

ART. XXXVII.—*Rhætic Plants from Honduras*; by J. S. NEWBERRY. With Plate VIII.

IN 1886 Mr. Chas. M. Rolker, a mining engineer and graduate of the School of Mines, brought from San Juancito, Honduras, among other geological specimens, a piece of metamorphosed shale containing several impressions of the fronds of cycads. As no Mesozoic fossils had before been found in this region the discovery interested me much and I have since made earnest efforts to obtain other specimens from the same locality. Mr. Rolker kindly seconded these efforts and wrote to Mr. T. H. Leggett, E.M., who was located at San Juancito, giving him all the information he possessed in regard to the locality where the fossils were found, and soliciting his coöperation. This was cordially granted, with interesting results.

The specimen brought by Mr. Rolker was a loose piece picked up on the surface and nearly two years passed before its place of origin was ascertained. In January last I received a letter from Mr. Leggett announcing the discovery of the plant beds and the shipment to me of a box of fossils. These were exhibited at a meeting of the N. Y. Academy of Sciences on Jan. 30, 1888, and were briefly described in the Transactions of the Academy, vol. vii, p. 113. Since that time Mr. Leggett has returned to New York bringing another box of fossils from the same place, among which are some additional species.

From the notes furnished me by Mr. Leggett it appears that the plant beds of San Juancito form part of a series of argillaceous shales now converted into hydromica schists several hundred feet in thickness. Below these, limestones crop out which are said to contain Carboniferous fossils, while above them are heavy masses of eruptive rock. The plant-bearing shales are much disturbed and metamorphosed, and are cut by a series of silver-bearing veins which have been worked for many years with considerable success. The outcrops which contain the plants are much decomposed and few good specimens have been obtained from them, but the number of species represented is large and it is evident that further excavation would result in the accumulation of much interesting material.

The age of the deposit as indicated by its plants is plainly Upper Triassic and the flora as a whole has a great resemblance to that of the coal-bearing strata on the Yaki river in Sonora, Mexico, described by me in the Report of the San Juan Exploring Expedition, and to that described by Schenk in *Die Fossile Flora der Grenzschichten des Keupers und Lias*

Frankens and to Nathorst's *Florau vid Bjuf*; a number of the species being identical and others closely allied.

The localities nearest to Honduras where fossils indicative of Triassic age have been before discovered were in Sonora, Mexico, 2000 miles north, and in the Andes of Peru, where Triassic rocks were found by David Forbes, 2000 miles south. The plants contained in the collection made by Mr. Leggett are here briefly described :

Zamites (Pterophyllum) Rolkeri Newb. Figs. 1, 2.

Frond a foot or more in length by two inches in width ; rachis chaffy ; pinnules diverging from the midrib at an acute angle, alternate, closely set, attached by the entire breadth of the base to the upper surface of the midrib, which they completely cover ; summit rounded or blunt-pointed ; nerves fine, parallel.

This plant has the general aspect of those described by Heer in the *Flora Arctica*, vol. iii, Pl. XIV, XV, XVI, under the names of *Zamites speciosus*, *Z. borealis* and *Z. acutipennis*, and should be placed in the same genus. It also still more closely resembles *Pterophyllum Nerbuddaicum* Feistmantel (*Flora of the Jabalpur Group*, p. 14, Pl. VI, figs. 9, 9a), and "*Zamites obtusifolius*" and "*Pterozamites gracilis*" of Emmons (*Amer. Geol. Rt.*, vi, p. 118, 119, figs. 85, 86).

It is evident that all these plants should be separated from *Zamites* if *Z. Feneonis* Brongt. be taken as a type of that genus. And they cannot be included in *Pterophyllum* if, with Schimper and Schenk, who have given us the latest and best classification of fossil cycads, we restrict that name to those in which the pinnules are set at a right angle with the rachis and are connate at their bases. Some writers would put them in *Ctenophyllum* and they are certainly closely allied to the group of cycads typified by *Pterophyllum pecten* of Lindley and Hutton (now *Ctenophyllum*), but have little in common with the gigantic *Ctenophyllum grandifolium* of Fontaine (*Older Mesozoic Flora of Virginia*), in which the pinnules are set on the side of the rachis, have the bases dilated and are sometimes a foot in length by half an inch in width.

Zamites (Otozamites) Leggetti Newb. Figs. 3, 4.

