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Sphenophyta from the Early Jurassic of the Mecsek Mts., Hungary

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ABSTRACT. Sphenophytes are frequent in the Hungarian Lower Jurassic which is represented in one locality in the Mecsek Mts., the region of Pécs and Komló. Although the material seems to be rich in specimens, a number (about half of the total amount) is so poorly preserved, that specific determination is impossible. In the total number of examined specimens which means 155 pieces, only two genera were recognized: *Neocalamites* represented by one species *N. carcinoides* Harris and *Equisetites*, with three species *E. columnaris* (Brongniart) Phillips, *E. muensteri* Sternberg, and *Equisetites* sp.

KEY WORDS: *Equisetites*, *Neocalamites*, Early Jurassic, Hungary

INTRODUCTION

The Early Jurassic (Hettangian) Hungarian locality in the Mecsek Mts. is a coal-field area with some, recently closed, shafts (Kossuth, Béta, Zobák) and quarries: Vasas, Pécsbánya and Rücker. The material, which was collected mainly from the sterile dumps, but also from quarries (although not in situ, from actual horizons), appeared to be rich in remains of Sphenophyta. Generally, the almost all groups of plants and main genera characteristic for Early Jurassic of the northern hemisphere are represented in the flora from the Mecsek Mts. (Barbacka 1992, 2000, 2001, Barbacka & Bodor 2008 – these provide also information about the area). Although remains from this locality are usually well preserved, the state of Sphenophyta is exceptionally poor. Only about half of the total number of collected specimens were suitable for identification, and that was possible only on the basis of their macromorphology.

Identification of the Hungarian material was quite difficult, because of the species variability. This divergence was caused partly by preservation, partly by strong differences in size. In each of the two species, *Equisetites muensteri* and *E. columnaris*, two morphotypes were distinguished which appeared to differ in size (large and small forms) or in the surface of stems (smooth and ribbed forms), respectively.

The taxonomy of fossil sphenophytes is quite difficult, and usually bases on such features like length and width of internodes, character of sheaths, number of leaves and their morphology, and features of stems. The cuticles of sphenophytes are usually difficult to prepare, so they are rarely described.

This paper presents the spenophytes from the Hungarian locality as a next phase of investigations on the entire flora.

MATERIAL

The total number of collected specimens belonging to Sphenophyta is 285: 45 fragments of *Neocalamites* and 240 of *Equisetites*. Only 110 specimens of *Equisetites* were preserved in a state satisfactory for examination. The remaining 130 specimens were recognized only as *Equisetites*, but with undistinguishable characteristics of the genus.

Although the organic material seemed to be perfectly preserved in the studied samples, only on one

specimen some small fragments of cuticle suitable for preparation are present. All other material is coalified to such a degree that it is destroyed during maceration.

SYSTEMATIC DESCRIPTION

Sphenophyta

Equisetales

Neocalamites Halle 1908

Neocalamites carcinoides Harris 1931

Pl. 1, figs 1–2.

1931 *Neocalamites carcinoides* Harris, p. 25, pl. 4, figs 2, 3, 5, 7, pl. 5, figs 1–6, text-fig. 5 A–D.

?1968 *Schizoneura carcinoides* (Harris)Weber, p. 39, pl. 1 figs 5, 6, text-figs 6a,b.

Material. Forty five specimens were determined as belonging to *Neocalamites carcinoides*. They are mostly stem fragments, often small, within one internode. The largest preserved fragments are 18–20 cm long, but many fragments do not reach 5 cm in length. Only few specimens have nodes visible and only one shows complete internode. Separated leaves, belonging probably to this species, were found only on one specimen. The stems are preserved as impressions and the leaves as compressions, but with cuticle not suitable for preparation.

Specimens: BP 89.192.1, 89.193.1, 89.156.1, 89.438.1, 91.115.1, 94.385.1, 91.394.2, 94.396.2, 94.491.1, 96.8.2, 98.147.2, 98.797.1–801.1, 98.821.1, 98.870.1, 98.885.1, 98.886.1, 98.889.1, 98.1149.1, 98.1263.1–1265.1, 2000.863.1, 2001.974.1, 2001.975.1, 2002.126.1–129.1, 2002.1031.1–1033.1, 2005.867.1, 2005.943.1, 2006.606.1, 2006.647.1, 2006.668.1, 2006.669.1, 2007.806.1, 2007.822.1, 2007.852.1, 2007.865.1.

