Acta Botanica Neerlandica **15** (1966) 389–393

THE OCCURRENCE OF *SALVINIA NATANS* (L.) ALL. IN HOLOCENE DEPOSITS OF THE RHINE DELTA

K. J. ZANDSTRA

(*Laboratory of Regional Soil Science, Agricultural University, Wageningen, the Netherlands*)

(*received January 26th, 1966*)

INTRODUCTION

Salvinia natans is a warm temperate species still living in Europe (Map 1). Up to 1936 it was only known from Pleistocene interglacial deposits. FLORSCHÜTZ and JONKER (1936) first mentioned it in 1936 in post-glacial deposits; only one macrosporangium was found in the Holocene underneath the Cathedral Square at Utrecht. In 1939 the same authors discovered large amounts of macro- and microsporangia in an Old Atlantic clay near Wijk bij Duurstede (Map 2).

According to GODWIN (1956), up to that year these were the only occurrences known from the west European Post-Glacial.

However, in 1961 JELGERSMA gave a diagram from Alphen-on-the-Rhine, in the delta region, where microsporangia of *Salvinia natans* had been encountered in gyttja and dy from the Atlantic period (Map 2).

Finally, the present author has added a new find, also from the Atlantic, in the same region of the Rhine delta (Map 2 and Fig. 1).

In view of the now known sites of occurrence, it would therefore appear likely that *Salvinia natans* had a natural habitat in the Rhine delta in the Atlantic. Hence it is by no means impossible that this species, which requires a warm temperate climate, may be encountered in other river clay regions in the same environment and period.

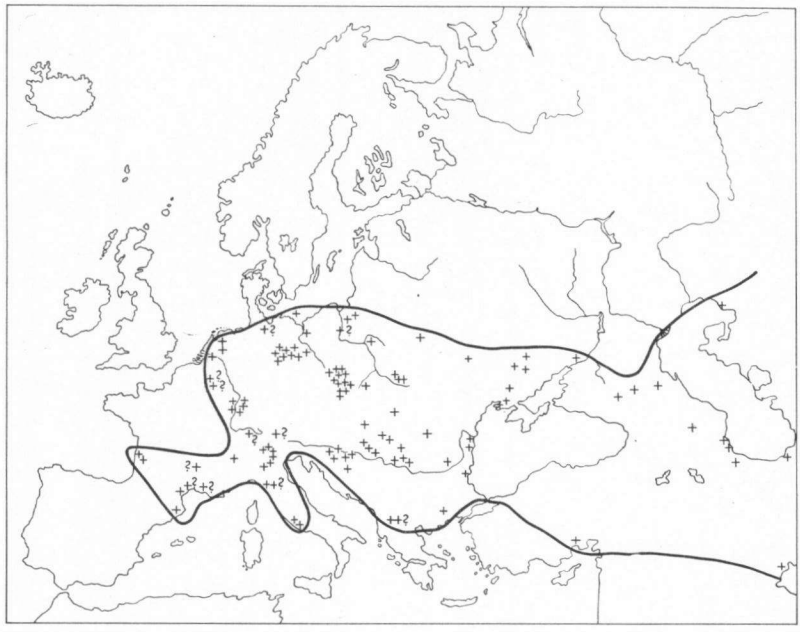
THE FIND-PLACE OF SALVINIA NATANS IN 1965

In 1965 the author sampled a profile in the Vuylcop polder in connection with an investigation into the Utrecht river area. This polder is situated between the Houten- and the Linschotensystem, former arms of the river Rhine (map in VINK, 1926 and 1954).