Fronds linear, one and a quarter inches in width by eight to ten inches in length ; pinnules alternate, crowded, set on the upper side of the rachis, their bases meeting above, closely approaching below ; in form they are oblong or linear, obliquely rounded above, sometimes slightly rounded at the base ; nerves fine, radiate below, parallel above.

This plant, like the preceding, was briefly characterized in the Transactions of the New York Academy of Sciences, vol. vii, p. 114. It differs from *Z. Rolkeri* in its shorter and broader pinnules and in its nervation, which is partly radiate. Better specimens than any yet obtained are needed before a complete description of it can be written, or its generic relations be accurately determined. Some of the pinnules appear to be attached by the entire base, while in others the attachment is only by the central portion and the nervation is more distinctly radiate. Like the preceding species it is only referred to *Zamites* provisionally, and it is almost certain that they will ultimately be assigned to different genera.

In general aspect this and the preceding species closely resemble *Ptilophyllum acutifolium* and *Pt. Cutchense* Morris, Fossil Flora of India, but are distinctly separated from them by the mode of attachment and the nervation.

It is evident that still another review of fossil cycads is needed although we have had so many already, but this is no place for it and it will be sufficient for our present purpose to refer the plants described above to *Zamites*, as Heer has done those with which I have compared them, leaving their final generic titles to be decided hereafter, by the study of more complete specimens.

Otozamites linguiformis, n. sp. Figs. 9, 10.

Fronds strong; rachis striate; pinnules one to two inches in length by half an inch in width, crowded, sometimes overlapping; below issuing from the rachis at right angles, above obliquely; outline long-tongue-shaped; summits evenly rounded, bases unequally cordate, attached by a single point at the center; nerves numerous, fine, simple or forked, radiating from the center of the base to all parts of the margin.

This handsome species is allied to, though quite distinct from, *Otozamites Macombii* N. from the Upper Triassic rocks of Sonora, Mexico. (Report of the San Juan Expedition, p. 141, Pl. iv, figs. 1, 2). In that species the pinnules are broader, are abruptly rounded or truncated at the summit, and on the lower part of the frond are quadrate; while the corresponding pinnules of the plant now described are oval. Some of the upper pinnules are set obliquely on the rachis, are long-elliptical in outline, slightly curved or sigmoidal, are obliquely rounded at the base and attached by a single point, thus conforming strictly to the definition of *Glossozamites* Schimper, and serving as a connecting link between that genus and *Otozamites*. Whether the rachis in our plant is furrowed as in the type species of *Glossozamites* (*G. Zittelli* Schenk) is not certain, but apparently it is so. Figure 10 represents one of the longer pinnules detached.

Taeniopteris glossopteroides Newb.

Frond simple, six to twelve inches in length by one and a half to two inches in width, spatulate in outline, summit sub-acute, base long-wedge-shaped, the median nerve strong and smooth, the lateral nerves relatively sparse and distinct, frequently forked at base, more rarely above, the branches sometimes approaching, forming elongated areoles but never inosculating.

This species was first obtained from Sonora, Mexico, and was described in the San Juan Report, p. 147, Pl. VIII, fig. 2a. By an error of the draughtsman the lateral nerves were represented as inosculating, but recent observation has shown that they do not join. Owing to this error another plant was confounded with this, which strengthened the misapprehension in regard to its nervation. This latter plant is shown in fig. 2 of the plate cited, where it is given a strong midrib, though it had none, unless toward the base; but has a distinctly reticulated nervation. It therefore belongs to Feistmantel's genus *Gangamopteris* and I have called it *G. Americanus*.* The plant I have named *Taeniopteris glossopteroides* is represented by a number of specimens in the collection of Mr. Leggett, but unfortunately owing to the weathering of the rock they do not show the nervation well. The lateral nerves from base to summit leave the midrib at an acute angle, generally arching with a gentle curve to the margin, but sometimes nearly straight. They are often forked near the base, more rarely above, sometimes running near together, but apparently never join. This nervation is just that of *Taeniopteris murantacea* Presl. (*Pecopteris macrophyllum* Brongt., *Stangerites marantacea* Bornem), a plant made the type of his genus *Danaeopsis* by Heer; but in that plant the frond is pinnate, in ours it is symmetrically spatulate, gradually narrowed to the base, and was undoubtedly simple. In all the characters shown in the specimens before me this plant comes nearest to the group of Permian species to which Schimper restricts the name of