Description. The stem is 3–8 cm wide, preserved internode is 7 cm long, others can reach over 15 cm in length. The surface of stem is finely ribbed, ribs are about 0.5 mm wide. Leaf scars are in most cases not visible, rarely there are circle impressions at the node, crowded, 1.5–2.0 mm in diameter (Pl. 1, fig.1). Detached leaves are elongated and taper at the base and apex. Only one small leaf is complete, it is 50 mm long, the others are fragmentary and fragments do not exceed 40 mm, but judging from the curve of the margins their length may be estimated as about 80 mm. Their width at the middle, which is the widest point, is 3–4 mm. Well visible midrib runs until the apex, the leaf blade is thin (Pl. 1, fig. 2).

Discussion. The species *Neocalamites carcinoides* Harris was transferred to the genus *Schizoneura* Schimper & Mougeot by Weber (1968). He stated that the leaves described from Greenland by Harris as *Neocalamites carcinoides* were arranged more in two groups, which is the feature of *Schizoneura*, than in a circle (like in *Neocalamites*). The specimens illustrated by Weber (1968, fig. 6a, b, pl. 1, figs 15, 16) are similar to those showed in Harris (1931, fig. 5), however, Harris described his material as having leaves around the stem. His other illustrations (Harris 1931, pl. 5, figs 3, 4, pl. 6, figs 2–6) do not show definitely arrangement of the leaves which may be interpreted in both ways, as result of preservation or compression.

The material from Hungary is badly preserved and very incomplete, but the observable features like size of the stem, its surface, leaf scars, and mainly morphology of leaves well correspond with material from Greenland. The stem of Hungarian species resembles also the stem of *Neocalamites lehmannianus* (Goeppert) Weber (Weber 1968 and synonyms), but it has much longer and thinner leaves, and do not possess such conspicuous midrib.

Based on similarity between Hungarian material and Harris' description I lean to identify Hungarian material as *Neocalamites carcinoides sensu* Harris 1931.

Equisetites Sternberg 1833

Equisetites muensteri Sternberg 1833

Pl. 1, figs 3–8

1833 *Equisetites muensteri* Sternberg, p.43.,pl. 16, figs1–5

1867 *Equisetites muensteri* Sternberg; Schenk, p. 14, pl. 2, figs 3–9a; pl. 3, figs 1–13.

1926 *Equisetites muensteri* Sternberg; Harris, p. 52, pl. 2, figs 1, 7.

1931 *Equisetites muensteri* Sternberg; Harris, p. 7, pl. 2, figs 6–11 (with synonyms)

1968 *Equisetites muensteri* Sternberg; Weber, p. 41, pl. 3, figs 32, 34.

1989 *Equisetites muensteri* Sternberg; Zhou, p. 135, pl. 1, figs 5, 6, 11, 13, 15A.

1994 *Equisetites muensteri* Sternberg; Hauptmann & Hauptmann, pp. 346–350, figs 2–17.

1997 *Equisetites muensteri* Sternberg; Schweitzer et al., p. 131, pl. 3, fig. 3, 4; text-fig. 10.

Material. Two morphotype groups preserved in different types of sediments were identified as *Equisetites muensteri* (see also Table 1). The first group of specimens, the smooth form (25 fragments) was preserved in siltstone and shaly siltstone which are known as fluvial or brackish enclosed bay sediments (Nagy 1969), and with preserved quite thick organic matter, which preparation being, however, impossible. The second group, ribbed (31 fragments) preserved in fine detritic siderite, represents delta sediments (Nagy 1969), and the organic matter is thin, brown, almost like impression. Both morphotypes remained mainly as large samples, reaching 25 cm in length.

