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Banatozamites remotus Czier sp. nov. (Cycadeoidales) from the Lower Jurassic of Anina, Romania

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Abstract. *Banatozamites remotus* – a new species of the Bennettitalean genus *Banatozamites* Czier 1996 – is described from Anina, a mining locality in Banat region, southwest Romania. The material originates from the Valea Terezia Member of the Steierdorf Formation, from Hettangian *pro parte* – Sinemurian continental deposits of the Getic Realm. The leaf has remotely disposed pinnules, the species being named after this character. The pinnules possess slightly obliquely arising veins, adaxial epidermis with trichomate cells disposed in conspicuous rows, abaxial epidermis with irregularly scattered stomata and strongly trichomate epidermal cells. The stomatal apparatus has semicircular guard cells with half-ring-shaped outer thickenings, being sunken in a pit covered by centripetal disposed roof-cells. The covering roof is circular, with rectangular mouth. *Banatozamites remotus* appears only in the *B. chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone. The genus and its species are endemic elements of the European Mesophytic.

Keywords. Macroflora, Mesophytic, Romania.

Introduction

This paper constitutes a continuation of a series of investigations accomplished by the author on the lower Jurassic macroflora of Anina (Czier 1995, 1996,

1998a, 1998b, 1999, 2000a, 2000b, 2000c, 2000d, 2001a, 2001b, 2001c, 2003). Anina is not just one of the most important coal-mining localities of the Banat region, south-west Romania, but also one of the most important fossil flora localities of the European Mesophytic. Before the First World War this locality was part of the Austrian-Hungarian Monarchy, and in the old literature also appears under the name Steierdorf or Stájerlak. Fossil plant collections with beautiful specimens originating from this locality, collected mostly in the 19th Century, are kept in Romania, Austria, Hungary, and possibly in other countries. One of these collections is that of the Botanical Department of the Hungarian Natural History Museum in Budapest (HNHM-BP). It has been studied by the author, some preliminary results being published in his thesis summary (Czier 2001c). In the past few years the author has redetermined some specimens of the collection. Several new species have been found belonging to the Cycadeoidales (Bennettitales) order. One of these new species is presented in this paper.

Geological data regarding the fossiliferous deposits

The Anina fossil flora mainly originates from the coal mines situated on the flanks of the anticline that bears the same name (Fig. 1). The coal-field was extensively exploited in the 19th – 20th Centuries, because the coals are of a good quality. However, besides the incontestable economical value, the exploitation was very important also from scientific point of view. It was a really impellent force for the general progress of the regional geological researches, bringing a substantial contribution not only to the knowledge about the lithology of the coal-bearing and adjacent deposits, but also to the enrichment of famous palaeontological collections from Budapest, Vienna, Timisoara, Bucharest. Despite of all these, the real scientific value of many plant fossils – collected mainly by the miners – a long time was unknown. It becomes more and more better known at the present time, when it is possible to accomplish studies not only on newly collected specimens but also on old collections that may contain still unstudied material. Now it is also possible to restudy specimens using modern methods. The data can be processed much more quickly, and the results may be interpreted in the context of the actual level reached by the science.

The Anina coal bed is situated in the lower Jurassic continental deposits of the Alpine sedimentary from the Reşița – Moldova Nouă zone that belongs to the Getic Realm of the Southern Carpathians. The plant fossils appear in the base- and top-cover of the coal-layers, as well as in many sterile intercalations. The thickness of the whole pocket with fossil flora bearing horizons is between 300

