On some Fossil Plants from the Coal-bearing Series of Nagatɔ.

By

Matajiro Yokoyama.

With Plates XXXII—XXXIV.

In the spring of 1890, Mr. Kochibe of the Geological survey discovered some plant remains in the coal-bearing series of Nagato at a place called Yamanoi, some 30 kilometers east of the city of Akamagaseki.[1] These plants he recognized as Mesozoic, and subsequently sent them to me for examination. On looking at these plants, I was at once struck by the occurrence of forms which are quite foreign to our Middle Jurassic flora, lately worked out[2] by myself, and which are hitherto known only as occurring in the Rhætic. Interested in this discovery, I visited the locality myself in the summer of the same year, in order to obtain, if possible, a larger number of species which, as I thought, would be quite indispensable for the determination of their exact age. Sorry to say, however, I did not succeed in making any great additions to the number of species, nearly all the plants which I found having been already represented in the collection of Mr. Kochibe. Still my collection proved to be very useful, for I had thus a larger number of individuals for comparison.

The coal-bearing series of Nagato occupies a limited area in the southern portion of that province bordering the Inland sea, and con-

1) This city is better known under the old name of *Shimonoseki*.

2) Yokoyama, *Jurassic Plants from Kaga, Hida, and Echizen, Journal of the College of Science, Imperial University, Japan, vol. III, part I, 1889.*

sists of a thick complex of sandstones, clay-slates and shales, with subordinate layers of schalstein and anthracite in its lower part and of browncoal in its upper part. These strata which form a low hilly country surrounded by mountains of granite and of Palaeozoic formation strike generally from east to west, and show steeper dips in the northern than in the southern part of the district, where they gently slope towards the sea. Owing to the repeated foldings to which these strata have been subjected, their geological structure is complicated, and has not yet been clearly made out. It will be only added here that our fossils were discovered in the lower or schalstein-bearing part of this formation.

The fossil locality lies on one side of a road which leads from the village of Yamanoi to the town of Habu, in a valley surrounded by hills. Here in a space of about 4 meters, I observed four fossil horizons. The lowest of them is a yellowish grey argillaceous sandstone yielding only *Dictyophyllum japonicum*, but in great numbers. The plants of this horizon are easily distinguishable from those of the others, being coloured dark green as if the vegetable matter were still remaining on them. The next horizon is that of a light greyish argillaceous sandstone which on weathering also assumes a yellowish colour. In this horizon all the species below described were found, Mr. Kochibe's plants having been probably taken also from this layer. The two upper horizons have yielded only some fragments of *Dictyophyllum japonicum*. Besides these two horizons there is, I presume, another, as I found some pinnæ of the same species in a black slate situated more to the north and occupying probably a higher position than the sandstones. From this, we can see that there are several fossiliferous zones in the coal-bearing series of Nagato. But at present as the number of species found in them is very small, it is not possible to make any palaeontological distinctions in them.

Fossils, where there they are found in abundance, are generally very well preserved. Owing, however, to the brittle nature of the rock containing them, it is very difficult to obtain any large specimen.

After these brief preliminary remarks I shall first pass to the description of the species, and then to the conclusions which can be drawn from them.

Description of the Species.

1. Asplenium Roesserti *Presl sp.*

Pl. XXXII, Fig. 1–5, Pl. XXXIV, Fig. 2.

Asplenium Roesserti Schenk, Fossile Pflanzen aus der Albourskette gesammelt von E. Tietze, p. 2, pl. I, fig. 2–4, II, 8–10, IV, 19, VI, 33, VII, 36.

Asplenites Roesserti Schenk, Foss. Flora d. Grenzschichten d. Keupers u. Lias Frankens, p. 49, pl. VII, fig. 6–7a, X, 1–4. Zeiller, Examen de la Flore foss. des Couches de Charbon du Tongking, p. 302, pl. X, fig. 3, 3a.

Chladophlebis nebbense var. Roesserti Nathorst, Floran vid Höganäs och Helsingborg p. 42, Helsingborg pl. II, fig. 1–3.