Specimens: BP 96.447.1, 96.479.1, 98.1122.1–1124.1, 98.1152.–154.1, 98.1166.1, 98.1167.1, 98.1211.1, 98.1239.1–1241.1, 98.1281.1–98.1284.1, 98.1286.1–1288.1, 98.1290.1–1292.1, 2000.127.1, 2001.939.1, 2001.942.1, 2002.1008.1, 2002.1009.1, 2003.435.1, 2003.437.1–442.1, 2004.42.1, 2004.43.1, 89.287.1, 91.45.1, 91.48.1, 91.49.1, 91.59.1, 91.64.1, 91.66.1, 91.70.1, 91.76.1, 94.121.1, 94.123.1, 94.125.1, 94.514.1, 94.515.1, 94.914.1, 98.1090.1, 98.1165.1, 98.173.1.

Description. The Hungarian specimens are unbranched stems, in the smooth form 13–27 mm (Pl. 1, fig. 3), in the ribbed one 15–20 mm wide (Pl. 1, fig. 6). The internodes are similar in both forms, usually 35–55 mm in length, maximum in smooth one 65 or 76 mm and in ribbed even to 117 mm (one specimen).

The number of leaves on the compressed half of stem is 11–17 in smooth form, and 8–11 in ribbed form. Leaves, which is especially visible in the smooth form, have 0.5–1.0 mm wide flanges along their margins (Pl. 1, fig. 3). The neighboring flanges may attach forming sheaths; in this case free teeth are 2–3 mm long (Pl. 1, figs 5–7). Sheaths are often very vague (Pl. 1, fig. 4). Flanges are observable only in the smooth form.

In the smooth form, the midrib is very thin, sometimes almost invisible and the stem is smooth as well. The ribbed form has very well marked midrib (4/5 of the leaf length) and strongly marked ribs on the surface of internodes (Pl. 1, fig. 6).

In both forms commissural furrows reach under the node for 4–9 mm.

Table 1. Comparison of the Hungarian morphotypes of *Equisetites*

feature \ species	*Equisetites muensteri*		*Equisetites columnaris*		*Equisetites* sp.
	smooth	ribbed	large	small	
type of leaf	free or sheath	free or sheath	sheath	sheath	sheath
number / half	10–12 (extr. 14, 15)	6–7	9–12 (extr.14–15)	11–13 (extr. 16) 29 around	31
total length of leaf (mm)	11–17	8–11	11–12	5–11	11
leaf width (mm)	0.8–2.5	2–4	1.5–2.0	0.8–1.0	0.7
free teeth (mm)	2–3	2–3	2.5–3.5	2–3	2.5–3.0
apex	subacute, acute	rounded, subacute	sharp acute	wide triangular, acute	sharp, spike
commisural furrow	narrow, 4–9 mm under node	not observed	wide with edge	narrow, 0.2 mm at the apex	line
midrib	thin, until apex	strong, 4/5 length	not observed	not observed	not observed
flanges	0.5 mm wide	not observed	not observed	not observed	not observed
length of internodes (mm)	35–55 extr. 65, 76	35 extr. 117	20–35	23–32	40
width of node (mm)	23–27	15–20?	13–30	7–10 (14)	27
furrow under node	1–9 mm	–	1–2 mm	–	5 mm
stem	smooth	strongly ribbed	sometimes finely striated, hairbases	sometimes finely ribbed hairbases	smooth
diaphragm	not found	6–15 mm in diameter, smooth, sometimes broken leaves	20–25 mm in diameter, smooth or grained, with tubercles at the edge	5–7 mm in diameter, smooth or grained, with tubercles at the edge	about 30 mm with dense thin teeth 2–5 mm, surface unknown

Diaphragms of the ribbed morphotype are 6–15 mm in diameter, smooth, sometimes with leaves at the edge, up to 10 mm long (Pl. 1, fig. 8). The diaphragm of the smooth morphotype is unknown.

Discussion. Although the two forms of the species differ from each other at first glance, they have common features like the occurrence of both sheaths and the free leaf tips, the shape of leaves, and the morphology of commissural furrows. These features correspond well with the stems illustrated by Schenk (1867), and others (Hauptmann & Hauptmann 1994, fig. 7– leaf teeth, sheath ibid fig. 3, Schweitzer et al. 1997, text-fig. 10, pl. 3, fig. 4 – leaf teeth).