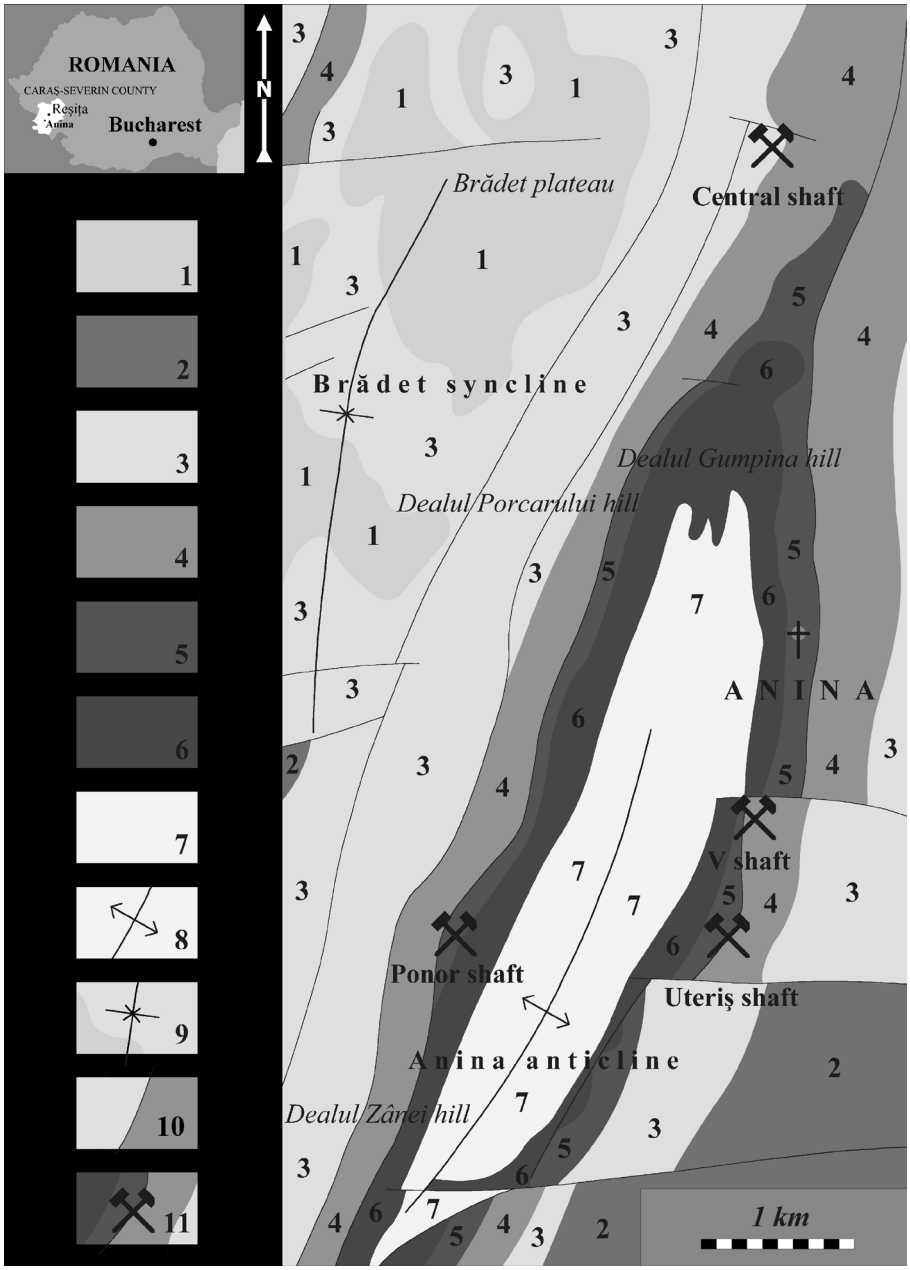

Fig. 1. Geological sketch of the fossil plant locality Anina. Based on Bițoianu 1987, with modifications. 1 - Quaternary; 2 - Lower Cretaceous; 3 - Oxfordian - Tithonian; 4 - Aalenian - Callovian; 5 - Pliensbachian - Toarcian; 6 - Hettangian pro parte - Sinemurian; 7 - Lower Permian; 8 - Anticline axe; 9 - Syncline axe; 10 - Fault; 11 - Mine.

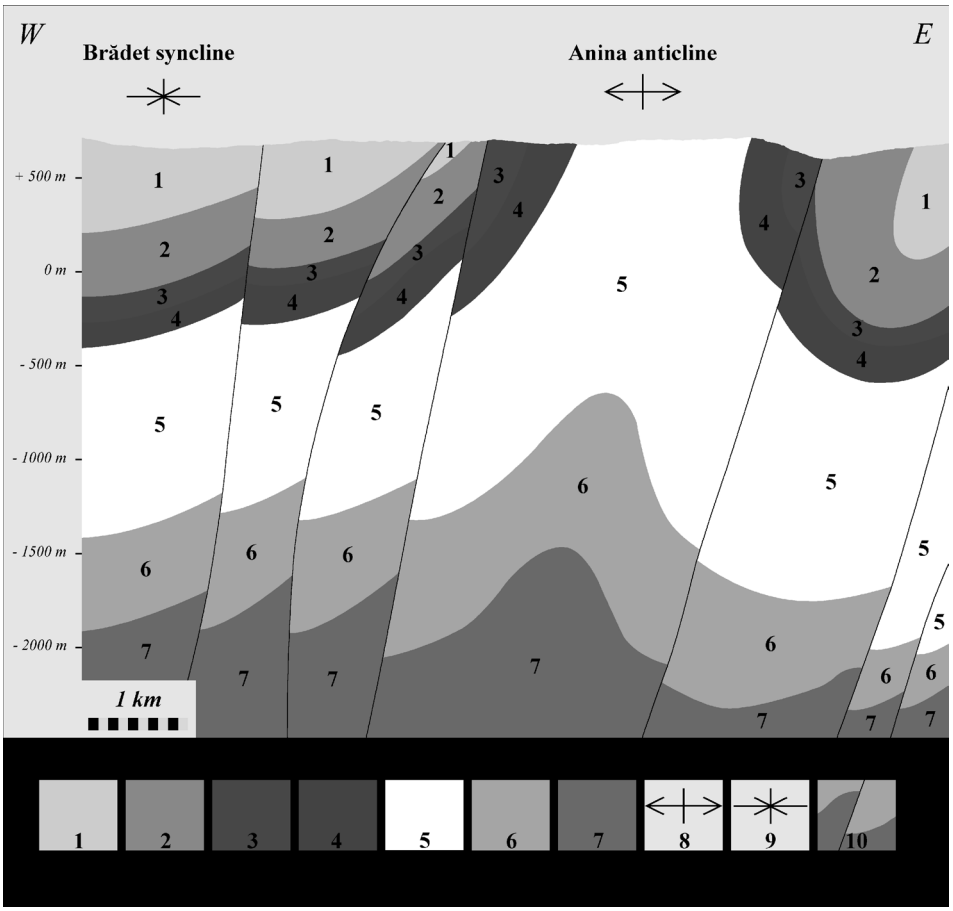

Fig. 2. Geological cross-section of the Anina area. From Bițoianu 1987, with modifications. 1 - Oxfordian - Tithonian; 2 - Aalenian - Callovian; 3 - Pliensbachian - Toarcian; 4 - Hettangian pro parte - Sinemurian; 5 - Lower Permian; 6 - Upper Carboniferous; 7 - Crystalline basement; 8 - Anticline axe; 9 - Syncline axe; 10 - Fault.

