64. Devonian Plants First Discovered in Japan.

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Over the extensive area covering South Manchuria and North China, Upper Palaeozoic is characterized by the Permian coal measure, with the characteristic Cathaysia flora. It is extended to Korea, but not to the Japanese Islands, where marine condition prevailed at that time and fossil remains of land plants are extremely rare; when found, the remains are fragmentary and in bad preservation, being ones drifted from land to sea¹⁾. Marine sediments of the Lower Carboniferous are lacking in the former region, while they are found in the Japanese Islands as well as in South China. Lower Carboniferous and Devonian plant beds are reported from South China²⁾ and these are now discovered in the Kitakami Mountain land³⁾, Northeast Japan, where marine deposits from the Gotlandian to the Permian with rich marine faunas are well developed with a few stratigraphical interruptions. There, in certain Lower Carboniferous and Devonian deposits, plant fossils are preserved in fairly good condition, together with numerous marine fossils, likewise in good preservation; hence, the deposits can not properly be called plant beds, being marine beds rich in plant fossils. Notwithstanding that, it is quite evident that at the time of deposition the land was near, since they are not only rich in good plant fossils, but also interbedded with conglomerates and especially with thin red beds. The plant-bearing deposits now in concern are distributed in Nagasaka-mura and the adjoining Takōzu-mura, both in Higashiiwai-gun, Iwate Prefecture, approximately lying at Lat. 39° N and Long. 141°15' E; this district is already well known for its localities of marine Upper Devonian fossils since the discovery

1) Yabe, H. and Endo, S., 1921, Discovery of Stems of a *Calamites* from the Palaeozoic of Japan. Sci. Rep. Tohoku Univ. Sendai, 2nd Ser., Vol. 5, No. 3, P. 93 (1).

2) Halle, T.G., 1936, On *Drepanophycus*, *Protolpidodendron* and *Protopteridium*, with Notes on the Palaeozoic Flora of Yunnan. Palaeontologia Sinica, Ser. A, Vol. 1, Fasc. 4, P. 5.

Gothan, W. and Sze, H.C., 1933, Ueber die Palaeozoische Flora der Provinz Kiangsu. Mem. Nat. Res. Inst. Geol. Acad. Sinica, No. 13, S.1.

Gothan, W., 1933, Ueber neue Lepidodendronfunde aus dem Unterkarbon von Lung-tan (China). Mem. Nat. Res. Inst. Geol. Acad. Sinica, No. 13, S. 105.

3) Tachibana, K., 1949, On the fossil flora of the Tobigamori formation. (In Japanese). Jour. Geol. Soc. Jap. Vol. 55, No. 648-649.

by M. Noda of *Spirifer verneuili*⁴⁾ Murchison and several other fossils which he identified or compared with *Camarotoechia pleurodon* (Phillips), *Chonetes hardrensis* Phillips, and *Aviculopecten* cfr. *losseni* (Koenen). The thick complex of slate and sandstone interbedding the fossiliferous beds, named by Noda the Tobigamori series, was compared by him with the Pilton beds of England¹⁾.

and I intend to divide the Tobigamori at its type locality into two formations, the lower Nakakura and the upper Karaumedate²⁾.

The Karaumedate formation consists mainly of sandy rocks and is characterized by *Syringothyris* (common), *Spirifer tornacensis* (common), *S. spp.*, *Leptaena*, *Pugnax*, *Productus* (common), *Rhipidomella michellini* (very abundant), *Athyris* spp. (including *A. lamellosa*), *Pleurodictium*, *Phillipsia* (common) and stem-joints of crinoids (very abundant), beside plant fossils (common), and closely resembles the Carboniferous slates of South Ireland. The lower, Nakakura formation which is disconformably overlain by the upper is chiefly composed of slaty rocks with schalstein, conglomerate and sandstone in addition; some of the sandstones are reddish. Most of the fossils of the younger formation enumerated above are lacking in the Nakakura, in which, on the other hand, *Spirifer verneuili*, *Camarotoechia pleurodon* and plant fossils are exceedingly common, and some other forms as *Productella*, *Athyris*, etc. also occur. These fossils and lithological nature of the Nakakura make it comparable with the Lower Pilton, Baggy and Marwood beds of North Devon, the Coomhora grits of South Ireland and the Lambian series of Australia, all of Upper Devonian (Famennian) age. The Karaumedate formation is unconformably overlain by the uppermost Visean Onimaru formation³⁾.