The difference between the two forms in the appearance of midrib and the ribs along the stem may be caused by different types of preservation. The same for the flanges which are lacking in the ribbed form; they are very delicate and in sandstone might have not been preserved. It may be also explained by different preservation of the various layers of stems like in *Equisetites beanii* (Bunbury) Seward (Schweitzer et al. 1997, text-fig. 17).

The difference in size between typical *Equisetites muensteri* and the Hungarian specimens regards only the smooth form. According to the emended diagnosis given by Harris (1931), the stems reach usually 20 mm in width, while in the Hungarian form in most cases this value is exceeded.

The most serious disagreement regards the number of leaves. The typical leaf number for the species *E. muensteri* is 6–8, which was observed in the ribbed form, while in the smooth one the number is almost twice of the typical value. Harris (1931) pointed out that in *E. muensteri* the number of leaves is almost constant and amount to 6–7 in a half of node. However, in some papers the presented specimens of *E. muensteri* have the number of leaves close to those of the Hungarian material (Hauptmann & Hauptmann 1994, Zhou 1989).

Both forms occurred in the localities Pécsbánya –quarry and Béta shaft, but the smooth form was present in some more sites: Kossuth shaft and Zobák shaft. They show also similar fragmentation (frequent large pieces). It suggests that differences in preservation might be caused by local changes in soil type or separate, different sedimentary basins.

Equisetites columnaris
(Brongniart 1828) Phillips 1875

Pl. 1, figs 9–16.

1828 *Equisetum columnare* Brongniart, p. 115, pl. 13, figs 1–4.
1875 *Equisetites columnaris* Brongniart; Phillips, p. 197.
1961 *Equisetum columnare* Brongniart; Harris, p. 15, text-figs 4, 5 E,F,I,J (with synonyms)
1997 *Equisetites columnaris* (Brongniart) Phillips; Schweitzer et al, p. 135, pl. 5, figs 1–7; pl. 6, figs 1–3; text-fig. 15 (with synonyms)

Material. The material consists of 52 fragments of stems with leaves preserved in siltstone and shaly siltstone. This species is represented by two morphotypes (Tab. 1), large (23 specimens), which were preserved as fragments up to 25 cm long, and small (29 specimens), which are more fragmented. The longest fragment of small type is 8 cm long. The material is preserved as compressions, but only on one specimen a small piece of cuticle of internode appropriate for preparation was present.

Specimens: BP 89.105.1, 89.163.1, 89.235.1, 91.67.1, 91.72.1, 94.250.1, 94.271.1, 94.278.–279.1, 94.301.1, 94.912.1, 96.144.1, 96.224.1, 96.405.1, 96.408.1, 96.412.1, 96.418. 96.421.–422.1, 96.447.1, 96.479.1, 98.1091.1, 98.1122.1, 2000.1260.1, 2000.1291.1, 2000.1294.1, 2001.1246.1, 2001.939.–941.1, 2001.945.1, 2002.141.1, 2004.33.1, 2004.1083. – 1089.1, 2004.1160.–1162.1, 2004.1165.1, 2004.1173.–1175.1, 2001.942.1, 2003.437.1, 2004.1089.1.

Description. The stems are unbranched, those of the large form are 12–25 mm wide (Pl. 1, figs 10, 11), in small forms 5– 10 mm (Pl. 1, fig. 12). Internodes of both forms are about equal length 20–35 mm, their surface is smooth. Leaf sheaths are 11–12 mm long in total (together with free teeth) in large forms, in small ones 5–11 mm. The number of leaves on one side of compressed stem ranges from 9–12, extremely 14–15 in the large form, and 11–12 extremely 14–16 in the small one (the whole section of stem with 29 teeth was observed in the small form). Free teeth are similar in both forms, 2.0–3.5 mm long with acute apices. Width of the leaves at the base is 1.5–2.0 mm in large forms and 0.8–1.0 mm in small forms. Commissural furrows in large form are 1 mm wide at its base, in small form 0.2 mm, narrowing downwards into spike. In the middle

longitudinal edge is observed. The internodes of both morphotypes are often covered by small pits, probably hair bases.

