EESTI NSV TEADUSTE AKADEEMIA TOIMETISED. GEOLOOGIA
ИЗВЕСТИЯ АКАДЕМИИ НАУК ЭСТОНСКОЙ ССР. ГЕОЛОГИЯ
PROCEEDINGS OF THE ACADEMY OF SCIENCES OF THE ESTONIAN SSR. GEOLOGY

1988, 37, 2
https://doi.org/10.3176/geol.1988.2.06

УДК 561:551.734.3(474.2)

Külli KALAMEES

SOME MIDDLE DEVONIAN PLANTS FROM ESTONIA

The Middle and Upper Devonian flora in Estonia was revised and described by P. W. Thomson in 1940. Since that time only some Devonian plant remains were collected together with fossil fishes. The plant localities were more thoroughly studied in 1982 when a new rich horizon in the Kose (Oore) quarry on the Pärnu River was discovered. Similar plant remains have been found at Tori, the well-known locality of fossil plants a few kilometres upstream. In Joosu numerous plant remains including sporangia which are very rare in our Devonian deposits, occur (see also Tallinn et. al., 1970). New information on the systematic position and structure of the Middle Devonian plants will be given. For the first time preparations of the fossil tissue (phytoleimma) from the Estonian material were made. In this paper a new taxon, *Pseudosporochnus estonicus* is described and additional information on the previously known form, *Hostinella*, is given. The plants come from the upper and lower part of the Estonian Middle Devonian. The material is housed at the Institute of Geology, Academy of Sciences of the Estonian SSR.

Division Pteridophyta
Class Cladoxylopsida

Genus *Pseudosporochnus* Potonie et Bernard, 1904

Type species *P. verticillatus* (Krejči, 1881) Obrhel, 1959.

Due to the terminal position of sporangia and mainly dichotomous branching *Pseudosporochnus* was long regarded as a psilophyte. S. Leclercq and H. P. Banks (1962) made clear the systematic position of the genus and studied its anatomy on the basis of *P. nodosus* showing the plant to be a pteridophyte. The new systematic position of the genus was given although the anatomy of other species was unknown.

Description (modified after Leclercq, Banks, 1962). Small trees or bushes by habit. Main stem (branch of the first order), bulbous at the base, divides digitately at the apex giving second order branches. The latter divide next by dichotomous forking and form the branches of the third order. Small ultimate appendages (fronds) are arranged spirally or irregularly on the branches of the second and third orders. Fertile and vegetative fronds branch dichotomously. Sporangia are borne in fertile fronds terminally.

Species: *Pseudosporochnus nodosus* Leclercq et Banks, 1962; *P. verticillatus* (Krejči, 1881) Obrhel, 1959; *P. chlupaci* Obrhel, 1959; *P. ukrainica* Ishenko, 1965 (Ищенко, 1965) and *P. estonicus* n. sp.

Age and distribution. From Middle to Upper Devonian (Eifelian — Frasnian). Eurasia, North America.

Pseudosporochnus estonicus n. sp.
(Pl. I, figs *1*—*9*; text-fig. 1, 2).

Holotype. N Va-2199 (Pl. I, fig. *1*). Housed at the Institute of Geology, Academy of Sciences of the Estonian SSR.

Occurrence. Middle Devonian, Givetian, Burtnieki Regional Stage.

Type locality. The clay quarry in Joosu, SE Estonia, USSR.

Material. 198 specimens were studied (18 fertile), all of them preserved as impressions. The material was collected by Dr. E. Mark-Kurik in 1971 and by the author in 1983 in Joosu.

Diagnosis. Branches divide in monopodial and dichotomous fashion. The angle of branchings varies from 15 to 140°; 90° and wider angles are common. Pinnae of the fertile frond dichotomize from 4 to 6 times. Sporangia, borne terminally and singly in the frond, are clearly determinable from the pinnae bearing them. They are oblong-oval in shape, 1.5—5 mm long and 0.6—2.5 mm wide.