– 500 m (Fig. 2).

Fossil macroflora has been recorded in the mining area also within the Permian deposits (Roth v. Telegd 1890; Răileanu *et al.* 1957). The mentioned Permian deposits (lower Permian), represented by a succession of conglomerates, microconglomerates, sandstones and clays of a red-violet colour, belong to the Variscan molasse – to the Lişava Member of the Ciudanovița Formation (Bucur 1991). They constitute the fundament of the coal-bearing deposits, and occur in the central axis of the anticline. The reddish horizon contains also microfauna, which indicates Autunian age (Bițoianu 1987).

The deposits of the alpine sedimentary cycle are unconformable over the Permian deposits. The first preserved layers of this cycle belong to the Jurassic – the cartographically delimitated intervals contain all its stages. The lower Liassic (Hettangian – Sinemurian) deposits consist of conglomerates, microconglomerates, sandstones of a large variety of granulation, siltstones, more or less refractory clays, coals. The facies is much resemblant to that known at Gresten in Austria. The likeness is strong, as the Triassic carbonate fundament at Gresten also fails (Lachkar *et al*. 1984). From a lithostratigraphical point of view, the mentioned facies corresponds in Banat region to the Steierdorf Formation, divided in two members. The basal sequence, where the coarse detrital material predominates, constitutes the Dealul Budinic Member. The coal bearing sequence above constitutes the Valea Terezia Member. Popa (2001) mentions some very scarce micro- or macroflora preserved in the member below, but does not publish further data about them, nor about the very rich microflora that he mentioned to be present in the member above. According to Bucur (1991, 1997), the Budinic Member is Hettangian *pro parte* in age, and the Valea Terezia Member is dated Hettangian *pro parte* – Sinemurian.

The fine lithological sequences of the Valea Terezia Member of the Steierdorf Formation, especially the blackish siltstones and the finely granulated sandstones, contain numerous horizons with plant macrofossils. They are coalificated impressions and compressions, generally good or very good preserved – sometimes even exceptionally. The flora was recorded by Foetterle (1850) who also gave a first list of the taxa. Foetterle (1852) concluded that the Anina flora is Liassic (lower Jurassic) in age – this dating is accepted since then. Ettingshausen (1852a, 1852b) recorded in that year already new material collected from this fossil locality, and was the first who also described the specimens, even if not all of them. However, the list of the known taxa became much more complete, and Anina a scientifically important locality, comparable with the most famous Mesophytic localities of Europe (Lunz, Scoresby Sound, Bornholm, Yorkshire, etc.). Three years after, Andrae (1855) published a monograph of the flora – that is a basic work referred to by many authors. The palaeobotanical data have been proved to be very useful especially in works of synthesis, e.g. those written by Kudernatsch (1855, 1857) who has redacted the first geological monograph and geological map of the Banat region. Numerous studies, old and new, regarding the flora, are mentioned in papers dealing with the history of the researches, and further comments can be read there (Semaka 1962a; Givulescu and Czier 1990; Givulescu 1998; Czier 2000a). The palaeobotanical researches continue up to our days, and they nevertheless will continue, because the flora is very rich one, both in number of taxa and

of specimens. At the end of the past century the flora contained 97 species (Czier 2000a). Now, the number of species is over 100 – the exact number will be known only when the researches will be ended, and when someone will accomplish the final revision of the flora.

The lower Liassic deposits are overlaid with up to 200 m thick horizon of black bituminous argillites, in some places with siderite concretions and thin coal intercalations. This horizon contains sporadic fossil plant remains, both of microflora (Antonescu 1973; Năstăseanu 1984) and macroflora (Andrae 1855). These deposits are assigned to the Uteriş Member of the Steierdorf Formation, being Pliensbachian in age (Bucur 1997).

Over the middle Liassic deposits lay Toarcian marls and calcareous marls with sandy marlstone intercalations. They constitute the Valea Sodol Member (Czier 2000b) – the first part of the Dealul Zânei Formation that entirely is dated Toarcian – lower Callovian (Bucur 1997). The marly deposits contain *Pseudogrammoceras* aff. *quadratum*, *Grammoceras fallaciosum*, *Cucullea cancellata*, and other invertebrate fossils (Mutihac 1959; Semaka 1962b; Năstăseanu 1964; Bucur 1997). They also contain a macroflora assemblage with *Cheirolepis münsteri*, *Williamsoniella vittata*, *Ptilophyllum rigidum* and a few of other taxa (Semaka 1962b).