The diaphragms are smooth, sometimes slightly grained, with circumferential ring of tubercles (Pl. 1, figs 9, 13, 14). The diameter of diaphragm in large form is 20–25 mm, in small form 5–7 mm.

The cuticle obtained from the large form is thin, the upper thicker than the lower one. On the upper cuticle cell outlines are indistinguishable (Pl. 1, fig. 16). On the lower cuticle (Pl. 1, fig. 15) they are irregular when visible, sometimes slightly sinusoid. Stomata, about 50 × 40 μm, are restricted to the lower cuticle. Guard cells are semicircular, very thin, longitudinally orientated and scattered irregularly between rows of cells with longitudinal sinusoid thickenings (according to Harris 1961, above furrows or leaf sheaths). Both cuticles show irregularly distributed transversal files of short striations. Other structures cannot be observed.

Discussion. The morphology of both forms is very similar, they differ only in size. The main features like morphology of leaves, stem and diaphragms as well as the cuticular structure well correspond to characteristics of *Equisetites columnaris*, however all specimens from Hungary, even the large form, are smaller than typical representatives of this species. The specimen described by Brongniart (unfortunately, the width of stem was not given), on the basis of the illustration (Brongniart 1828, pl. 13, figs 1–2) seems to be much larger than our material. The specimens from Yorkshire have stems usually 4–5, but even 6.5 cm wide (Harris 1961, emended diagnosis), however, the stem shown in Harris (Harris 1961, fig. 4D) is only 1 cm wide. Specimens from Iran were up to 5 cm but smaller occur, too (Schweitzer et al. 1997) A little closer to the Hungarian samples is another Iranian material described by Kilpper (1964) under the name *Equisetum veronense* (Zigno) Kilpper, which was later included by Schweitzer et al. (1997) to *Equisetites columnaris*. The width of these stems was 1.2–3.5 cm.

The narrowest Jurassic *Equisetum* described up to now is *E. filum* Harris from Yorkshire (Harris 1979), being only 1.5–3.5 mm wide, but it is much narrower than Hungarian small form, and its morphology is different.

Both the large and small Hungarian forms occurred in the same localities: the quarries Pécsbánya and Vasas, as well as the Béta and Zobák shafts, the large form occurred also in the Rücker quarry. It makes difficult to explain the size disproportions with different conditions in particular sits, but possibly there were local changes of moisture or light restricted to small areas.

Equisetites sp.

Stem

Pl. 1, figs 17–18.

Material. Two small fragments of stems were preserved in siltstone. They were compressed, but the cuticle was not suitable for preparation.

Specimens: BP 2003.437.1, 2009.420.1.

Description. The stems are 20 and 27 mm wide, the only preserved internode is 40 mm long. The leaf sheaths are composed of crowded narrow leaves. Their total length is 11 mm, width of leaf at the base 0.7 mm. The free teeth are 2.5–3.0 mm long, the apices form sharp spikes. The distance between the teeth is about 1 mm. The number of leaves is about 31 on the compressed half of stem. The commissural furrow reaches 5 mm under node (Pl. 1, fig. 17).

Some separate fragments of diaphragms were found, which might have belonged to this morphotype. Their diameter might have reached 30 mm. The surfaces of these diaphragms are smooth, and thin dense teeth are found at the edge, up to 5 mm long. Some diaphragms remained only as arch-shaped file of teeth up to 8 mm long and 0.5 mm wide (Pl. 1, fig. 18).

Discussion. This morphotype differs considerably in shape and number of leaves from the both described species. While the leaf numbers in *Equisetites muensteri* and *E. columnaris* vary from 12 to 24 and from 18 to 26, respectively (around the stem), in *Equisetites* sp. this number is about 60 – which is beyond the usual variability. The shape of free teeth is also different, being narrow as a needle, and connected by U-shaped base.