All of our specimens excepting fig. 3, 4, pl. XXXII agree so well with the figures of *Asplenium Roesserti* given by Schenk and Nathorst, that I have not the slightest doubt about their identity with this well known species. The pinnules are more or less falcate and inclined forward, with secondary veins only once forked. As to the form of the pinnules, I must say that they are very variable, being sometimes long and finger-like, sometimes short and triangular, as may be sufficiently seen from the specimens here figured. The arrangement of pinnæ along the principal rhachis is in our specimens opposite or subopposite which according to Schenk is said to be the case in the lower part of the frond.

Specimens represented in fig. 3, 4, pl. XXXII, differ from others in having twice forked secondary veins in spite of the smaller size of the pinnules, much as in figures commonly given of the typical forms of *Asplenium whitbiense Brgt.* (e. g. in Heer's Beitr. z. Juraflora Ostsib, u. d. Amurl. 1876, pl. I, III. and in Schenk's Jurassische Pflanzen in Richthofen's China, vol. IV, pl. LII.). But as it has been already shown by eminent authorities, that *Asplenium whitbiense* is synonymous with *Alethopteris indicum Old. et Morr.*,[1] which in turn exhibits no difference from our *Asplenium Rœsserti*,[2] so it would be now quite objectionable to separate the above specimens into distinct species. Still however, as I obtained no transitional forms between the two, I should prefer to describe forms with bifurcate secondary veins as *Asplenium Rœsserti var. whitbiensis.*

Asplenium Rœsserti occurs in the Upper and Lower Gondwana System of India, in the Rhætic of Europe, Persia and Tongking, and in the Lower Oolite of various countries.

This fern is very common at Yamanoi, being the most abundant fossil next to *Dictyophyllum japonicum.*

2. Dictyophyllum cf. acutilobum *Braun sp.*

Pl. XXXII, Fig. 6.

Dictyophyllum acutilobum Schenk, Foss. Pflanzen a. d. Albourskette, p. 5, pl. II, fig. 7. Foss. Flora d. Grenzschichten, p. 77, pl. XIX fig. 3–5, XX, 1. Nathorst, Floran vid Höganäs och Helsingborg, p. 14, Höganäs äldre pl. I, fig. 8, p. 44, Höganäs yngre, pl. I fig. 10–13, Helsingborg pl. I fig. 6–10. Zeiller, Exam. de la flore foss. du Tongking, p. 311, pl. X, fig. 11.

---

1) Feistmantel, *Fossil Flora of the South Rewah Gondwana Basin*, p. 29, 1882, Calcutta. Heer, *Beitr. zur Juraflora Ostsib. u. d. Amurl.* 1876, p. 38.

2) Saporta considers in his "Plantes Jurassiques" (Paléont. franc. Terr. Jurass., Végétaux) p. 301, *Chladophlebis (Asplenium) Rösserti* Presl as identical with *Pecopteris (Asplenium) whitbiensis* Brgt.

A fragment of a coarsely toothed pinna, with teeth triangular, obtusely pointed at apex and slightly inclined forward, and with reticulate venation, is undoubtedly a species of *Dictyophyllum* which is at least very closely akin to *Dictyophyllum acutilobum* of the Rhætic of Europe. In our only specimen the teeth are closer together than in most of the figures given of this species, and the secondary veins slightly zigzag.

Besides occurring in the Rhætic of Europe, this species has been also described as occurring in that of the Albours Chain in Persia and of Tongking.

3. Dictyophyllum japonicum *n. sp.*

Pl. XXXIII.

Although this is the most abundant of all the plants found at Yamanoi, yet not a specimen was obtained representing a complete frond, all being isolated pinnæ, which may be characterized as follows :

Pinnæ linear-lanceolate, broadest near the middle, slightly tapering towards both ends, lobed except near the base where they are simply wavy or entire; lobes more or less inclined forward, triangular in shape, with the anterior margin straight or concave, with the posterior margin usually convex, and the apex obtusely pointed. Rhachis very strong, straight or somewhat curved, running to the apex of the pinnæ; secondary veins, coarse, slightly crooked or zigzag, directed forward and going up to the apex of each lobe, thus forming its median vein; tertiary veins distinct, somewhat inclined anteriorly and dichotomizing, the branches forming by their union with those of the neighbourring ones coarse pentagonal or hexagonal nets, which are usually drawn out in the direction of the median vein; quaternary veins very fine, forming secondary nets within the primary ones.