4) Yabe, H. and Noda, M., 1933, Discovery of *Spirifer verneuili* Murchison in Japan. Proc. Imp. Acad., Vol. 9, No. 9, P. 521, Figs. 1-6.

1) Noda, M., 1934, Geology of the Environs of Nagasaki, Kitakami Mountainland. (In Japanese). Jour. Geol. Soc. Jap., Vol. 41, P. 431.

2) Karaumedate named after the Mt. Karaumedate (唐梅館山), immediately north of Nagasaki, and Nakakura derived from the village section known as Nakakura, (中倉) north of Nagasaki, where Noda first collected *Spirifer verneuili*.

3) The details of this study will be published elsewhere.

Description.

Leptophloeum Dawson 1862.*Leptophloeum* cfr. *australe* (McCoy). (Figs. 1-6)*Lepidodendron nothum*, Carruthers, 1872, Quart. Jour. Geol. Soc., Vol. 28, P. 350, Pl. 26, Figs. 1-14.*Lepidodendron australe*, McCoy, 1874, Prod. Pal. Viet., Dec. 1, P. 37, Pl. 9, Figs. 1a, 1b.*Lepidodendron nothum*, Feistmantel, 1878, Palaeontographica, Supp. Bd. 3, Lief. 3, Heft 2, S. 69, Taf. 1, Figs. 1-5.*Lepidodendron australe*, Feistmantel, Ibid., S. 76, Taf. 13, Figs. 3-4.*Lepidodendron nothum*, Feistmantel, 1879, Palaeontographica, Supp. Bd. 3, Heft 4, S. 141, Taf. 1 (19), Figs. 1-2.*Lepidodendron australe*, Jack and Etheridge, 1892, Queensland Palaeont., P. 196, Pl. 5, Figs. 1-10.*Leptophloeum australe*, Walton, 1926, Mem. Proc. Manchester Lit. Phil. Soc., Vol. 70, No. 10, P. 113, Figs. 1-4.*Leptophloeum australe*, Hirmer, 1927, Handbuch d. Paläobotanik, S. 317, Figs. 368-369.

The stems are covered with rather large, nearly rhomboidal cushions which are regularly arranged spirally; though often more or less obliterated, the leaf-cushions are in general wider than long; as shown by the following measurement:

Specimen.	Width.	Length.
No. 1.	11 ----- 12 mm.	10 ----- 11 mm.
No. 2.	8 ----- 9 mm.	7 ----- 8 mm.
No. 3.	9 ----- 10 mm.	8 ----- 9 mm.

The leaf-cushions are nearly flat, being somewhat more elevated at the central part than at the marginal. The leaf-scars are very small, oval or circular, 1 mm or less in diameter, generally situated near the apex of the leaf-cushions or sometimes at a little above the centre; not seldom they show a circular pit, marked on the apex, which is barely visible to the naked eyes. There is a narrow, but distinct horizontal furrow impressed above the leaf-scar, which is slightly shallower than those separating the leaf-cushions.

There are 31 specimens of the stems now at disposal, most of which are, however, in the so-called *Bergeria* state.

Lepidodendroid stems of the type similar to ours are known from the Upper Devonian of Spitzbergen¹⁾, Siberia²⁾, Australia and North America, of them, *Leptophloeum australe* (McCoy) from

1) Nathorst, A.G., 1894, Zur Paläozoischen Flora der Arktischen Zone enthaltend die auf Spitzbergen, auf der Baren-Insel und auf Novaja-Zemlja von den Schwedischen Expeditionen entdeckten Paläozoischen Pflanzen. Kongl. Svenska Vetenskaps-Akad., Handl. Band. 26, Nr. 4. (*Bergeria* sp., S. 14, Taf. 2, Fig. 8).