Ôishi (1940) described *Equisetites multidentatus* which was characteristic by more than 80 teeth in sheath. The difference of about

20 teeth between this species and morphotype from Hungary is in my opinion too high to be explained by usual variability.

The diaphragms found presumably belong to this morphotype, but their diameters suggest larger stems than the preserved one. Their affinity was supposed only on the basis of needle-shaped leaves at the margins and its exclusion from two other species.

Harris (1961), in the description of *Equisetites columnare*, mentioned that its stems can have up to 50–80 leaves in the lower parts while in the upper parts usually ca. 25. This would suggest that the morphotype *Equisetites* sp. from Hungary might be a badly preserved, lower part of *E. columnaris*. In my opinion, however, the lower part of the stem should be proportionally wider, and the leaves should have the same morphology, which in present case are completely different.

Cone

Pl. 1, fig. 19

Material. One impression of incomplete equisetalean cone was found, separate from the stems.

Specimen: BP 2007.160.1.

Description. The fragment belongs to an unexpanded cone. It is 13 mm wide in the widest point, and 11 mm long. Sporangiophores are immature and crowded. Their heads are regularly hexagonal, with sharp borders of facets, quite deeply concave (Pl. 1, fig. 19), their diameter ranges downwards from 1.0 to 1.8 mm (outer outlines). The central area is 0.5–1.0 mm in diameter. The details of head structure are unrecognizable. The attachment is not visible. No spores isolated from the cone.

Discussion. The cone fragment is small and the impression does not show details of its structure. It is most probable that the cone belongs to one of two species common in the Mecsek Mts.: *Equisetites columnaris* or *E. muensteri*. Unfortunately, both species have similar cones. The size of sporangiophore-heads is a little smaller than in cone of *E. muensteri* described by Harris (1931), but well corresponds with the size given by Zhou (1989).

According to Harris (1931) the cone of *E. columnaris* is a little larger (heads about 3 mm wide) and robust, on the other hand Schweitzer et al. (1997) described juvenile forms belonging to this species, which are of the same size as the Hungarian one. Lack of details in structure of heads makes more exact determination impossible.

Roots

Fig. 1

Some samples of *Equisetites* were preserved as fragments of rhizomes with roots. Their attribution is unknown because of poor preservation. The compressed width of rhizomes is 17–25 mm. The roots, 3 mm wide have numerous thin (0.5 mm) branches at almost straight angle (Fig. 1).

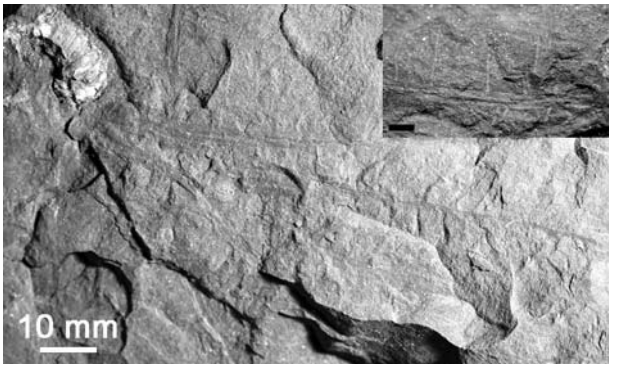

Fig. 1. Roots arising from the rhizome of one of the *Equisetites* species

Their preservation and position suggests very calm, undisturbed environment, the sediment is of limnic origin, so it can be assumed that the plants grew along the lake banks and fossilized *in situ*.

GENERAL REMARKS

Sphenophytes show the same tendency as the whole flora from the Mecsek Mts. which is not rich in taxa. Only four species from two genera were described. However, two species show distinctly two morphotypes, which suggests diverge environmental conditions, or slight climatic changes during Hettangian, or a different state of preservation. The state of fragments and their size confirm undisturbed conditions and fossilization *in situ* for *Equisetites* and transport of *Neocalamites* which are broken to a much higher degree than *Equisetites*. The leaves of *Neocalamites* which appeared thin and delicate were not preserved