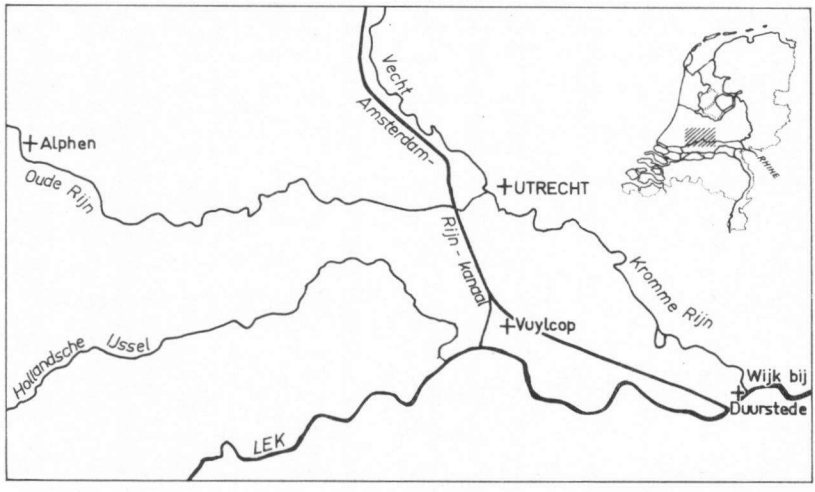
The samples were collected near the Hoonrug, a silted up stream-channel. The site is located to the south of the Amsterdam-Rhine Canal, midway between the 46 and 47 km marks, east of the ferry to Houten, in a meadow about 2 m past the berm ditch (Map 2).

THE PROFILE

0– 60 cm backswamp clay disturbed by excavation
60– 83 cm backswamp clay
83–100 cm black, tight, buried soil horizon
100–110 cm humose backswamp clay



Map 1. Distribution of *Salvinia natans* (L.) All. in Europe (after HEGI). + ? = Fossil



+

Map 2. Part of the Rhine delta with location of *Salvinia* finds (+)

