STUDIES ON THE CENOZOIC PLANTS OF HOKKAIDÔ AND KARAHUTO

II. *SALVINIA NATANS* ALLIONI *FOSSILIS* SUBSP. NOV. FROM KARAHUTO AND S. *FORMOSA* HEER FROM HOKKAIDÔ

By

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With 1 Plate and 2 Text-figures

(Contribution from the Department of Geology and Mineralogy, Faculty of Science, Hokkaidô Imperial University, Sapporo; No. 278)

Genus *Salvinia* ALLIONI

Salvinia is an interesting fern belonging to Hydropteridineae. As the details of the genus are so well rendered in the original memoires and have found their way into all text-books of Botany and Palaeobotany, there is no need to recapitulate here the details of them. Therefore the present short note aims chiefly at the announcement of the occurrence and the description of this plant in Hokkaidô and Karahuto with additional note on its occurrence in these two islands.

There are more than a dozen living species of *Salvinia* mostly confined to a narrow geographical distribution in the equatorial region except *S. natans* (Japanese name *Sansyômo*) which is well known and widely distributed in the temperate parts of Asia, North America and Europe. Fossil records of the genus are known since the Eocene and as many species as the living *Salvinia* have been recorded from the Tertiary rocks in different parts of the world. Although little has been known of the reproductive organ of *Salvinia*, the recent investigation of the microsporangia of European Tertiary *Salvinia* by KIRCHHEIMER[1] is noteworthy as it proves certainly the

(1) F. KIRCHHEIMER: Die fossile Vertreter der Gattung *Salvinia* MICH. Planta, Bd. IX, Ht. 3, 1929; Bd. XI, Ht. 1, 1930; Bd. XIII, Ht. 1, 1931.

existence of this Hydropterid in the Tertiary age with little morphological variation in regard to the vegetative characters compared with the living forms.

In Japan, this genus was recorded by FLORIN[1] from the Nakanosima coal-mine of Kyûsyû (upper part of the Takasima Group[2]), and by KRYSHTOFOVICH[3] from the Chang-gi florule of Tyôsen under the name *S. formosa* HEER, while some imperfect specimens were reported from the Kanayama coal-bearing beds (the Kawabata Series; Miocene[4]), the Horokabetu Shale of the Palaeogene Isikari Series[5] and from the Tertiary strata of Sinano (Eocene, according to ENDÔ)[6], as *S.* sp. In adjacent lands, *Salvinia* has been described by YABE and ENDÔ[7] as *S.* sp. indet. from the Honkeiko Group in South Manchuria which they suggested the possibility of being not older than the Upper Cretaceous in age from the fact that *Salvinia* has never been recorded from the pre-Tertiary strata. Mr. INAI[8] who obtained *Pinoxylon dakotense*

(1) R. FLORIN: Eine Uebersicht der fossilen *Salvinia*-Arten mit besonderer Beruecksichtigung eines Fundes von *Salvinia formosa* HEER im Tertiaer Japans. Bull. Geol. Inst. Univ. Upsala, Vol. XVI, 1919, p. 248.

(2) T. NAGAO: Palaeogene Coal-bearing Formations of the Islands of Kyûsyû. Sci. Rep., Tôhoku Imp. Univ., Sec. Ser. (Geology), Vol. XI, No. 1, 1927.

(3) A. KRYSHTOFOVICH: To the Tertiary Flora of Chang-gi in Korea. Rec. Geol. Com. Russ. Far East, No. 18, 1921, p. 14 (*Salvinia* sp. cfr. *S. formosa* HR.).

(4) S. MURATA: On the Kanayama Coal-Bearing Beds. Hokkaidô Sekitan Kôgyô-kai-Si, No. 207, 1931, p. 5. In this report, Mr. MURATA maintained the Palaeogene age of the Kanayama coal-bearing beds from which *Salvinia* sp. has been obtained. However, the recent progress of stratigraphical study made by the members of our Department appears to suggest the Neogene age (the Kawabata Series) of the beds. No palaeontological evidences at our disposal are inconsistent with this suggestion.