* The distinction between *Gangamopteris* and *Glossopteris* is not quite as clear as it might appear from a comparison of the specimens figured and described by Feistmantel in his Flora of the Talehir-Karharbari Beds; the diagnostic character of *Gangamopteris*, the absence of a midrib, being variable, as shown in his *Glossopteris decipiens* (op. cit., p. 17, Pl. XVIII, figs. 3-5), in which the midrib fades out in the upper part of the leaf. This I find also to be true of a number of Australian specimens in my possession. These include many leaves of small size having the spatulate outline and rounded summit of *G. Browniana*, and labeled as such, and others, much larger, of *G. ampla* Dana. Both these forms show a midrib only near the base, and have a nervation but sparingly reticulate, with elongated meshes. Other specimens representing Dana's *G. elongata* and *G. reticulum* (Geol. U. S. Exploring Expedition Atlas, Pl. XIII, figs. 2, 3, 4) have the midrib persistent to the summit and the nervation strongly reticulate throughout. These two forms might stand for *Gangamopteris* and *Glossopteris* if to the former genus a midrib were conceded for part of the length of the frond.

Taeniopteris, viz: *T. multinervis* Weiss, *T. Eckardi* Germ, etc. More and better specimens must, however, be obtained from Honduras before the relations of these plants can be accurately determined.

Encephalartos ? denticulatus, n. sp. Fig. 5.

Size of frond unknown, rachis smooth or finely striated longitudinally; pinnules diverging at an angle of about 45°, lanceolate, 30^{mm} long by 6^{mm} wide, acute, gradually narrowed to the point, abruptly narrowed at the base which is attached by its entire breadth; margins set with numerous, spiny teeth; nerves fine, mostly parallel, somewhat radiate from the base and many terminating in the teeth of the margin.

Of this remarkable cycad only a single specimen has yet come into my hands. This is a fragment apparently from the middle of a frond showing three complete pinnules and the bases of two others. Its general characters are well shown in the figure. So far as known this is the first instance of the discovery of a cycad with denticulated pinnules in American Mesozoic rocks, and among foreign cycads only a group of species of *Sphenozamites* have pinnules with toothed margins. It is not uncommon to see this character in living cycads, particularly in *Encephalartos* and *Zamia*. In the latter genus the nerves are parallel and terminate in closely approximated marginal teeth or notches toward the upper extremity. In the former genus, however, forms occur which are almost exactly like those presented by the fossil under consideration, viz: fronds bearing pinnules obliquely inserted, contracted at the base, lanceolate in outline, having fine mostly parallel nerves and margins set with spiny teeth, e. g., *Encephalartos Altensteinii* Lehmann, Cape of Good Hope. This correspondence in the form of the pinnules is so close that I felt warranted in placing our fossil provisionally in the genus *Encephalartos*. The fructification will of course be necessary for a demonstration of generic identity and has not yet been obtained.

Only one fossil species of *Encephalartos* has yet been described and that is *E. Gorceixianus* Saporta, from the Miocene Tertiary of Koumi, Greece. This has lanceolate, acute entire pinnules, two inches long, somewhat constricted at the base and slightly decurrent; nerves parallel. It is supposed to represent an extinct species of *Encephalartos* similar to *E. Lehmani* of South Africa, but the similarity between these fossil species is scarcely as great as between the plant under consideration and *E. Altensteinii* Lehm., with which I have compared it.

Sphenozamites robustus, n. sp. Figs. 12-14.

Fronde large, form unknown, pinnules one to four inches in length, ovoid or lanceolate in outline, narrowed and thickened at the base, pointed at summit, margins entire, thickened; nerves few and strong at base, forking and multiplying above, diverging to all parts of the margins, not converging at summit.

Quite a number of pinnules, all more or less imperfect, of this remarkable cycad, are contained in the collection brought by Mr. Leggett from Honduras. They vary considerably in form and size, but present characters which are somewhat at variance with those of any other fossil cycads known, though they most resemble those of some species of *Sphenozamites*. They are distinctly wedge-shaped at base, expanding to an unsymmetrical ovoid or lanceolate outline above with radiate and divergent nerves, which below are few and coarse, above very fine. In the larger pinnules the summit is pointed and in some cases unsymmetrically acute. If, as seems probable, the curvature of the pinnules was toward the summit of the frond the general aspect of the plant may have been much like that of *Sphenozamites Geylerianus* Zigno (Flor. Fos. Oolitica, vol. ii, p. 107, Pl. xxxix, figs. 1, 2) only it must have been much larger. Fragments of the lower portions of the pinnules are not unlike some of the specimens of *Podozamites latipennis* figured by Heer (Flor. Fos. Arctica, vol. vi, Pl. xiv and xv), but the nerves are not parallel with the margins nor do they converge at the summit.