Description. Branches are naked, sometimes longitudinally striped. Three branch types can be recognized: 1) monopodially divided branches (Pl. I, figs *5*, *6*), 2) dichotomously divided branches (Pl. I, figs *2*, *3*, *4*, *7*, *8*) and 3) the systems of small dichotomizing pinnae that may be taken as analogical organs of fern leaves; branchlets are represented by fertile fronds (Pl. I, fig. *1*) and vegetative fronds (Pl. I, fig. *9*). Branching is monopodial and dichotomous. The number of branchings reaches up to 15 in holotype. The distances between forkings on the fertile frond vary from 11.7 to 1.5 mm becoming shorter towards the apex. In lower sterile parts of the plant distances between branchings are longer. Branching is quick, especially in the terminal regions of the branches. Pinnae dichotomize on the fertile frond from 4 to 6 times.

Vegetative branches are 0.2—12.5 mm and fertile ones 0.2—1.5 mm wide. As the material is fragmental, the order of the branches cannot be observed.

The angles between branchings vary greatly: from 15 to 140°. Vegetative parts of the plant seem to branch at more acute angles than fertile ones. Angles of vegetative branches are 15—110° (more often 50—80°), these of fertile branches 28—140° (more often 60—90°).

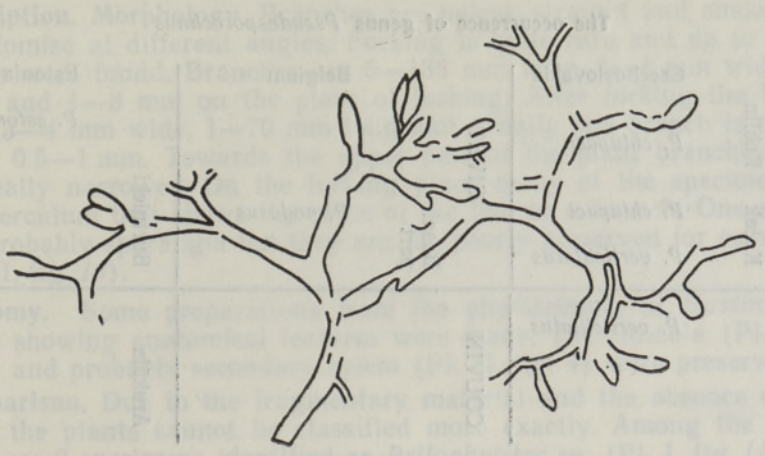
Sporangia, borne singly and terminally on the frond, are oblong-oval in shape. They are clearly determinable from the pinnae bearing them. 62 sporangia were measured. Their length is 1.5—5 mm, most often 3—3.9 mm (45.2%) and 2—2.9 mm (29%), on the average 3.12 mm; the width is 0.6—2.5 mm, on the average 1.32 mm, most often 1—1.9 mm (77.4%). The length-width relation on the average is 2.35 showing sporangia to be more than 2 times longer than wide. The thickness of walls, measured in 19.4% of sporangia, was 0.1—0.3 mm, on the average 0.15 mm. 25.8% of sporangia were mature. The opening of the sporangium was taken as the criterion of maturity. Most of the split sporangia (81.3%) were more than 3 mm long. In spite of several attempts no spores and fragments of cuticula were found.

The largest specimen is 22 cm long and 6.5—6 mm wide (Pl. I, fig. *5*). The most informative and best preserved specimen is the holotype (Pl. I, fig. *1*; text-fig. 1) showing the fertile frond. Branches dichotomize from 4 to 6 times. Branching is quick, distances shorten towards the apex (10.8—2 mm). Branches are 1.2—0.3 mm wide. Angles between dichotomies are quite wide: 48—140° (more often 80—110°). Singly and terminally borne sporangia are 2—4.2 mm long and 1—1.8 mm wide.

Comparison. The characteristics that distinguish *Pseudosporochnus estonicus* from the other species of the genus are: 1) sporangia are borne singly (in *P. nodosus* and *P. verticillatus* in pairs); 2) the measurements

Pseudosporochnus estonicus n. sp.
Fig. *1*. Fertile frond (holotype), Va-2199, 2×. Figs *2—4*. Dichotomously divided branches: *2* — Va-2198, 1/3×; *3* — Va-2197, 1/2×; *4* — Va-2196, 1/2×. Figs *5—6*. Monopodially divided branches: *5* — Va-2195, 1/2×; *6* — Va-2194, 1/2×. Fig. *7*. Dichotomously (or monopodially) divided branches, Va-2193, 1×. Fig. *8*. Dichotomously (dichopodially) divided branches, Va-2192, 1×. Fig. *9*. Sterile frond, Va-2191, 1×. Fig. *10*. *Hostinella* sp. Sporangia (?), Va-2188, 1×. Fig. *11*. *Psilophytites* sp., Va-2185, 1/3×.