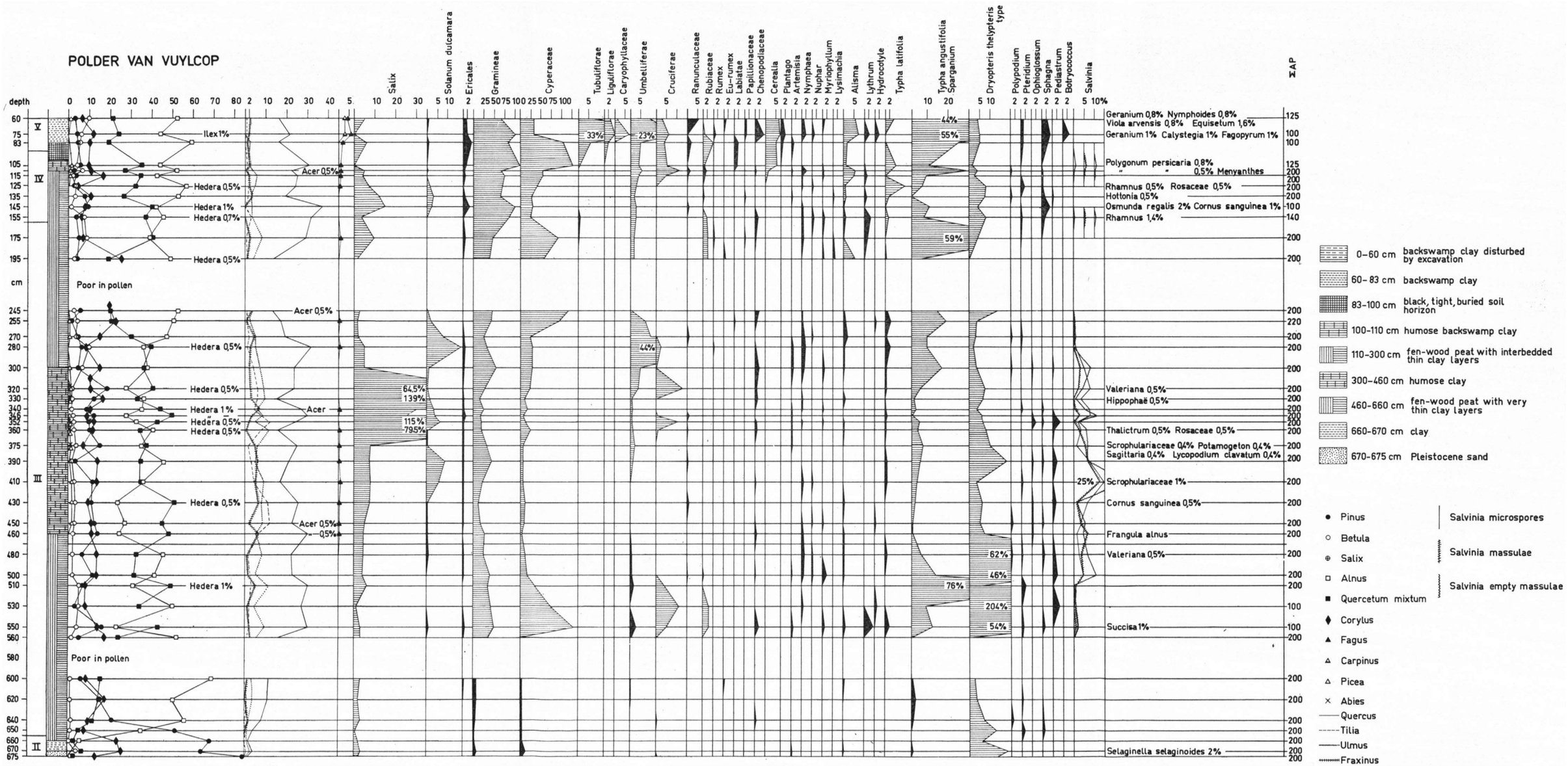


Fig. 1. Diagram of the Vuylcop polder. II. Boreal; III. Atlantic; IV. Subboreal; V. Subatlantic

Facing p. 390

110–300 cm fen-wood peat with interbedded thin clay layers
300–460 cm humose clay
460–655 cm fen-wood peat with very thin clay layers
655–670 cm clay
670–675 cm Pleistocene sand.

The layer of clay overlying the sand belongs to the fluvial Low-Terrace of BENNEMA and PONS (1952). It was also observed by VINK (1926) and DE BOER and PONS (1960). A cross section showed the 300–460 cm layer to be a wedge of clay originating in the Hoornrug (cf. Fig. 4, DE BOER and PONS, 1960). This wedge was particularly rich in remains of aquatic plants, including the water fern *Salvinia natans*. The black layer (83–100 cm) is a fire layer and hence deficient in pollen.

POLLEN ANALYSIS

A number of particular difficulties are involved in the pollen analysis of specimens from the river clay area.

The Rhine brings down pollen from its upstream area and may deposit it in the Utrecht basins. Thus several slides contain pollen of *Abies* and *Picea* which do not belong to the Post-Glacial native flora, although both general occurred in the Alpine forelands, the Vosges and the Black Forest, FIRBAS (1949).

The clay wedge samples contain small percentages of *Fagus* pollen in the Atlantic period. To a lesser extent S. JELGERSMA (1961) found the same in the coastal area. Since the beech is not a native of the Netherlands Atlantic period it would seem likely that in this case it was brought down by the Rhine. In the Old Atlantic beeches were a considerable feature of the upstream area of the Rhine, FIRBAS (1949).

At the same time, however, we should not overrate the possibility of pollen grains being brought down by the Rhine. The pollen composition of the samples indicates a well-developed local vegetation.

Evidence of the local deposition of pollen of such aquatic and marsh plants as *Alnus*, *Typha*, *Gramineae*, *Cyperaceae*, etc. is to be found in the occurrence of clods of pollen that would certainly have become detached if carried by the stream. The occurrence of stellate hairs of *Nymphaea* and rootlets of *Gramineae* and *Cyperaceae* is also self-explanatory in this connection.

The possibility of *S. natans* in the Atlantic period being carried down from the upper Rhine areas is to be precluded for the following reasons: firstly, the fragile, reticulated sporangium wall was often intact and it is unlikely that this could have withstood long transport by water; secondly, the occurrence of *S. natans* is limited to the Atlantic period.

THE DIAGRAM

$\sum$ A.P. The records are based on 200 tree pollen per spectrum, but this figure could not be reached in some layers with a high percentage of charcoal (fire layers) owing to the lack of, or severe corrosion

of the pollen grains. *Salix* was excluded from the $\sum$ A.P. owing to overpresentation.

$\sum$ N.A.P. The numbers of pollen and spores of herbs were calculated at percentages of $\sum$ A.P.

Of *Salvinia natans* there were counted in the slides:

a. massulae (hardened rounded alveolate mass with maturing spores);
b. empty massulae (without spores);
c. microspores.

Moreover a large number of macro- and microsporangia have been obtained by washing from the clay.