2) Neiburg, A.G., 1939, Devonian Flora from North-Eastern Balkhash regions (Kazakhstan). C.R. Acad. Sci. U.R.S.S., Vol. 23. (*Leptophloeum australe* McCoy, P. 739).

Australia and *L. rhombicum* Dawson³⁾ from N. America closely resemble ours.

L. australe and *L. rhombicum* were once thought by Carruthers⁴⁾ to be specifically identical; at present they are usually regarded as two distinct species, based on the different position of leaf-scars, which are situated at the centre of the cushions in the American form and at their apex in the Australian. In our materials, they are variable in position, being apical in some specimens (Figs. 3, 3a and 5) and lying near the centre of cushions or midway between the center and the apex in the others (Figs. 2, 2a and 2b); speaking in general, the scars always occupy a position far above the centre of cushions, and in this respect, our form stands more closely to *L. australe* than to *L. rhombicum*.

In our specimens, a shallow but very distinct furrow is impressed above the leaf-scars; it is variable in its extension, sometimes being visible only at the upper corner of (Figs. 3, 3a and 5) or extending to the lateral angles of the leaf-cushions (Figs. 2, 2a, 2b and 4); it is somewhat depressed at the middle (Fig. 4). The furrow is particularly distinct in Fig. 4, but the leaf-scar is here obsolete. Similar furrows are also sometimes shown by *L. australe* (Jack and Etheridge, 1892, Pl. 5, Fig. 6) and *L. rhombicum* (Dawson, 1862, Pl. 12, Fig. 8b). In so far as stems are concerned, the Japanese ones are indiscriminable from the Australian one figured by Jack and Etheridge.

There is another specimen, a young stem with leaves attached, derived from the same formation, but from a different locality (Fig. 6); it is not only very small, but also somewhat ill-preserved. The stem, about 3 mm broad, is covered with small leaf-cushions about 1.5 mm wide, which though indistinct in their outline and surface-marking, appear to be spirally arranged. These leaves projecting upwards at an angle of about 75° from leaf-cushions are small, acicular and parallel-sided, being less than 20 mm in length and 0.7 mm in the widest part, thence tapering apically to a sharp point; they are single-nerved.

3) Dawson, J.W., 1862, On the Flora of the Devonian Period in North-Eastern America. Quart. Jour. Geol. Soc., Vol. 18, P. 316, Pl. 12, Fig. 8, and Pl. 17, Fig. 53.

Dawson, J.W., 1863, Further Observations on the Devonian Plants of Maine, Gaspé, and New York. Quart. Jour. Geol. Soc., Vol. 19, P. 462, Pl. 18, Fig. 19.

Smith, G.O. and White, D., 1905, The Geology of the Perry Basin in South-eastern Maine. U.S. Geol. Surv., Prof. Paper No. 35, P. 69, Pl. 6, Figs. 1-4.

Kräusel, R. und Weyland, H., 1941, Pflanzenreste aus dem Devon von Nord-Amerika. Palaeontographica, Bd. 86, Abt. B, S. 56, Taf. XI, Figs. 7-11.

4) Carruthers, W., 1872, Note on Fossil Plants from Queensland, Australia. Quart. Jour. Geol. Soc., Vol. 28, P. 352.

It is not proven that this young stem belongs to the same species with the larger ones referred to above. Dawson described and figured several leaves (Dawson, 1863, Pl. 18, Fig. 19), but this combination of the leaves to the stems are doubted by Carruthers and others (Carruthers, 1872, Kräusel and Weyland, 1941); Kräusel and Weyland¹⁾ specially stressed that the leaves were not yet known from *Leptophloeum*. For a while, the study of the further details of our leaved stem is left for future.

Kräusel and Weyland²⁾ mention peltate small leaves to be characteristic to *Leptophloeum*, these are not yet found in our material. Notwithstanding that, the Nakakura material is provisionally referred to *L. australe* from the Upper Devonian Lambian series of Australia on their great similarity in several features as stated above. The Lambian series agrees with our Nakakura formation in several particulars, abundant occurrence of *Spirifer verneuili* and *Camarotoechia pleurodon* in association with *Leptophloeum*, and shallow-water nature of the deposits as indicated by the frequent intercalation of conglomerate and sandstone, and also of red beds.