Among other described fossil cycads none seem to approach so near to the plant before us as the species of *Sphenozamites* with entire pinnules, and here the resemblance is so close that I have felt justified in referring it provisionally to that genus.

Sphenozamites? grandis, n. sp.

Pinnules four inches or more in length, oblong or lanceolate, obtuse, narrowed and thickened toward the base, nerves strong, straight, simple or rarely forked, part diverging from the base to the margins, part running parallel to the upper extremity.

Of this plant we have numerous fragments in the collection, but none of them complete organs. The pinnules were four or five inches in length by an inch in width and are conspicuous for their clear and strong nervation, which is radiate from the base. They undoubtedly represent a large cycad, hitherto undescribed, but it will be necessary to have complete pinnules to decide whether it should be referred to *Sphenozamites*, *Otozamites*, or *Glossozamites*. It must have been much like the plant described by Feistmantel (Foss. Flora of the Lower Gondwanas, p. 19, Pl. xx, figs. 4, 5) under the name of

Glossozamites Stoliczkanus, and should doubtless be included in the same genus, but it seems to me very doubtful whether that should be the same as that for which *G. Zitteli* stands as the type.

Anomozamites elegans, n. sp. Figs. 6-8.

Fronds narrow, elongate, delicate, from half an inch to one inch in width, length unknown; midrib straight and persistent but slender; pinnules near base in close contact, as broad as long, forming a scolloped margin to the midrib; above subquadrate or rhomboid in outline with the lower external angle rounded, the upper subacute, produced; nerves fine, simple or forked, parallel with the upper margin of the pinnules.

Among the fossil plants brought from San Juancito by Mr. Leggett are a number of narrow fronds with subquadrate pinnules which evidently represent the group of cycads which runs through the Mesozoic rocks of Europe, beginning with *A. minus* Brgt. in the Rhætic and ending with *A. Schaumburgensis* Dunker, in the Wealden. It is perhaps most like *A. gracilis* Nathorst (Sveriges Fossila Flora, p. 43, Pl. XII, figs. 4-12), but from this as well as from the other species referred to it is distinguishable by the more pointed and produced upper angles of the pinnules. Figure 6 apparently represents the basal portion, fig. 7, the middle and fig. 8, the summit of these fronds.

Pterophyllum propinquum? Goepp.

Fronde large, pinnules subalternate, linear, long-pointed, four inches in length by one-half an inch in breadth at base, gradually narrowed to the acute extremity, springing from the rachis at right angles; base sometimes slightly rounded and narrowed, oftener attached by its entire breadth; nerves distinct, simple, parallel.

The specimens I have of this plant are too few and imperfect to make a comparison with the species described by Goeppert entirely satisfactory. The bases of some of the pinnules seem to be slightly contracted and with a few divergent nerves. If this should be shown by better specimens to be a constant character it would bring this plant into *Zamites* and into close relationship with *Z. Renevieri* Heer, of which the size and general aspect must have been very similar.

Pterophyllum Braunsii? Schenk.

Of this plant one complete pinnule and several fragments are contained in the collection, but are scarcely sufficient for accurate determination. It is evident, however, that we have here the remains of a species of *Pterophyllum* or *Nilssonia* remark-

ably like, if not identical with that described by Schenk (Flora der Grenzschieben, p. 168, Pl. XL, figs. 2, 3) under the name of *Pterophyllum Braunsii*. The pinnules were attached by the entire base, are an inch in width by two and a half inches in length, the summit is obliquely rounded, the nervation fine, parallel and simple, sometimes dotted as shown in Schenk's figure.

A nearly related plant to this is *Pt. princeps* Oldham and Morris (Fossil Flora of the Rajmahal Series, p. 23, Pl. x-XIII), but our material is too imperfect for the determination of specific identity or difference.

Dioonites longifolius? Emmons.

An imperfectly preserved fragment from the middle of a frond is all we have of a plant that if not identical with must have been very closely allied to that described by Emmons (Amer. Geol., Part VI, p. 116, fig. 83) from the Upper Triassic strata of North Carolina.

Dioonites Carnallianus? Goepp.