A glance at the plate with show that a great resemblance exists between this species and *Thaumatopteris Münsteri var. abbreviata* Göpp. (Schimper, Traité de Paléont Véget, vol. I, pl. XL, fig. 7) from the Rhætic of Franconia. So great is this resemblance, that I was at first inclined to treat the two species as identical ; but a careful comparison between Schimper's figure and many tens of specimens at hand seems to show that the secondary veins in our plant are not so strong and rigid as in the European. Besides, none of our specimens had the lobes linear and finger-like as in the figure of Schimper, but always had them more or less triangular. Under these circumstances, I deem it more advisable to treat it as a new species.

Dictyophyllum japonicum is also not unlike *Camptopteris serrata* Kurr (Nathorst, Floran vid Bjuf, pl. V, fig. 3) in the general appearance of its pinnæ. But the latter is said to have very indistinct secondary veins.

A *Spiropteris* shown in fig. 5, pl. XXXIV, I believe to belong to *Dictyophyllum japonicum*, as it was found in the lowest fossil horizon, where no other species occur.

4. Dictyophyllum Kochibei *n. sp.*

Pl. XXXIV, Fig. 1, 1a.

Pinnæ elongated, deeply pinnatifid ; pinnules ovate or ovately lanceolate, crenate at margin, obtusely pointed at apex, passing off either at right angles from the rhachis, or slightly inclined forward. Rhachis moderately strong ; secondary veins quite distinct, somewhat zigzag, one in each lobe ; tertiary veins also distinct, forming by their union two to three rows of irregularly polygonal nets ; quaternary veins very fine, forming secondary nets within the primary ones.

Judging from the size of the rhachis and the weaker impression

made by the lobes on stone, this fern seems to have been more delicate than the preceding one.

The only European species which can be compared with it is *Thaumatopteris Schenki* Nath. (= *T. Brauniana* Schenk) from the Rhætic of Sweden (Nathorst, Flora vid Höganäs och Helsingborg, p. 46 Höganäs yngre, pl. I, fig. 1, Helsingborg, pl. II, fig. 4) and Franconia (Schenk, Flora der Grenzschichten, p. 73, pl. XVIII, fig. 1-3, pl. XIX, fig. 1.). It has also crenate pinnules; but these are generally linear and much longer, and the crenations finer.

As to the generic denomination of our species, I follow Prof. Schimper Schenk, who considers *Thaumatopteris* Göpp, as identical with *Dictyophyllum* Lindl. et Hutt. (Handbuch der Palaeontologie, II. Abtheil. p. 138).

The figured specimen is the only one found.

5. Podozamites lanceolatus *Lindl. sp.*

Pl. XXXIV, Fig. 3, 4.

Podozamites lanceolatus Nathorst, Floran vid Bjuf p. 73, pl. XVI, fig. 2-10a, Heer, Juraflora Ostsibiriens, 1876 p. 45, 106, pl. I, fig. 3a, pl. XXIII, 1c, 4abc, XXVI, 2-10, XXVII, 1-8. Beitr. 1878, p. 6, 20, pl. V, fig. 1-11. Foss. Flora Spitzbergens, p. 35, pl. VII, fig. 1-7c,d. Schmalhausen, Juraflora Russlands, p. 29 pl. V, fig. 3-5c. Schenk, Jurassische Pflanzen, in Richthofen's China, vol. IV, p. 248, pl. XLIX, fig. 4, 5, p. 255, LI, 3, LII, 8, p. 258. LI, 7, p. 261, LIV, 2c. Yokoyama, Jurassic Plants from Kaga, Hida and Echizen, p. 45, pl. IV, V, VI, 1, VII, 8b, XII, 18, XV, 12b.

Podozamites distans Zeiller, Exam. flore foss. du Tongking, p. 320, Pl. XL, fig. 2. Nathorst, Beitr. z. foss. Flora Schwedens p. 23, pl. XIII. fig. 6-16, XV, 20.

Zamites distans Schenk, Flora d. Grenzschichten p. 158, pl. XXXV, fig. 10, XXXVI.

Now and then occur leaflets of a *Podozamites* which are to be identified with the well known cosmopolitan species above named. Our specimens are all in fragments, that represented in fig. 3 being the

best, but wanting the tip. Judging from its general outline, it seems to belong to the variety *genuina* of Heer in which the leaflets are drawn out into an acuminate apex. Fig. 4 appears to have been much shorter, and I am not quite sure whether it really belongs here.

6. Baiera ? sp.

Pl. XXXIV. Fig. 6.