The upper Liassic deposits are conformably overlaid by the second part of the Dealul Zânei Formation, lithologically represented by marlstones and marly sandstones. These layers contain *Ludwigia murchisonae, Neera kudernatschi, Gryphaea calceola* and other fossil invertebrates, as well as *Otozamites decorus* and some other plant megafossils, which according to Semaka (1962b) prove the lower Aalenian age.

From the rest of the Jurassic deposits, and from those belonging to the lower Cretaceous and to the Quaternary around Anina, no macroflora fossils are known.

The modern methods applied in the field of palaeobotany, e.g. the *in situ* study of the spores and the cuticular study with the scanning electron microscope (SEM) allow us getting more and more detailed knowledge about the characters of diverse taxonomic categories. However, this is not all. Finally, they permit us implicit to build and to complete our image on the flora and vegetation of each geological period, and to reconstruct the characteristic environments and taphonomic processes. In the present days, when the coal-mining industry is in a general regress, and many mines are closed, the possibilities of collecting new plant fossils from the underground are very restricted. In this context, the old palaeontological collections, mainly those which contain still unstudied specimens, may present exceptional scientific value.

Material and methods

The material described in this paper consists of a hand specimen (HNHM-BP. 602151/1), a microscope slide (NO. 16) and a scanning electron microscope stub (NO. 7 SEM).

The hand specimen was collected from the Anina coal formation, presumably in the 19th Century. It was undetermined, on its old label is just written „fern impression".

Cuticle preparations were made by macerating pinnulae in Schulze's reagent (HNO_3 plus $KClO_3$) and neutralizing with KOH. Cuticles were either mounted in glycerine-jelly for microscope slide preparation or on transparent film for SEM preparation.

Systematic palaeontology

SPERMATOPHYTA
CYCADEOIDALES

Banatozamites Czier 1996

Type. *Banatozamites chlamydostomus* Czier, 1996

Banatozamites remotus Czier sp. nov.
Plate 1, figures 1 – 2; Plate 2, figures 1 – 2; Text-figures 3 – 6

2001c *Ptilophyllum* sp. A. Czier, p. 35

Derivation of name. Latin, *remoti*, distantly. After the leaflets distanced from each other by gaps. For details see Váczy (1980).
Holotype. Hand specimen HNHM-BP. 602151/1 (Pl. 1, fig. 1; Text-fig. 3), microscope slide 16 (Pl. 1, fig. 2; Pl. 2, fig. 2; Text-figs. 4, 6), SEM preparation 7 (Pl. 2, fig. 1; Text-fig. 5).
Repository. Botanical Department of the Hungarian Natural History Museum, Budapest, Hungary.
Type locality. Anina, Romania.
Lithostratigraphical unit. The Valea Terezia Member of the Steierdorf Formation (Bucur 1991).

Biostratigraphical unit. The *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone (Czier 1999).
Age. Hettangian pro parte – Sinemurian.
Diagnosis. Leaf gradually narrowing in the distal direction. Rachis partly concealed by the basal portion of alternately disposed pinnules. Pinnules distanced from each other by gaps equalling about half of their width. Pinnules linear or slightly falcate, with margins entire, apex rounded to slightly obtuse. Venation consisting of slightly obliquely arising veins, about half of their number simple, the others once dichotomised at all levels, ending in apex and in the distal half of the margins. Adaxial epidermis composed of dominantly conspicuous rows of rectangular epidermal cells, usually with their longest sides parallel to the margins. Cell walls sinuous, with marked sinuosities. Trichome bases present. Abaxial epidermis with irregularly scattered stomata. Epidermal cells of the abaxial epidermis differing from those of the adaxial one in possessing less sinuous walls, a hollow papilla, and very numerous trichome bases. Stomatal apparatus possessing semicircular guard cells with cutinised half-ring-shaped outer thickenings, and subsidiary cells with almost