Hostinella sp.
Figs *1—3*. Fragments of cuticula: *1* — 200×; *2—3* — 310×. Fig. *4*. Secondary xylem, 1800× /Figs *1—4*: Va-2182 and Va-2183/. Figs *5—8*. Dichotomously divided branches, *5a* — Va-2189, *5b* — Va-2190, 1/2×; *6* — Va-2184, 1/3×; *7* — Va-2186, 1/2×; *8* — Va-2187, 1/2×.



Text-fig. 1. Fertile frond, *Pseudosporochnus estonicus* (holotype), 2×.

of sporangia are greater; 3) sporangia are clearly determinable from the pinnae bearing them (in *P. verticillatus* pinnae smoothly become sporangia); 4) the shape of sporangia is oblong-oval; 5) the angle of branchings is wider than in other species: 15—140° (15—110° in vegetative parts, 28—140° in fertile parts); in *P. chlupaci* it is 24—66°, in *P. nodosus* 14—98° (vegetative parts) and 18—45° (fertile parts) measured from the figures by S. Leclercq and H. P. Banks (1962); 6) pinnae dichotomize on the fertile frond from 4 to 6 times. In *P. nodosus* they dichotomize 3, in *P. verticillatus* 2—3, in *P. chlupaci* 4 times according to the data or figures by R. Kräusel, H. Weyland (1933), S. Leclercq, H. P. Banks (1962) and J. Obrhel (1959).

Discussion. From the morphological aspect it is interesting to note that in *P. estonicus* the fertile frond is wider and sporangia larger than in other species. This may indicate the difference in life conditions such as density of plants, light conditions, growing place, etc., but also the difference in evolutionary organization levels. Biostratigraphical aspects are also of note. *P. estonicus*, coming from the Burtnieki Regional Stage seems to be one of the youngest Middle Devonian representatives of the genus. The other Middle Devonian species occur mostly in the upper part of the Eifelian and lower part of the Givetian. In one case the genus is recorded from the Frasnian (Banks, 1966). It is not quite clear which part of the Givetian the Burtnieki Regional Stage corresponds to (Сорокин et al., 1981). If this stage represents approximately the whole Givetian, the horizon with *P. estonicus* occupies a higher level than the other Middle Devonian species. In this case *P. estonicus* appears to be the youngest among the Givetian species (see the Table). Accordingly, the greater measurements of sporangia and the wideness of fertile fronds can be explained by the difference of the geological age.

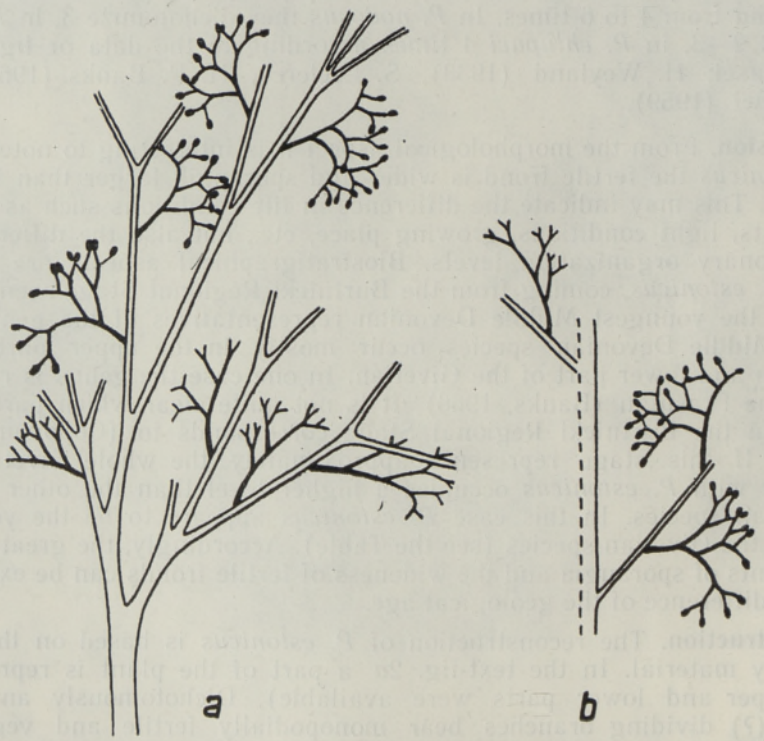
Reconstruction. The reconstruction of *P. estonicus* is based on the fragmentary material. In the text-fig. 2*a* a part of the plant is represented (no upper and lower parts were available). Dichotomously and digitately (?) dividing branches bear monopodially fertile and vegetative fronds. The fronds are probably spirally or irregularly arranged. It is also possible that monopodially divided branches bear fronds in the opposite or alternative fashion (text-fig. 2*b*). Specimen in Pl. I, fig. *5* is monopodially divided but cannot be the axis of the frond due to its thickness.