Fragments of long, parallel-sided leaves, apparently representing lobes of a Baiera or of a Ginkgo, occur in some cases thickly scattered on faces of stone. In one case they were observed arising from a common base, as shown in the figure, each having 3-4 parallel veins. It is much to be regretted that the specimens are so imperfect as not to allow any precise determination.

As to the results to be drawn from the study of the above plants, I must say that the number of species is yet too limited to allow us to form any very definite conclusions. Some of them however seem to be tolerably characteristic. *Dictyophyllum acutilobum*, has hitherto been restricted to the Rhætic of Europe and the similar formations of Persia and Tongking. *Dictyophyllum japonicum*, although new, exhibits a great relationship to *D. Münsteri var. abbreviata* Göpp., which occurs only in the Rhætic. A third *Dictyophyllum*, *D. Kochibei* is quite new, showing only a distant relation to the Rhætic form *D. Schenki* Nath. *sp.*. It cannot therefore, strictly speaking, be employed in the determination of the age. The two other well determinable species, *Asplenium Roesserti* and *Podozamites lanceolatus*, are widely diffused in the Rhætic as well as in the Jurassic. Thus we have here two species pointing to the Rhætic, and two species pointing

to the Rhætic or to the Jurassic. From these facts, I am inclined to believe, at present, that this little flora is somewhat older than that of the Middle Jurassic of Central Japan, corresponding either to the Liassic or, as it seems more probable, to the uppermost Trias or Rhætic of Europe. Only the discovery of a greater number of species can decide the question. It is here interesting to note that a similar flora is already known to exist in Tongking, (Zeiller l. c.) and perhaps also in China,[1] Nathorst having recently mentioned *Dictyophyllum Nilssoni Brgt. sp.* and *Podozamites lanceolatus distans Prest.* as occurring in the "Upper Yangtszi." Another point to be noted in our flora is the comparative frequency of species of *Dictyophyllum*, a genus which had its maximal development in Europe during the Rhætic time.

1) Nathorst, *Om förekomsten af Dictyophyllum Nilssoni Brgt. sp. i Kinas Kolförande Bildningar.* Oefversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1890, No. 8.

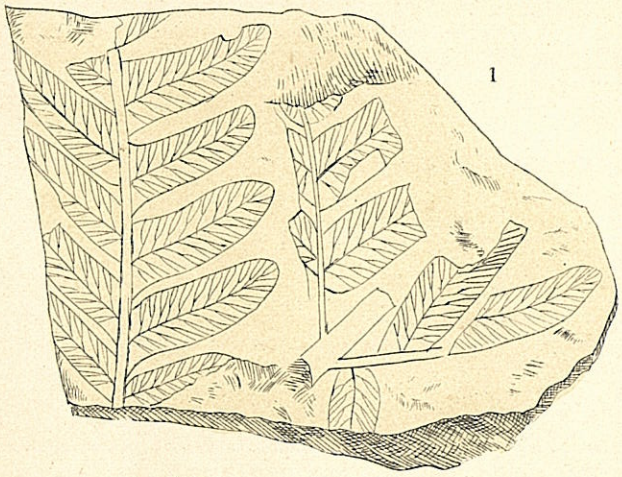
PLATE XXXII.

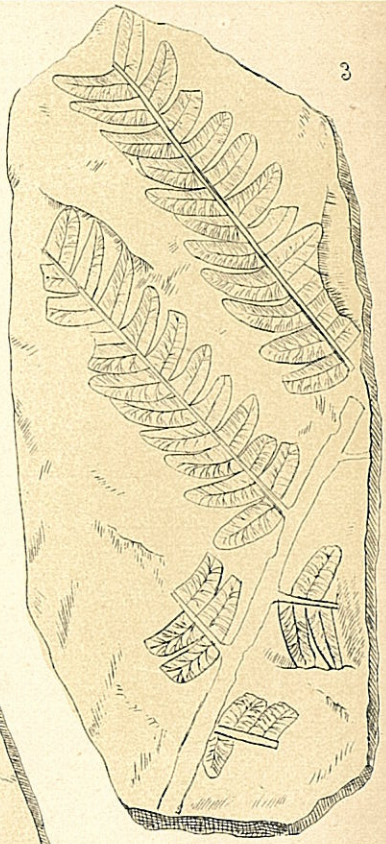
Plate XXXII.