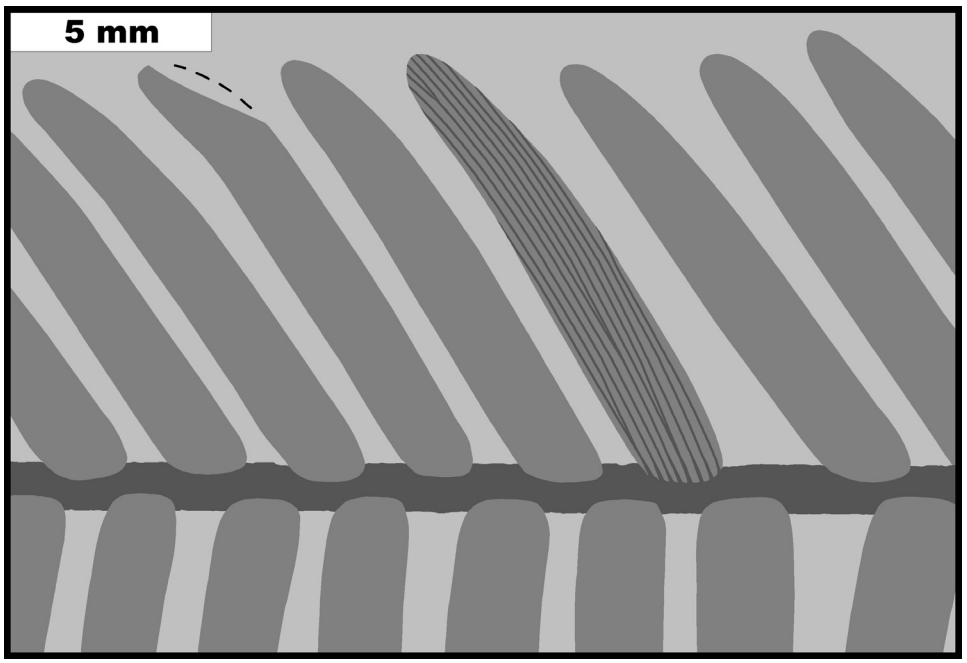

Fig. 3. *Banatozamites remotus* sp. nov. Shape, size, attachment and venation of pinnules.

straight walls. Stomata sunken in stomatal pit, covered by papillate and strongly trichomate roof-cells with slightly sinuous walls, forming a circular roof. Covering roof possessing rectangular mouth located above the guard cells.

Supplementary description. The type specimen represents the medial-distal part of a small-sized leaf (Pl. I - Fig. 1). It is preserved on a length of 55 mm, the width measured at its proximal and distal end being of 21 mm and 15 mm respectively. The rachis is straight, 1.2 mm wide. The pinnules are attached with their whole bases on the upper surface of rachis, but the pinnula base never covers the base of the pinnula on the opposite side of the rachis. The pinnule base is symmetrical, and the margins are not decurrent nor contracted. The pinnulae are not flat, but slightly convex toward the adaxial surface. The length and the width of pinnules gradually diminish from 12 mm and 2.5 mm at the proximal part of the type specimen, to 9 mm and 1.7 mm at the distal end. At one part of the pinna rachis the pinnules are attached almost at right angle, 80° – 90°, while at the other part the attachment angle proximally is 75°, and distally decreases gradually even down to 45°. So, the pinna appears to be asymmetrical. The veins arise from the whole

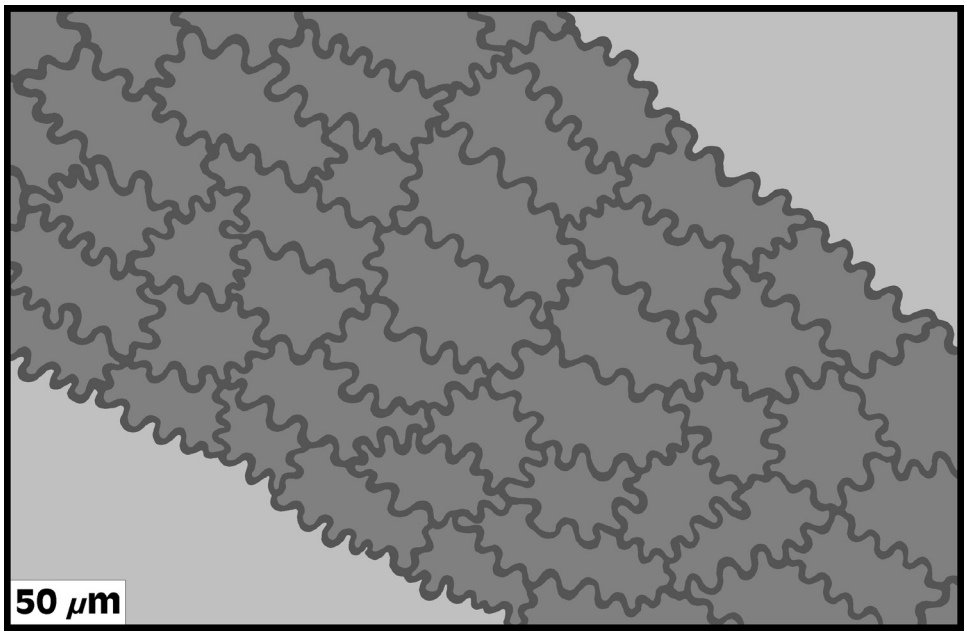

Fig. 4. *Banatozamites remotus* sp. nov. Adaxial cuticle, showing rows of sinuous-walled cells.