(5) H. IMAI: Stratigraphical Studies of the Coal-bearing Tertiary of the Isikari Coal Field, the Isikari Series (in Japanese). Journ. Geogr. Soc. Tôkyô, Vol. XXXVI, 1924.

(6) H. HUZIMOTO: A Tertiary Plant Bed of Kitaaiki Village, Nagano Prefecture (in Japanese). Ibid., Vol. XXXVII, No. 437, p. 63 (*Salvinia* sp. cfr. *S. formosa?*).

(7) H. YABE and S. ENDÔ: *Salvinia* from the Honkeiko Group of the Honkeiko Coal-Field, South Manchuria. Jap. Journ. Geol. and Geogr., Vol. V, No. 3, 1927, p. 113.

(8) Y. INAI: On the So-called Hon-kei-ko Bed. Journ. Geol. Soc. Japan, Vol. XLIII, No. 512, 1936, p. 303.

KNOWLTON from a horizon 150–180 m. lower than that from which *Salvinia* sp. indet. described by YABE and ENDÔ has been yielded, claimed the Lower Cretaceous age, or even older than it, of the Honkeiko Group. Thus he wrote "from the evidence of *Pinoxylon dakotense* KNOWLTON, which was found in the lower part of Bed Thb. (*Salvinia* bed), it becomes evident that the stratum yielding it is either contemporaneous or nearly so with the Dakota formation in age. However, since an allied species, *Pinoxylon Yabei* SHIMAKURA, is known from the Middle Jurassic of Manchoukuo, it is very probable that the Bed containing *P. dakotense* belongs to an age falling in the Middle Jurassic to Lower Cretaceous." Therefore if this view may be accepted, *Salvinia* sp. indet. from the Honkeiko Group is the oldest record of this genus in the world.

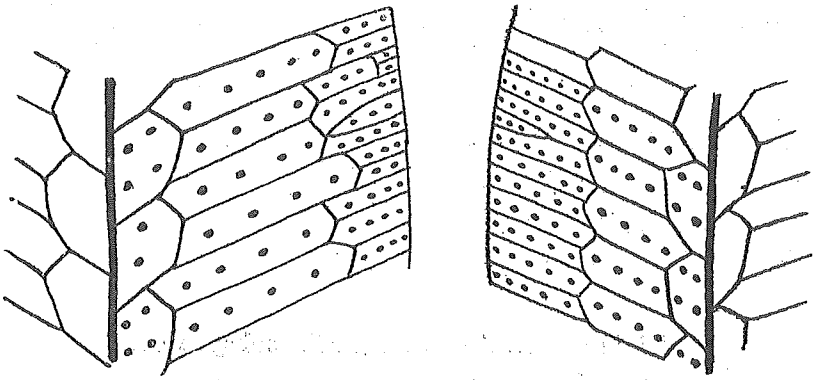
Salvinia natans ALLIONI *fossilis* subsp. nov.

Pl. XLIV (I), Figs. 1, 1a, 2, 2a, 3, 3a, 4.

Description: Leaves orbicular or ovate, varying somewhat in size, the maximum dimensions being 10 mm. in length and 8 mm. in breadth. Midnerve well-defined, with two rows of archeids on both sides, the inner one which runs close to the midnerve being low and the other close by to the outside being higher and narrower, reaching about midway, then the lateral nerves are straight, simple or rarely forking and reaching the margin. Tubercles or spines number 9–12 to each row and usually well marked. Neither sporocarps nor submerged leaves are known.