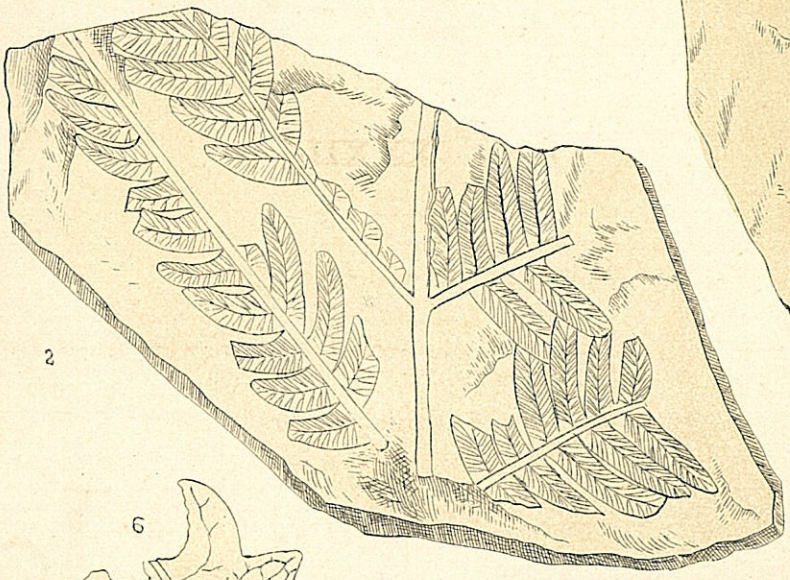
Fig. 1, 2, 5.—Asplenium Rœsserti *Presl. sp.*

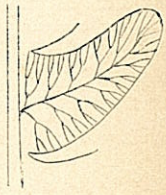
„ *3, 3a, 4.*—Asplenium Rœsserti *Fresl.* var. whitbiensis *Brgt.*

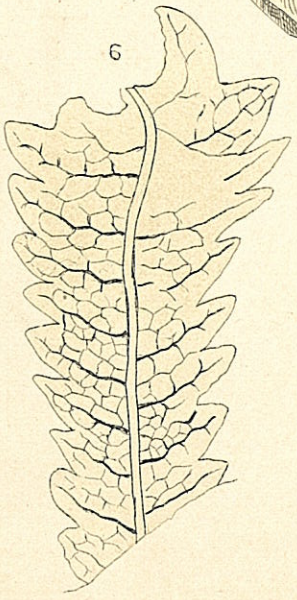
„ *6.*—Dictyophyllum cf acutilobum *Braun sp.*

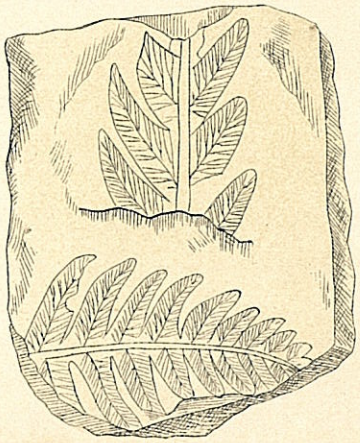


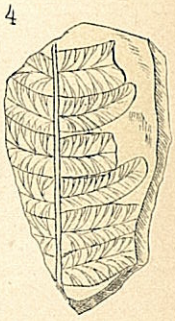












Auctor in lapidem del.

PLATE XXXIII.

Plate XXXIII.

Fig. 1–7.—Dictyophyllum japonicum *n. sp.*; 2 left represents the basal part and 5 the apical part of a pinna.

Auctor in lapidem del.

PLATE XXXIV.

Plate XXXIV.