The occurrence of genus *Pseudosporochnus*

	Czechoslovakia	Belgium	Estonia
GIVET			*P. estonicus*
Sbrsko Roblin	*P. chlupaci*		
Kačak	*P. chlupaci*	GIVET	
	P. verticillatus	Basal part *P. nodosus*	Burtnieki
EIFEL	*P. verticillatus*		
Choteč		COUVIN	Arukūla

Genus *Hostinella* Barr ex Stur, 1882 emend. Potonie et Bernard, 1904
Hostinella sp.
(Pl. I, fig. *10*; Pl. II, figs *1—8*).

Material. 113 specimens.
Occurrence. Kose (Oore) quarry and the Tori outcrop on the Pärnu River, West-Estonia. Middle Devonian, Eifelian, Pärnu Regional Stage.



Text-fig. 2. The reconstruction of *P. estonicus*, $^1/_3\times$. Dichotomously and digitately divided branches bear monopodially fertile and vegetative fronds (*a*). It is also possible that monopodially divided branches bear fronds in opposite or alternative fashion (*b*).

Description. Morphology. Branches are naked, straight and smooth. They dichotomize at different angles. Forking is quite rare and up to 3 dichotomies were found. Branches are 5—135 mm long, 1—4 mm wide at the base, and 1—8 mm on the place of forking. After forking the branches are 0.5—4 mm wide, 1—70 mm long and usually one branch is narrower about 0.5—1 mm. Towards the upper part of the plant branches become gradually narrower. On the forking place many of the specimens have a tuberculum that shows the place of the bud or a branch. One specimen has probably sporangia but they are too poorly preserved for examination (Pl. II, fig. *10*).

Anatomy. Some preparations from the phytoleimma of *Hostinella*-type stems showing anatomical features were made. The cuticula (Pl. II, figs *1—3*) and probably secondary xylem (Pl. II, fig. *4*) were preserved.

Comparison. Due to the fragmentary material and the absence of fertile parts the plants cannot be classified more exactly. Among the material there are 2 specimens identified as *Psilophytites* sp. (Pl. I, fig. *11*) differing only in small pits on the branches (see Høeg, 1952). It is not excluded that they also belong to *Hostinella*.

Discussion. Due to the presence of cuticula and probably secondary xylem one may suggest that the plant remains belong to the class Progymnospermopsida. However, they belong more possibly to the genus *Rellimia* (*Milleria*, *Protopteridium*). The problem is discussed by several authors (e. g. Banks, 1967; Beck, 1976; Bonamo, 1977). Similar plant fossils identified by P. W. Thomson (1940) from Tori as psilophytes under the name of *Aulacophycus sulcatus* Eichw. belong to a more developed group (e. g. Pteridophyta and/or Progymnospermopsida). Nowadays the plants that belonged to the psilophytes (Psilophyta) are mainly reclassified into different taxa.