Fig. 1 shows an impression of the upper surface of a leaf; it shows clearly the nervation consisting of well-defined midnerve, two rows of archeids and simple or forking lateral nerves reaching the margin; the well marked tubercles or spines are also clearly represented. Fig. 2 shows an impression of the lower surface of the leaf, spinous appendages are clearly seen covering the whole surface of the leaf, as are visible in the lower side of leaves in *S. natans*. In fig. 3 are shown fine meshes arranged regularly in such a direction as to make a wide angle with the midnerve. Fig. 4 is a photograph of a specimen of *S. natans fossilis* collected by M. SHIMAKURA from Odasu in Karahuto and kindly sent the present writers for comparison. SHIMAKURA already reported the occurrence of *Salvinia* at Odasu in the lecture delivered in the meeting

of the Palaeontological Society of Japan held in Tôkyô in February 18th, 1939, but the result has not yet been brought to publication. His specimen is in the Institute of Geology and Palaeontology, Tôhoku Imperial University, Sendai.



Text-fig. 1. Comparison of nervation between *Salvinia natans* (a) and *S. natans fossilis* (b), considerably enlarged.

Remarks and comparison: The present fossil varies considerably in regard to the shape and size of the leaf. It is generally ovate in outline but sometimes it becomes orbicular or obovate. The apex is generally rounded, but sometimes shallowly notched.

In size and form of the leaf and in the nervation, the present fossil can hardly be distinguished from the living *S. natans* ALL. and the two appear to be specifically almost identical. But after a considerable hesitation, the writers decided to treat the present fossil as a subspecies of *S. natans* taking into consideration the fact that the occurrence of the fossil form is from the Miocene rock and that in the fossil type the spines are more numerous than in the living species.

The occurrence in Karahuto of the present fossil hardly distinguishable from *S. natans* is particularly interesting because the living species does not exist in Karahuto and Hokkaidô, the occurrence in Japan being confined only to Honsyû, the main island.

Occurrence (all in Karahuto):

Kanta-zawa, Esutoru-mati, Nayosi-gun; Akusyu volcanic group; coll. T. INOUE.

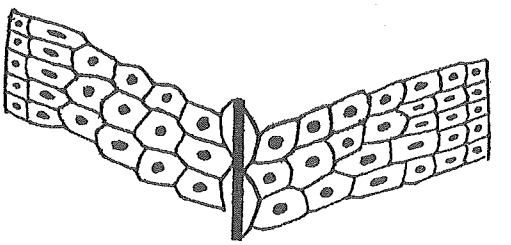
Odasu, Mihama-mura, Kusyunnai-gun; Noda volcanic group; coll. M. SHIMAKURA.

Salvinia formosa HEER

Pl. XLIV (I), Figs. 5, 5a, 6, 6a, 7, 7a, 8, 8a, 9, 9a.

1859. *Salvinia formosa* HEER: Flora Tertiaria Helvetiae, Vol. III, p. 156, pl. CXLV, figs. 13, 13b, 15.
1880. *Salvinia formosa* SCHIMPER and SCHENK: Palaeophytologie, in ZITTEL's Handbuch der Palaeontologie, Bd. V, p. 153, fig. 118.
1881. *Salvinia formosa* VELENOWSKY: Die Flora aus dem ausgebrannten tertiären Letten von Vrsonic bei Laun. Abh. k. Boehm. Ges. Wiss., VI, Folge Vol. II, No. 1, p. 12, pl. I, figs. 14–17.
1894. *Salvinia formosa* HOLLICK: Fossil *Salvinia*, including Description of a New Species. Bull. Torr. Bot. Club, 21, No. 6, p. 256, pl. 205, fig. 6.
1903. *Salvinia formosa* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 269, pl. 51, figs. 2, 3.
1904. *Salvinia formosa* BRABENEC: Ueber einen neuen Fundort von tertiären Pflanzen in der untern Zone von Zaaser Schichten. Bull. Int. Ac. Sci. Bohêma, p. 1, pl. I, figs. 2a–d.
?1919. *Salvinia formosa* FLORIN: Eine Uebersicht der fossilen *Salvinia*-Arten mit besonderer Berücksichtigung eines Fundes von *Salvinia formosa* HEER im Tertiär Japans. Op. cit., p. 246, pl. XI; text-fig. 1.
?1921. Cfr. *Salvinia formosa* KRYSHTOFOVICH: To the Tertiary Flora of Changgi in Korea. Rec. Geol. Com. Russ. Far East, No. 18, p. 14.
?1930. Cfr. *Salvinia formosa* HUZIMOTO: A Tertiary Plant Bed of Kitaaiki Village, Nagano Prefecture (in Japanese). Op. cit., p. 63.