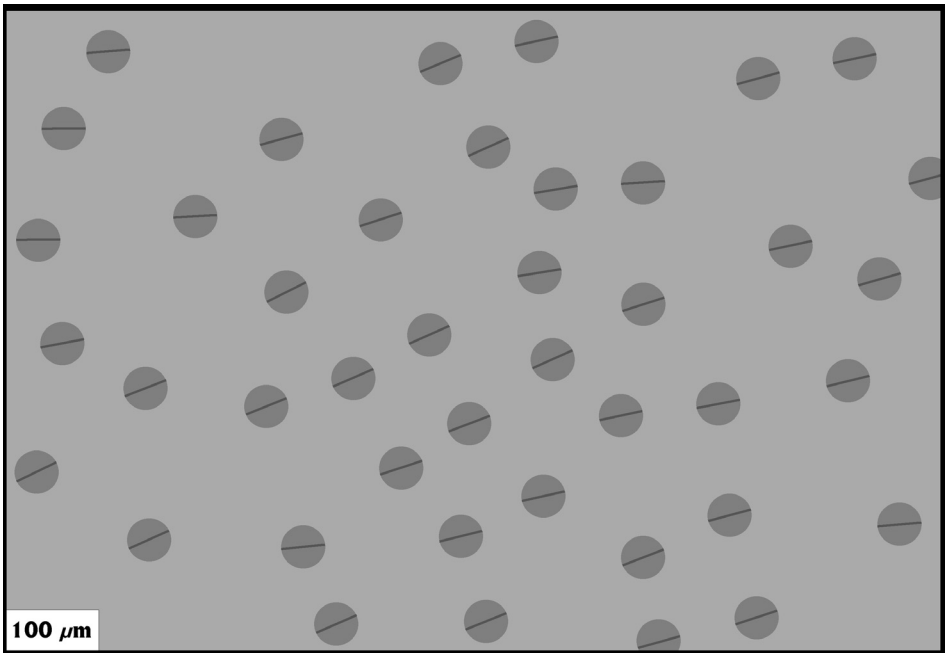

Fig. 5. *Banatozamites remotus* sp. nov. Distribution of stomata on abaxial cuticle. Stomata represented by circles, the line in the middle indicating the direction of the pore.

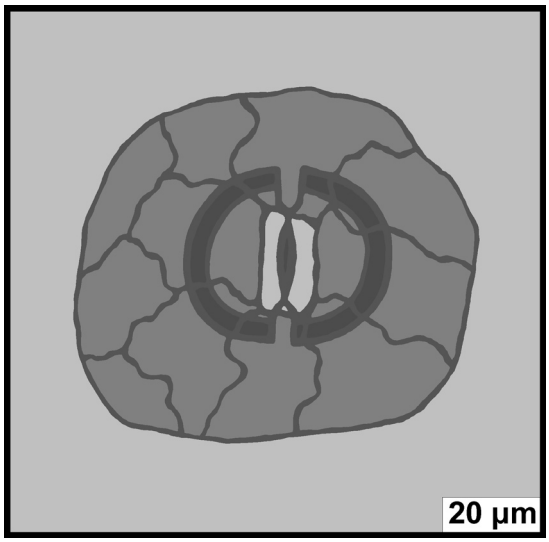

Fig. 6. *Banatozamites remotus* sp. nov. Covering roof with roof-cells and rectangular mouth in the middle, located above the guard-cells.

base of pinnulae. They are not convergent and not divergent, but almost parallel, slightly curved in the acroscopic direction. A typical pinnula has about eight veins per base. Because half number of the veins dichotomize in its basal, medial, or apical third (Fig. 3), the veins number in the medial portion of pinnula usually is 10 – 12, the venation density being about 5 veins per mm.

Cuticles are very good preserved, thick, easily detachable. As the microscope preparations contain both upper and lower cuticles of the same pinnulae, the cuticular study undoubtedly revealed the hypostomatic character of the lamina. The adaxial cuticle shows no differentiation of the epidermal cells of the venal or intervenal regions. All the normal epidermal cells possess walls with more or less marked sinuosities, but those of the adaxial epidermis may be even very sinuous walled (Pl. I – Fig. 2). The length and width of the cells measured on the adaxial cuticle vary between 30 – 110 µm, respectively between 30 – 70 µm (Fig. 4). The dimensions of the cell-walls sinuosities („wavelength" / „amplitude") are in the limits of 8 – 24 µm / 5 – 13 µm. While the adaxial cuticle shows no papillae, the base of the hollow papillae measured on the abaxial cuticle is 10 – 18 µm in diameter. Although the ordinary cells of the abaxial epidermis show parallel orientation, there are no differentiated stomatal and non-stomatal bands. However, although the stomata are irregularly scattered, they appear with the pore transversely oriented to the veins (Fig. 5). Stomatal density is 80 – 90 stomata per mm^2, the Stomatal Index near about 14 (12 – 16).

The stomatal apparatus is paracytic (Pl. II – Fig. 1). The length of each of the two guard cells of the stomatal apparatus is about 40 µm, the width of about 20 µm, so their width/length ratio is about ½. The subsidiary cells are rectangular to rounded in shape, 45 µm wide (range 30 – 60 µm). The porus is 20 µm long.

The stomatal pit is covered in average by 11 roof-cells (range 8 – 14), each of them possessing a papilla. The covering roof diameter is about 80 µm (range 70 – 90 µm), so the portion which it occupies is about four times greater than the guard-cells portion (Pl. II – Fig. 2). The shape of the mouth, located in the middle of the roof, is the result of the centripetal disposition of the slightly sinuous-walled roof-cells (Fig. 6).

Discussion, comparison, and conclusion

The macro- and microscopical characters both allow assignment of the material to the genus *Banatozamites* Czier 1996. Most relevant generic characters are the attachment of the pinnules with their whole bases on the upper surface of

rachis, the symmetrical pinnula base, the not decurrent nor contracted margins of pinnulae, the arisement of the veins from the whole pinnule base, the slightly curved veins in the acroscopic direction, the hypostomatic lamina, the sinuous walled normal epidermal cells, the paracytic stomatal apparatus, the transversely oriented porus of the stomata. The generic characters, compared with those of other relevant Bennettitalean genera, were extensively discussed (Czier 2000).