This plant is imperfectly shown in the collection made by Mr. Leggett, but is plainly distinct from any other with which it is associated. It evidently belongs to a group of cycads which form a marked feature in the Rhætic flora and of which *Pterophyllum Carnallianum* of Goeppert may be taken as a type. In this group the fronds are broad, the pinnules very long and narrow, attached to the rachis by the entire bases, which are sometimes slightly decurrent, but never expanded upward nor connate; the nerves are sharply defined, but fine, simple and parallel.

More material will be required before the identity of the Honduras plant with that to which it is provisionally referred can be asserted. It is, however, a distinct element in the San Juancito flora and deserves mention from its relationship with the group of Rhætic cycads with which I have compared it.

Nilssonia polymorpha Nathorst.

Only a few fragments of this plant are contained in the collection made by Mr. Leggett, but these are quite sufficient to show its distinctness from any other with which it is associated and to determine its generic relations. Whether the segments of the frond were united, as is usual in *N. polymorpha*, can only be determined from other collections, but this is not indicated by the specimens before us; the pinnules being entirely distinct and separated.

Fragments of the species of *Anomozamites* found with this might at first sight be confounded with it, but in these the

divisions of the frond are not carried down to the rachis and the nervation is much finer. A similar and perhaps an identical species of *Nilssonia* occurs in the Triassic coal basin of Sonora, Mexico.

Nöggerathiopsis, sp.

Among the fossil plants from Honduras, as well as those collected by Remond in Sonora, are some which perhaps represent different genera, certainly different species, but which are alike in having spatulate or wedge-shaped leaves several inches long, traversed by a fine or coarse parallel nervation. Part of these undoubtedly belong to the genus *Nöggerathiopsis* so common in the Mesozoic rocks of Australia and India, but they are too imperfect to be satisfactorily identified or described. Some of them must have been a foot or more in length, and they differ considerably in shape, either expanding rapidly or being long and strap-like. The nervation is sometimes so fine as scarcely to be visible, in other cases very coarse, but exact.

Several ferns are contained in the collection, but the specimens are too much weathered and decayed to permit of their identification or satisfactory study. All these, with many other things of which only fragments have been obtained by Mr. Leggett, will doubtless receive attention and elucidation from those who hereafter may have an opportunity of studying the rich flora which it is the object of this paper to bring to the notice of geologists.

This discovery of a Triassic flora in Honduras is a matter of special interest, as nothing of the kind had before been met with in that section of the globe; but it is only another illustration of the uniformity of the vegetation of the world during the Triassic age. This uniformity was, however, only a development of the systematic progress of plant life. The reign of Acrogens ended with the Permian. The Rhætic epoch was therefore about the middle of the reign of Gymnosperms. No Angiosperms were yet in existence, for they began in the Cretaceous. Hence, after the decadence of the *Lepidodendra*, *Sigillaria*, *Calamites* and *Cordaite*, the whole world was opened to occupation by the new dynasty of plants, the Gymnosperms (Cycads and Conifers) and the peculiar group of Mesozoic ferns. They lost no time in entering upon their promised land and spread until they covered all portions of the, to them, habitable globe.

Where the Gymnospermous flora originated, or how it was developed from the Acrogens, if it was so developed, and through the exercise of what elements of superiority it superseded them, we are as yet in ignorance. It is, however,

a matter that may well excite our wonder that, migrating such immense distances from their places of origin, through every phase of soil and climate—through all the zones of the Eastern Hemisphere, and now, as we learn from this group of Honduras plants, through the New World—they marched, holding so firmly to their original group of characters, generic and specific, that wherever we open their tombs we recognize them instantly as old friends. In their long marches some perished by the way, and here and there their numbers were recruited by new forms, imported or developed; but the leading members of the troop, in virtue of some occult protection against outside influences, preserved almost without alteration all the complicated characters of their vegetative and reproductive systems.

We shall look now with eagerness to South America for the identification there of this Mesozoic flora, which we have found in full development in Virginia, New Mexico, Sonora, and now in Honduras. It had before been recognized in Australia—where it seems to emerge from the Paleozoic flora and perhaps began—New Zealand, India, Tonquin, China, Turkestan, and various parts of Europe.

Hence, with its discovery in South America we shall see it reaching as a girdle around the entire globe. This girdle was not put around the earth, however, like Puck's, in forty minutes, but in thousands and millions of years; for when we realize with what slowness the migration of plants takes place, we must recognize in the universal distribution of the Carboniferous and Mesozoic floras evidence of the lapse of intervals of time of which the duration is simply immeasurable to us.

RHAETIC PLANTS FROM HONDURAS.

Am Jour Sci , Vol. XXXVI.

Plate VIII