1. Specimens from Uryû: Leaves orbicular to ovate in outline, rather small measuring 8–13 mm. in length and 5–12 mm. in breadth, with cordate base, round apices and entire margin. Midnerve rather thick and distinct, with a series of low archeids on each side; lateral nerves 16–18 in number given off from the archeids at an angle of about 50°, taking zigzag course, forking midway and mostly close to the margin to form regular hexagonal, rectangular or polygonal meshes with connecting cross bars. Tubercles or spines rather large, usually one to each mesh.



Text-fig. 2. *Salvinia formosa* HEER from Sasakizawa, Uryû-gun, enlarged to show the nervation and the tubercles.

2. Specimens from Yamabe: Floating leaves oval, about 13 mm. long and 10 cm. broad. The number of lateral nerves about

17 on each side of midnerve. Tubercles are distinct and 7 in number in each row. Other vegetable characters are quite similar to the specimens from Uryû described above.

3. Specimens from Kami-Horonobe: A single imperfect specimen is at hand.

Remarks: *Salvinia formosa* HEER varies considerably in the size of the floating leaves, variation ranging, in the type specimen from Switzerland figured by HEER, from 25 mm. to 27 mm. in length and from 17 mm. to 20 mm. in breadth; in the Tongking specimen figured by ZEILLER the length is 15–25 mm. and the breadth is 10–20 mm.; but in the Japanese ones, the largest are 13 mm. long and 12 mm. broad and the smallest ones 8 mm. long and 5 mm. broad.

Specimens described by FLORIN from the Nakanosima coal-mine of Kyûsyû as *S. formosa* appears to differ somewhat in respect to the nervation from the ordinary type of *S. formosa*, the meshes being considerably irregular, if the sketches are correctly drawn. However, the present writers can not make any statement on this point because no additional material of *Salvinia* from this locality are at their disposal.

S. formosa HEER can be distinguished from *S. natans fossilis* subsp. nov. in the comparatively larger leaves, shorter meshes and larger and less number of tubercles (compare the text-figures 1 and 2).

Occurrence (all in Hokkaidô):

Sasakizawa and Daikokuzawa, tributaries of the Horonitati-betu-gawa, near the Syôwa coal-mine, Numata-mura, Uryû-gun, Prov. Isikari; Obira Series; coll. T. TOKUDA.

Yamabe coal-mine, Sorati-gun, Prov. Isikari; Kanayama Coal-bearing beds; coll. K. UWATOKO.

Kami-Horonobe, Horonobe-mura, Tesio-gun, Prov. Tesio; Horonobe coal-bearing beds; coll. K. HUZIOKA and T. WADA.

Post script

After the manuscript of the present paper was sent to press, the writers received from Dr. R. FLORIN an important paper on *Salvinia* (R. FLORIN: Zur Kenntnis einiger fossiler *Salvinia*-Arten

und der früheren geographischen Verbreitung der Gattung. Svensk Bot. Tid., Bd. 34, H. 4, 1940). Therefore his paper was not referred to in the present paper.

EXPLANATION OF THE PLATE XLIV (I)

The figures are in natural size, if not otherwise stated. The specimens are in the Department of Geology and Mineralogy, Faculty of Science Hokkaidô Imperial University, except one in fig. 4 which is in the Institute of Geology and Palaeontology, Tôhoku Imperial University, Sendai.

Salvinia natans ALLIONI *fossilis* subsp. nov.

Figs. 1, 1a, 2, 2a, 3, 3a. Loc. Kanta-zawa, Esutoru-mati, Nayosi-gun, Karahuto. Akusyu volcanic group (Noda volcanic group).