Environment

Aquatic and marsh plants may be classified in six different types of vegetation, depending on the water level Westhoff *et al.* (1946):

1. *Potamion*, plants growing in water less than 4 m deep: *Salvinia natans, Potamogeton, Nymphaea, Nuphar, Menyanthes, Hottonia, Nymphoides, Myriophyllum, Pediastrum.*
2. *Phragmition*, plants growing in water 2–0.25 m deep: *Typha, Alisma, Sagittaria.*
3. *Magno-caricion*, plants growing in water 0.25–0 m deep: *Cyperaceae.*
4. *Filipendulo-petasition*, water level 0 m. Herbs, no woody species, *Filipendula, Lythrum, Lysimachia, Succisa, Hydrocotyle, Valeriana. Thalictrum, Eurumex.*
5. *Alnion*, water level 0 m. Alternately wet and dry. In combination with woody species. *Solanum dulcamara, Ophioglossum, Osmunda, Dryopteris thelypteris.*
6. *Salicion*, water level 0 m. Alternately wet and dry. A preference for mineral soils. *Salix spec.*

As the diagram of the Vuylcop polder shows, *S. natans* belongs to the *Potamion.*

The relative fall in the water level caused by the sedimentation of river clay changed the character of the vegetation. At the same time there was a fall in the discharge of the Hoonstroom, with the result that river water was only occasionally brought down to the basin. Peat growth occurred, but bands of clay are still visible in the peat. At some periods there was enough water in the basin for the sporadic appearance of *S. natans*, but in increasingly smaller numbers. At the end of the Atlantic the climate gets unfavourable for *S. natans.*

The environment of *S. natans* in Jelgersma and Florschütz and Jonker is given below for comparison.

In Jelgersma's (1961) diagram we find *Nymphaea, Nuphar, Typhaceae, Myriophyllum, Sagittaria* and *Potamogeton* in the *S. natans* range.

No herb pollen is included in the Florschütz and Jonker (1939) diagram, but fruits, leaves and seeds are shown. In the layer in which *S. natans* occurs we again encounter *Nymphaea, Nuphar, Potamogeton, Alisma, Sparganium, Chara* and *Batrachium*, together with *Phragmites.*

It will be seen from the above that *S. natans* occurs in the same type of vegetation in three out of four find-places. The water fern prefers

stagnant eutrophic water 2 to 4 m in depth. The Atlantic supplied the need of a warmer climate than that prevailing today.

At present *S. natans* does not occur north of the upper Rhine area, but it is occasionally transported thence to Holland by wood drafts and sometimes maintains itself for several decades FLORSCHÜTZ and JONKER (1939).

CONCLUSION

In the delta areas of the Rhine *Salvinia natans* occurred in three different diagrams during the Atlantic. Entire massulae, macro- and microsporangia have been found; in particular, the intact, foamlike network of massulae, their large numbers and the long period over which they are found, would make local growth appear extremely probable, as also the correspondence with the environment. This is a fairly deep basin, rich in eutrophic water plants, in which a gradual silting-up occurs.

REFERENCES

BENNEMA, J. and L. J. PONS. 1952. Donken, Fluviatiel Laagterras en Eemzee-afzettingen in het westelijk gebied van de grote rivieren. Boor en Spade **5**: 126–137.

DE BOER, TH. A. and L. J. PONS. 1960. Bodem en grasland in de Vijfherenlanden. Verslagen van landbouwkundige onderzoekingen, **66–6**: 7–72.

FIRBAS, F. 1949. Spät- und nacheiszeitliche Waldgeschichte Miteleuropas. Allgemeine Waldgeschichte. Jena.

FLORSCHÜTZ, F. and F. P. JONKER. 1936. Botanisch onderzoek van den Utrechtschen Bodem. Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen. Wetenschappelijke Verslagen. Bijlage III. Wetensch. Versl. **3**: 120–121.

———— and ————. 1939. A botanical analysis of a late-pleistocene and holocene profile in the Rhine delta. Rec. trav. bot. Néerl. **36**: 686–696.

GODWIN, H. 1956. The history of the British Flora. Cambridge.

HEGI, G. 1935. Illustrierte Flora von Mittel-Europa (2nd ed.) **1**: 68. München.

JELGERSMA, S. 1961. Holocene sea-level changes in the Netherlands. Maastricht.

VINK, T. 1926. De Lekstreek; een aardrijkskundige verkenning van een bewoond deltagebied. Amsterdam.

————. 1954. De Riviersteek. Baarn.

WESTHOFF, V., W. DIJK, H. PASSCHIER and G. SISSINGH. 1946. Overzicht der Planten Gemeenschappen in Nederland. Amsterdam.