No similar fossils have yet been reported from the Upper Devonian of China. From Siberia, the Upper Devonian of the Kirgis region yielded *Lepidodendron* cfr. *nothum* Unger¹⁾, and the Devonian of the Kazakhstan *Leptophloeum australe*, according to Neiburg²⁾. The extension of the latter species to Siberia is not improbable, in view of its occurrence in Japan.

Horizon and age: Nakakura formation, Upper Devonian.

Localities: Kitaiwairi, Nagasaka-mura, Yokosawa and Natsuyama, Taközu-mura.

Cyclostigma Houghton 1859.

Cyclostigma sp. (Figs. 7-8)

Five ill-preserved specimens from Yokosawa in association with *Spirifer verneuili* and *Leptophloeum* cfr. *australe*, bear small scars distinctly marked on the surface; the scars are arranged in regular spirals (Fig. 7) or in whorls.

Probably they belong to *Cyclostigma* and seem to resemble most closely the American form which Kräusel and Weyland compared

1) 2) Kräusel, R. und Weyland, H., 1941, Pflanzenreste aus dem Devon Nord-Amerika. Palaeontographica, Bd. 86, Abt. B, S. 60.

Kräusel, R. und Weyland, H., 1949, Pflanzenreste aus dem Devon XIX, *Gilboaphyton* und die Protolipidophytales. Senckenbergiana, Bd. 30, S. 147.

1) Obrutschew, W.A., 1926, Geologie von Sibirien, S. 139.

2) Neiburg, M.F., 1939, Devonian Flora from North-eastern Balkash Regions. (Kazakhstan). C.R. Acad. Sci. U.R.S.S., Vol. 23, No. 7, P. 739.

with *C. kiltokense*³⁾

Horizon and age: Nakakura formation, Upper Devonian.

Locality: Yokosawa, Takōzu-mura.

These specimens described above are preserved in the Institute of Geology and Mineralogy, Tokyo University of Education.

In closing, I wish to offer my great thanks to Dr. H. Yabe, M.J.A., for kindly reading this manuscript, and also to Prof. H. Fujimoto, under whose sincere guidance the present study was carried out.

3) Kräusel, R. und Weyland, H., 1941, Pflanzenreste aus dem Devon von Nord-Amerika. Palaeontographica, Bd. 86, Abt. B, (cfr. *C. kiltokense* Haughton, S. 63. Taf. 8. Figs. 11-13, Taf. 11, Figs. 3-6).

Explanation of Figures.

All figures except Fig. 2b are natural size.

Leptophloeum cfr. *australe* (McCoy).

Fig. 1. Part of a deformed stem. Loc. Natsuyama. Reg. No. 13109.

Fig. 2. An impression, showing the scars and furrows of the leaf-cushions; the scars are situated little above the centre of the leaf-cushions. Loc. Yokosawa. Reg. No. 13120.

Fig. 2a. The cast of the stem represented in Fig. 2. Reg. No. 13121.

Fig. 2b. A leaf-cushion from the specimen, Fig. 2, figured to show the furrow extending between the lateral angles and a pit on the apex of the leaf-scar. Slightly magnified.

Fig. 3. Cast of a stem with larger leaf-cushions, showing the apical scars. Loc. Yokosawa. Reg. No. 13212.

Fig. 3a. Part of Fig. 3, showing the position of the furrows and scars in the leaf-cushions.

Fig. 4. Another example, with obsolete scars and well-defined furrows of the leaf-cushions somewhat depressed at the middle. Loc. Yokosawa. Reg. No. 13165.

Fig. 5. Part of stem (impression), showing large leaf-cushions with apical scars. Loc. Yokosawa. Reg. No. 13104.

? *Leptophloeum* cfr. *australe* (McCoy).

Fig. 6. A young stem with acicular leaves. Loc. North of Yokosawa. Reg. No. 13156.

Cyclostigma sp.

Fig. 7. An ill-preserved specimen, showing the scars arranged in regular spirals. Same locality as Fig. 2. Reg. No. 13172.

Fig. 8. Another specimen, showing the arrangement of the scars. Same locality as Fig. 2. Reg. No. 13117.