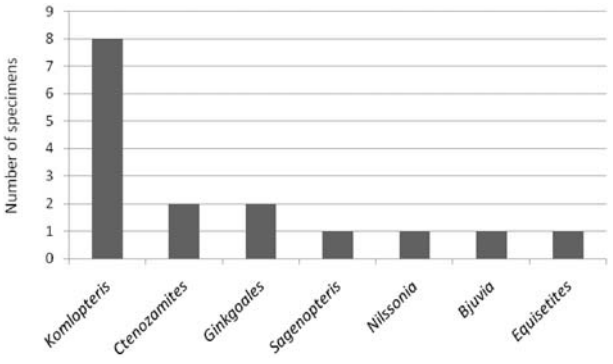

Fig. 2. Co-occurrence of the remains from the genus *Neocalamites* with leaves of other genera

in recognizable state (they are probably a component of undistinguishable detritus which is quite common in Hungarian locality).

The co-occurrence of genus *Neocalamites* with other genera is shown in the Figure 2, and co-occurrence of *Equisetites* in Figure. 3. The number of *Equisetites* specimens which were not accompanied by other plant species of the slabs, is almost equal with those which co-occurred being 66 and 62, respectively. The same data for *Neocalamites* are 29 and 16, respectively.

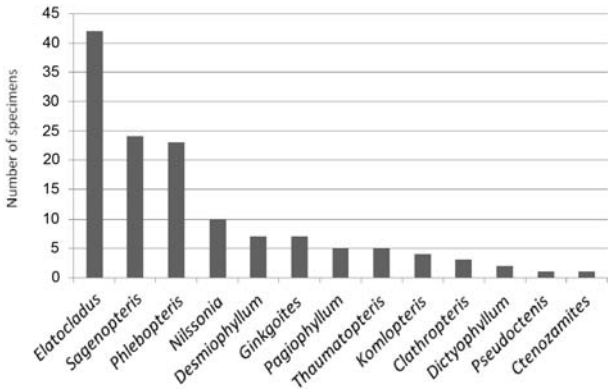

Fig. 3. Co-occurrence of the remains from the genus *Equisetites* with leaves of other genera

Most specimens of the genus *Equisetites* occurred together with the following genera: *Elatocladus*, *Sagenopteris*, *Phlebopteris*, and *Nilssonia*, while the genera *Komlopteris*, *Ctenozamites* (transferred recently to *Ptilozamites*, Popa & McElwain 2009), and representatives of the Ginkgoales were most frequent with Neocalamites.

The territory of the Mecsek Mts. during Hettangian time is known as a delta with numerous lakes and system of lagoons (Nagy 1969). Plants grew partly in direct contact with water basins such as lakes or river branches, partly on islands or inland. The difference in composition of accompanying plants confirms that the Hungarian sphenophytes grew in different conditions, *Equisetites* in wetter areas, with *Elatocladus* which was supposed to grow partly in shallow water along river or lake banks or in swamps (other mentioned genera are also typical for wet circumstances, Nagy 1969), and *Neocalamites* a bit further from the banks, in the forest formed by *Komlopteris* and the Ginkgophytes.

