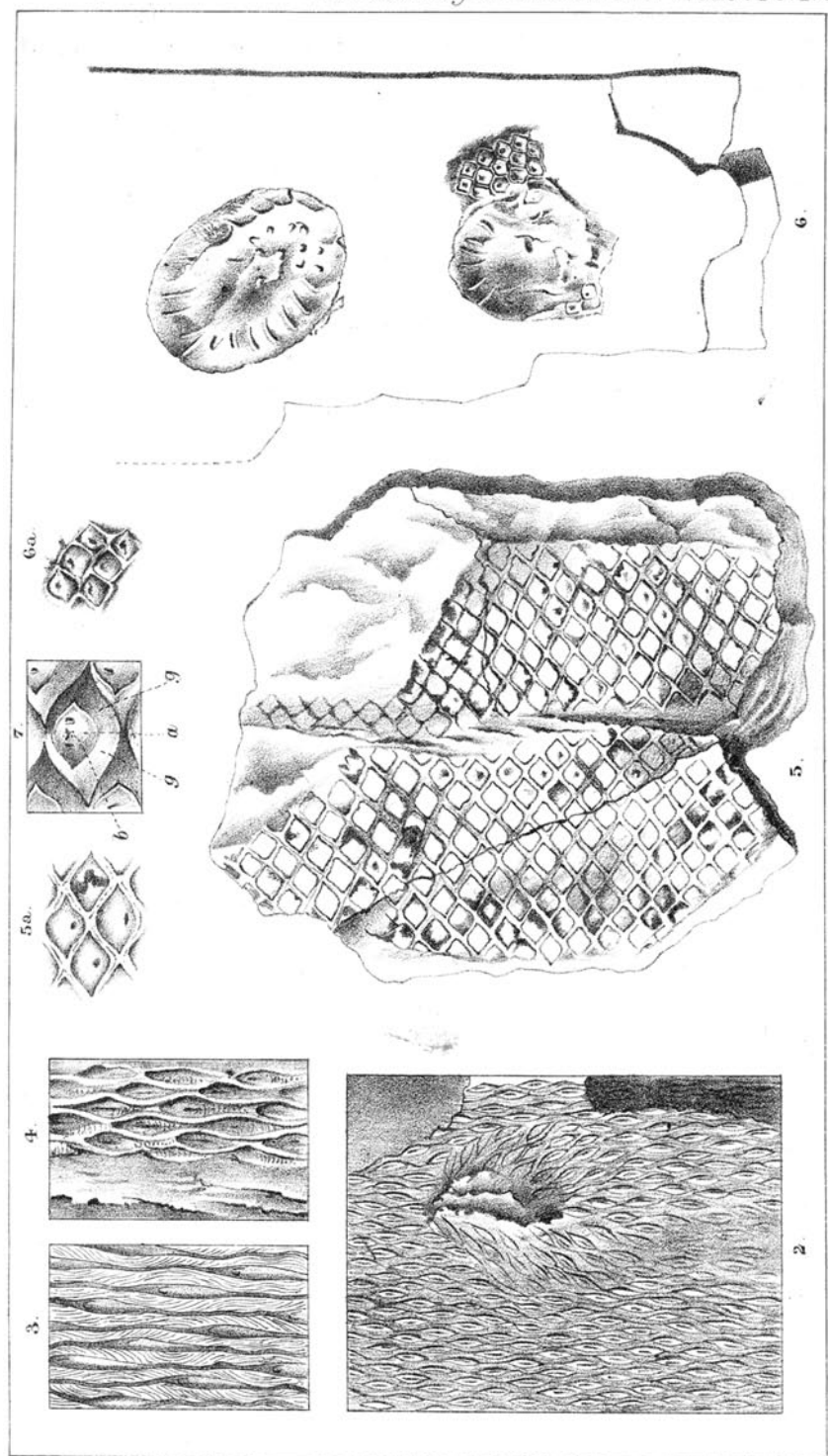
Fig. 1, Pl. IX. B, represents the form so accurately that no detailed description is necessary.

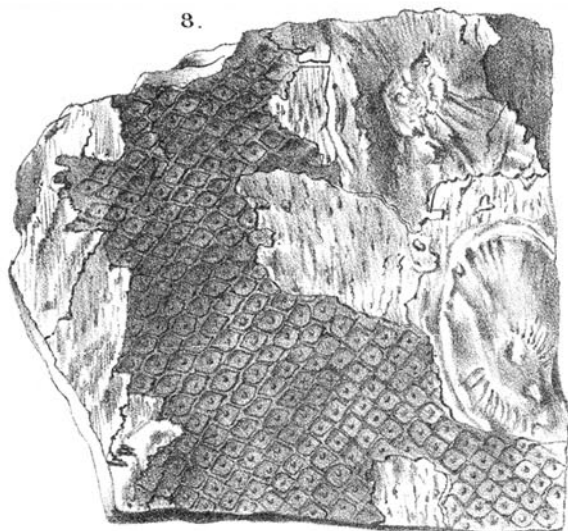
Bütschli states that this animalcule, when isolated for observation, quickly loses its normal contour, and becomes spherical, finally disintegrating.

While I was investigating a drop of water teeming with *Chilomonas* a minute flagellate amœboid form (fig. 2) entered the field, and after swimming uncertainly about for some moments, settled to the bottom of the live-box, where it moved in amœboid fashion, the two flagella becoming merged in the pseudopodium-like processes. The presence of about twenty small highly refractive bodies, suspected to be germs, was noticed. Soon the mass became so diffused as to form a mere film, and presently disintegrated, setting free these bodies, which swam away. Several similar individuals were found, some of which, on becoming quiescent, took a globular shape, retaining both flagella to the last. This sphere then grew larger and its wall thinner, until, like a bubble, it burst, liberating the germs, which were always present and very

* From the 'Journal of the New-York Microscopical Society.'







R. Kidston del.

Mintern Bros. lith.

8. *Sigillaria discophora*, Konig sp.

9. *Sigillaria Taylora*, Carruthers sp.