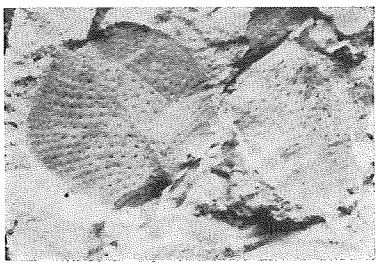
Fig. 4. Loc. Odasu, Mihama-mura, Kusyunnai-gun, Karahuto. Noda volcanic group.

Salvinia formosa HEER

Figs. 5, 5a, 6, 6a, 7, 7a. Loc. Sasakizawa, a tributary of the Horonitatibetugawa, Numata-mura, Uryû-gun, Prov. Isikari, Hokkaidô. Obira Series (Kawabata Series).

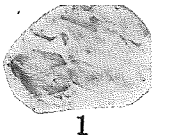
Fig. 8. Loc. Kami-Horonobe, Horonobe-mura, Tesio-gun, Prov. Tesio, Hokkaidô. Horonobe coal-bearing beds (Kawabata Series).

Fig. 9. Loc. Yamabe coal-mine, Sorati-gun, Prov. Isikari, Hokkaidô. Yamabe coal-bearing beds (Kawabata Series).



3a ×3

1a ×3



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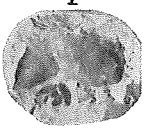

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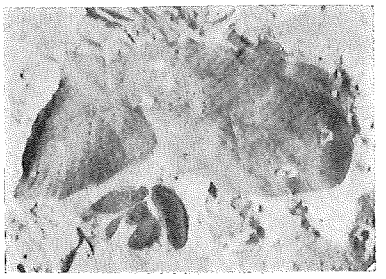

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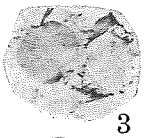

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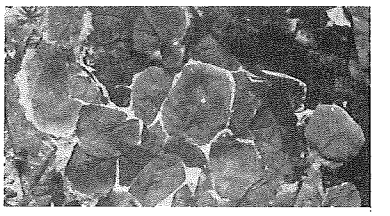

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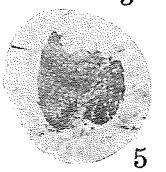

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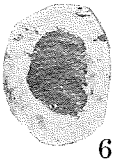

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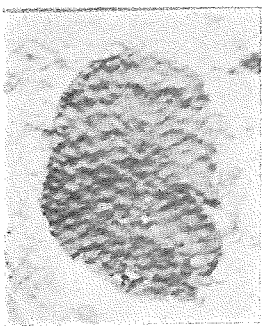
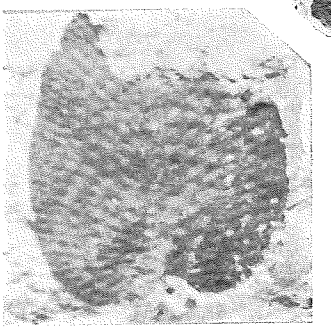
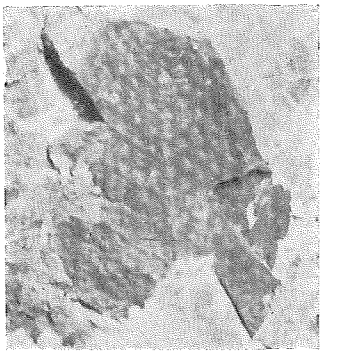


6a ×3



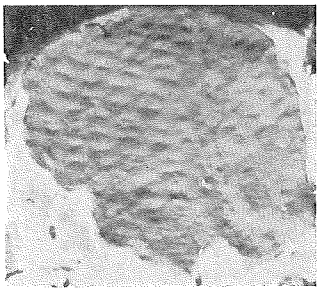
5a ×3



9a ×3

7a ×3

9



8a ×3

Kumano photo.

S. Ôishi and K. Huzioka: Salvinia from Hokkaidô and Karahuto.