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PLATE

Plate 1

Neocalamites carcinoides Harris

1. Stems, No 91.61.1
2. Detached leaves, No 98.823

Equisetites muensteri Sternberg

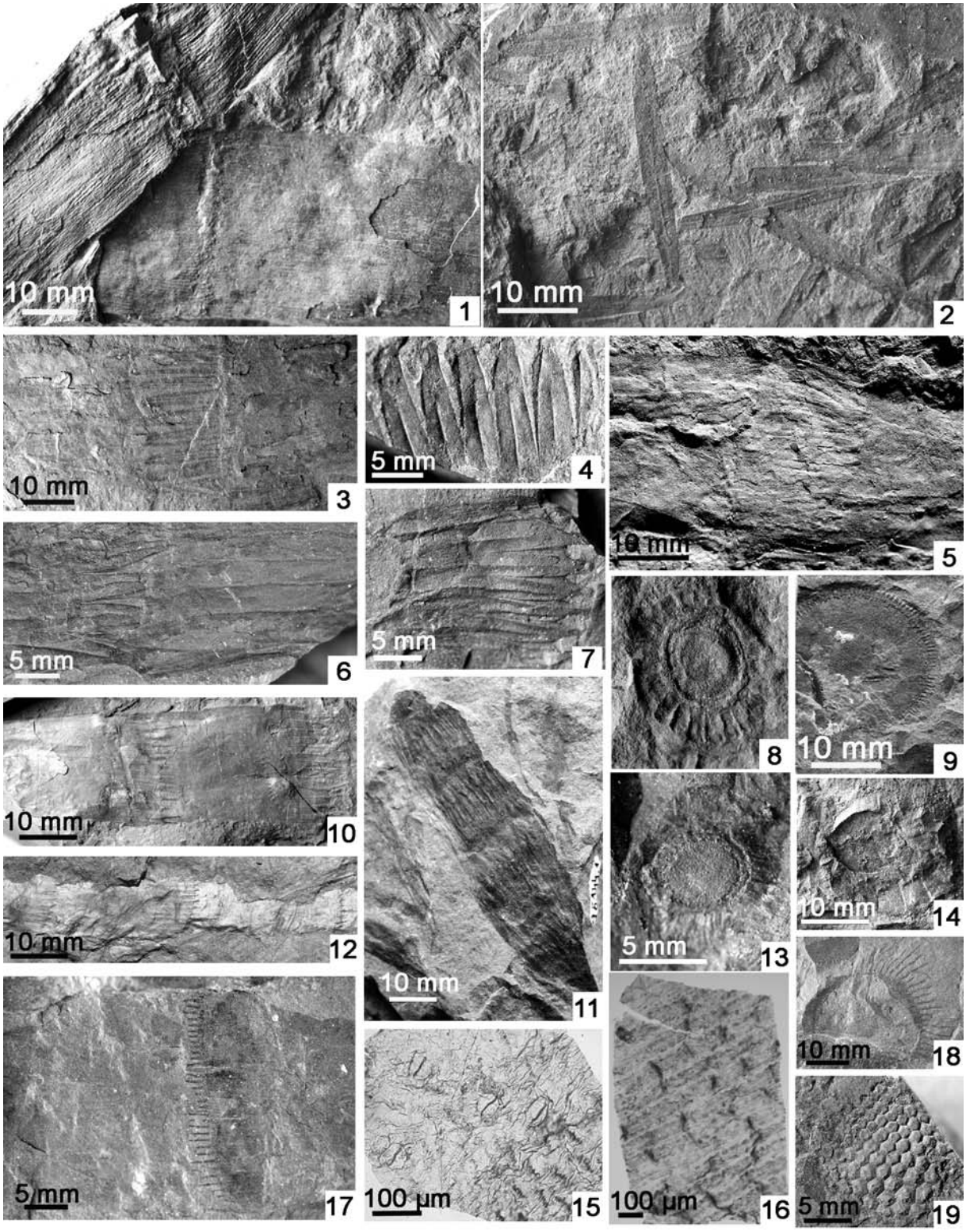
3. Stem of smooth form with free leaf teeth, No 89.297.1
4. Leaf teeth in the ribbed form, No 98.1288.1
5. Stem of smooth form with sheath, No 2003.476.1
6. Stem of ribbed form, No 98.1036.1
7. Stem of ribbed form with sheath, No 98.1122.1
8. Diaphragm of ribbed form, No 2007.907.1

Equisetites columnaris (Brongniart) Phillips

9. Diaphragm of the large form, No 94.205.1
10. Stem of the large form, No 94.279.1
11. Large form, the juvenile plant, No 96.144.1
12. Stem of the small form, No 2004.1089.1
13, 14. Diaphragms of the small morphotype, No 2004.1085.1., 98.1167.1
15. Lower cuticle showing stomata and transversal striations, No 89.235
16. Upper cuticle with transversal striations, The same specimen as fig. 15

Equisetites sp.

17. Stem with sheath and small teeth, No 2001.944.1
18. Diaphragm with very fine leaves, No 94.233.1
19. Fragment of cone, No 2007.160.1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