The single hitherto known species of the genus *Banatozamites* was the type species *B. chlamydostomus*. Although some characters described on the new material appear to be much resemblant or even the same with that species, a considerable number of specific characters do not allow assignment to it. Therefore, a new species, named *B. remotus*, is proposed. The characters common for *B. chlamydostomus* and *B. remotus* of course are the generic characters, as well as a series of other characters. It is possible that at least some of these latter also might be generic characters: the straight pinnae rachis, the asymmetry of the pinnae caused by the different attachment angles of the pinnules at the one and the another part of the rachis, the alternate disposition of pinnules, the fact that the pinnula base never covers the base of the pinnula on the opposite side of the rachis, the entire margins of pinnulae, the dichotomisation at all levels of the forked veins, the very good preservation state of the cuticles, the adaxial cuticle showing no differentiation of the epidermal cells of the venal or intervenal regions, the arrangement in rows of the adaxial epidermal cells, the rectangular shape of the adaxial epidermal cells, the orientation of the adaxial epidermal cells usually with their longest sides parallel to the margins, the markedly sinuous walls of the adaxial epidermal cells, the absence of papillae on the adaxial epidermis, the parallel orientation of the ordinary cells of the abaxial epidermis, the presence of papillae on the abaxial epidermis, the almost straight walls of the subsidiary cells of the stomatal apparatus, the stomata sunken in a stomatal pit, the presence of a papilla on each of the roof-cells, the location above the guard-cells of the covering roof's mouth. Their status will result after the study of the entire *Banatozamites* material from the studied collections. Those of them which unequivocally will be proven as generic characters may be then enclosed in an emended diagnosis of the genus.

The characters that differentiate *Banatozamites remotus* from the type species *B. chlamydostomus* are rendered in the table below (Tab. 1). The most important differential characters are specific characters. They indicate the measure in which the rachis is concealed by the basal portion of the pinnules, the setting of pinnulae, the shape of pinnulae, the pinnulae apex, the arisement of the veins, the appearance of simple veins, the appearance of forked veins, the dichotomization of the veins, the ending of the veins, the conspicuousness of the rows of the adaxial

Tabel 1. Differences between the species of genus *Banatozamites*, based on macro- and microscopical characters.

Character	*Banatozamites chlamydostomus*	*Banatozamites remotus*
Value that the pinnae surface may exceed (Value that the pinnae length may exceed x Value that the pinnae width may exceed)	6600 mm^2 (110 mm x 60 mm)	1155 mm^2 (55 mm x 21 mm)
Average width of pinnae rachis	1.5 mm	1.2 mm
Measure in which the rachis is concealed by the basal portion of the pinnules	Almost entirely	Partly
Setting of pinnulae	Closely	Distanced from each other by gaps equalling about half of their width
Shape of pinnulae	Linear or rectangular, sometimes slightly falcate	Linear or slightly falcate
Measure of the pinnulae convexity toward the adaxial surface	More or less	Slightly
Attachment angles of the pinnules	65° – 80°	45° – 90°
Apex of pinnulae	Rounded	Rounded to slightly obtuse
Dimensions (Length / Width) of the pinnules	22 – 32 mm / 6 – 11 mm	9 – 12 mm / 1.7 – 2.5 mm
Arisement of the veins	Perpendicularly	Slightly obliquely
Direction of the veins	Slightly divergent	Almost parallel (not convergent and not divergent)
Appearance of simple veins	Occasionally	Half of the total number of veins

Appearance of forked veins	Usually	Half of the total number of veins
Dichotomization of the veins	Once or repeatedly	Once
Ending of the veins	In the apex, in the whole acroscopic margin, and in the distal half of the basiscopic margin	In apex and in the distal half of the margins
Number of veins per base of a typical pinnula	16	8
Density of the venation in the middle of a typical pinnula	3 veins/mm	5 veins/mm
Detachability of the cuticles	Normal	Easy
Size of the cuticles before the maceration	Normal	Thick
Conspicuousness of the rows of the adaxial epidermal cells	More or less	Dominantly
Presence/Absence of trichomes on the adaxial epidermis	Absent	Present
Dimensions (Length / Width) of the epidermal cells of the adaxial epidermis	40 – 60 µm / 25 – 40 µm	30 – 110 µm / 30 – 70 µm
Dimensions (Wavelength / Amplitude) of the cell-walls sinuosities of the adaxial epidermal cells	5 – 13 µm / 8 – 15 µm	8 – 24 µm / 5 – 13 µm
Presence/Absence of stomatal bands in the abaxial epidermis	Present	Absent