By the occurrence of plant remains in the Kose (Oore) quarry, i. e. 1.5 m below the boundary of Tori and Tamme members, one may conclude the existence of the third, the highest plant horizon in the Pärnu Regional Stage. Two lower plant horizons at Tori were described by K. Orviku in 1930.

According to this study *Hostinella* sp. and *Psilophytites* sp. in the Pärnu Regional Stage occur. Probably they belong to Pteridophyta or Progymnospermopsida. *Pseudosporochnus estonicus* n. sp. from the Burtnieki Regional Stage is a primitive fern (pteridophyte).

Acknowledgements. The author of the paper wishes to thank Drs A. Jurina, E. Mark-Kurik, A. Kleesment, S. Meien, A. Gomankov, A. Piirisoo, Prof. Dr. V. Masing and K. Ronk for their kind help.

REFERENCES

Banks, H. P. Devonian flora of New York State. — Empire State Geogram, 1966, **4**, 10—24.

Banks, H. P. Anatomy and affinities of a Devonian *Hostinella*. — Phytomorphology, 1967, **17**, N 1—4, 321—330.

Beck, C. B. Current status of Progymnospermopsida. — Rev. Palaeobot. Palynol., 1976, **21**, 5—23.

Bonamo, P. M. Rellimia thomsonii (Progymnospermopsida) from the Middle Devonian of New York. — Am. J. Bot., 1977, **64**, N 10, 1272—1285.

Høeg, O. A. Psilophytites, a new form-genus of Devonian plants. — Palaeobotanist, 1952, N 1, 212—214.

Kräusel, R., Weyland, H. Die Flora des böhmischen Mitteldevons. — Palaeontographica, 1933, B, **78**, 1—46.

Leclercq, S., Banks, H. P. Pseudosporochnus nodosus sp. nov., a Middle Devonian plant with cladoxylalean affinities. — Palaeontographica, 1962, B, **110**, 1—34.

Obrhel, I. Neue Pflanzenfunde in dem Sbrsko-Schichten (Mitteldevon). — Vestn. ústřed. Úst. Geol., 1959, 34, N 5, 384—387.
Orviku, K. Keskdevoni põhikihid Eestis. — Tartu Ülikooli Geol. Inst. Toim., 1930, N 21.
Tallinn, K., Räägel, V., Kurik, E. Joosu savileiukoht ja devoni kivistised. — Eesti Loodus, 1970, nr. 12, 739—741.
Thomson, P. W. Beitrag zur Kenntnis der Fossilen Flora des Mitteldevons in Estland. — Loodusuurijate Seltsi Aruanded, 1940, nr. 45, 195—216.
Ищенко Т. А. Девонская флора Большого Донбасса. Киев, 1965.
Сорокин В. С., Лярская Л. А., Савваитова Л. С. и др. Девон и карбон Прибалтики. Рига, 1981.

House of Young Naturalists,
Tartu

Received
Apr. 2, 1987

Külli KALAMEES

KESKDEVONI TAIMI EESTIST

Keskdevoni floora leiukohtade uurimisel Eestis avastati 1982. aastal Pärnu jõel Kose (Oore) karjääris uus taimefossiile sisaldav tase (Eifel, Pärnu lade). Käesolevas töös on kirjeldatud antud leiukohast pärinevat *Hostinella* sp. Esmakordselt tehti Eesti devoni taimedest fütolemmi preparaadid. Joosu karjäärist (Givet, Burtnieki lade) kirjeldati sõnajalgtaimede uut liiki *Pseudosporochnus estonicus*. Taimel esinevad sporangiumid.

Кюлли КАЛАМЕЭС

НЕКОТОРЫЕ СРЕДНЕДЕВОНСКИЕ РАСТЕНИЯ ИЗ ЭСТОНИИ

В 1982 г. были изучены среднедевонские местонахождения флоры Эстонии. На р. Пярну в карьере Козе (Оope) был обнаружен новый более высокий уровень с остатками растений пярнуского времени (эйфель). Описаны остатки *Hostinella* sp. из этого местонахождения. Впервые из найденного материала были изготовлены препараты фитолеймы. Дано описание нового вида птеридофита *Pseudosporochnus estonicus* (живет, буртниекский горизонт). У этого растения обнаружены спорангии.