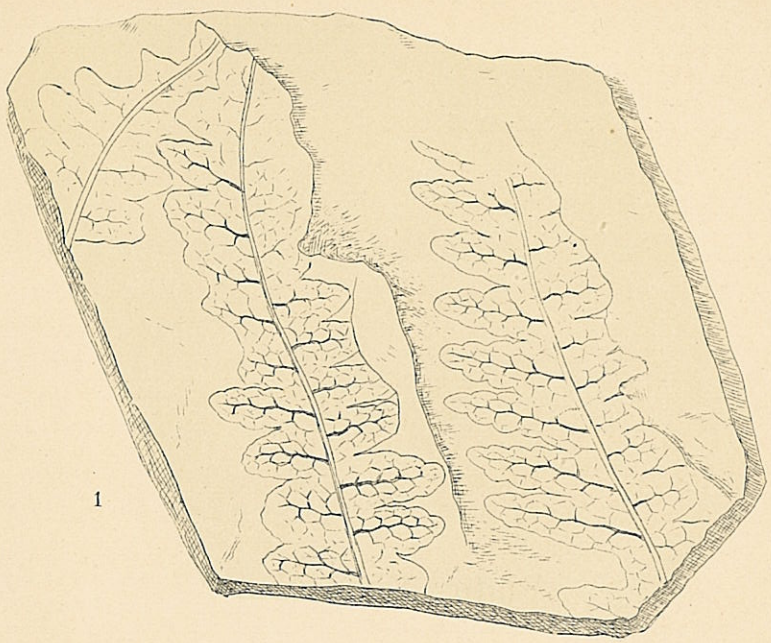
Fig. 1, 1a.—Dictyophyllum Kochibei *n. sp.*

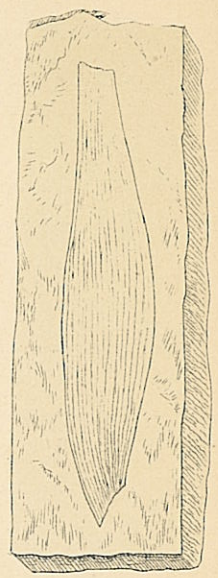
„ *2.*—Asplenium Roesserti *Presl. sp.*

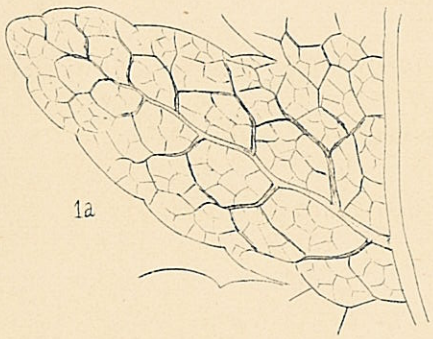
„ *3, 4.*—Podozamites lanceolatus *L. et H. sp.*

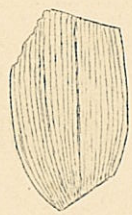
„ *5.*—Spiropteris.

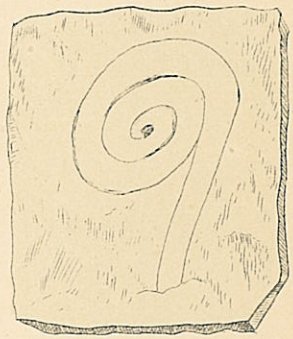
„ *6.*—Baiera ? sp.

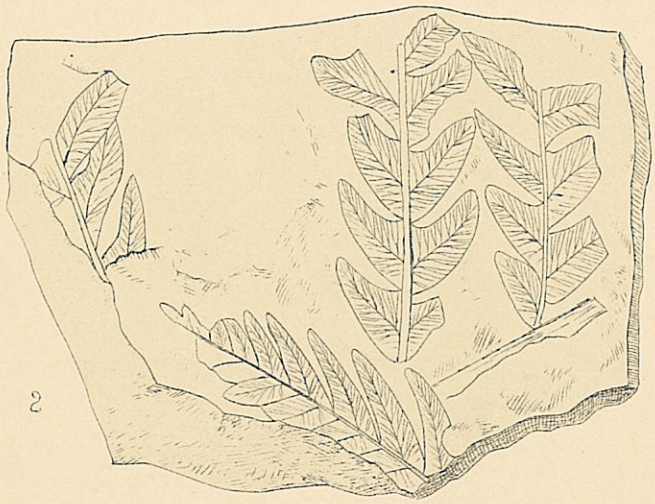


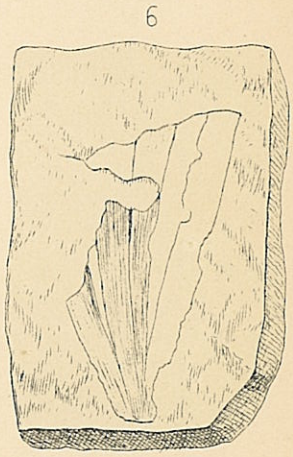












Auctor in lapidem del.