Arrangement of stomata in the abaxial epidermis	The stomata in the stomatal bands almost always are arranged in two rows, but rarely, short parts with three rows also appear (sometimes, bands formed by a single row of stomata have been observed, indicating the dichotomising of a vein)	Irregularly scattered
Width of the stomatal bands / Width of the non-stomatal bands	60 – 220 µm / 130 – 200 µm	Not measurable (there are no differentiated stomatal and non-stomatal bands)
Presence/Absence of trichomes on the normal epidermal cells of the abaxial epidermis	Absent	Present (very numerous)
Base diameter of the abaxial epidermal cell's papilla	15 µm (11 – 19 µm)	14 µm (10 – 18 µm)
Shape of the guard cells of the stomatal apparatus	Semiellipsoidal	Semicircular
Width/Length ratio of each of the two guard cells of the stomatal apparatus	¼ (12 µm / 50 µm)	½ (20 µm / 40 µm)
Shape of the cutinised outer thickenings of the guard cells	Crescent	Half-ring
Shape of the subsidiary cells	Rounded	Rectangular to rounded
Width of each of the two subsidiary cells	18 µm (12 – 24 µm)	45 µm (30 – 60 µm)
Length of the porus	30 µm	20 µm
Stomatal density	40 – 50 stomata/mm2	80 – 90 stomata/mm2
Stomatic index	9 (8 – 10)	14 (12 – 16)

Shape of the covering roof	Oval (with the major diameter perpendicularly oriented to the pore)	Circular
Width/Length ratio of the covering roof	¾ (60 – 90 µm / 80 – 120 µm)	1/1 (70 – 90 µm / 70 – 90 µm)
Number indicating how many times the portion occupied by the covering roof is greater than the guard-cells portion	9	4
Number of roof-cells covering the stomatal pit	7 – 16	8 – 14
Measure in which the walls of the roof-cells are sinuous	Normally	Slightly
Presence/Absence of trichomes on the roof-cells that cover the stomatal pit	Absent	Present (strongly trichomate)
Position of the roof's mouth	Slightly laterally	In the middle
Shape of the mouth	Stellate	Rectangular
The more or less centripetally disposed covering items that determine the shape of the mouth	Sinuous-walled roof-cells and papillae	Slightly sinuous-walled roof-cells

epidermal cells, the presence or absence of trichomes on the adaxial epidermis, the presence or absence of stomatal bands in the abaxial epidermis, the presence or absence of trichomes on the normal epidermal cells of the abaxial epidermis, the shape of the guard cells of the stomatal apparatus, the shape of the cutinised outer thickenings of the guard cells, the presence or absence of trichomes on the roof-cells that cover the stomatal pit, the measure in which the walls of the roof-cells are sinuous, the shape of the covering roof, the shape of the mouth. However, the two species also have many other characters, which show differences. Not all of these characters are enough significant for specific differentiation, but they are also important to completing the list with data that may help the determination of

new *Banatozamites* material. The mentioned features point to the value that the pinnae surface may exceed, the average width of pinnae rachis, the dimensions of the pinnules, the attachment angles of the pinnules, the measure of the pinnulae convexity toward the adaxial surface, the direction of the veins, the number of veins per base of a typical pinnula, the density of the venation in the middle of a typical pinnula, some macroscopical aspects of the cuticles like their detachability and size before maceration, dimensions of the epidermal cells of the adaxial epidermis, dimensions of the cell-walls sinuosities of the adaxial epidermal cells, arrangement of stomata in the abaxial epidermis, width of the stomatal and non-stomatal bands, base diameter of the abaxial epidermal cell's papilla, stomatal density, stomatic index, width/length ratio of the guard cells, shape of the subsidiary cells, width of the subsidiary cells, length of the porus, number of roof-cells covering the stomatal pit, width/length ratio of the covering roof, the number indicating how many times the portion occupied by the covering roof is greater than the guard-cells portion, the position of the roof's mouth, the more or less centripetally disposed covering items that determine the shape of the mouth.

It can be concluded, in a nutshell, that the new species compared to the genotype is characterised by remotely disposed pinnulae possessing slightly obliquely arising veins, adaxial epidermis with trichomate epidermal cells disposed in conspicuous rows, abaxial epidermis with irregularly scattered stomata and strongly trichomate epidermal cells, stomatal apparatus with semicircular guard cells possessing half-ring-shaped outer thickenings, circular covering roof with rectangular mouth.

Palaeophytogeographic, biostratigraphic, and palaeoclimatic considerations

It has been already shown that *Banatozamites* is an element of the European autochthon palaeoflora (Czier 1996), and the lower Jurassic flora of Romania has mixed origin (Czier 2000d). Both the two species *B. chlamydostomus* and *B. remotus* appear only in the *Banatozamites chlamydostomus* Subzone of the *Clathropteris meniscioides* Biozone, in the Hettangian pro parte - Sinemurian continental deposits of the Getic Realm. All the specimens have been collected from the same fossil locality. In this context, *Banatozamites* appears to be an endemic genus of the European Mesophytic, and its species *B. chlamydostomus* and *B. remotus* endemic species.

Banatozamites, with its species *chlamydostomus* and *remotus*, brings a

contribution to the argumentation of the mangrove forest association of a coal-generating biotope, which existed at Anina in the early Jurassic times (Givulescu and Czier 1990). As the assemblages of this type are characterised especially with the predominance of the Nilssoniaceae (Cycadales) and of the Zamitaceae s. l. (Bennettitales), *Banatozamites* fit in the series of these plants that denote a warm and wet climate (Taugourdeau-Lantz and Vozenin-Serra 1987).

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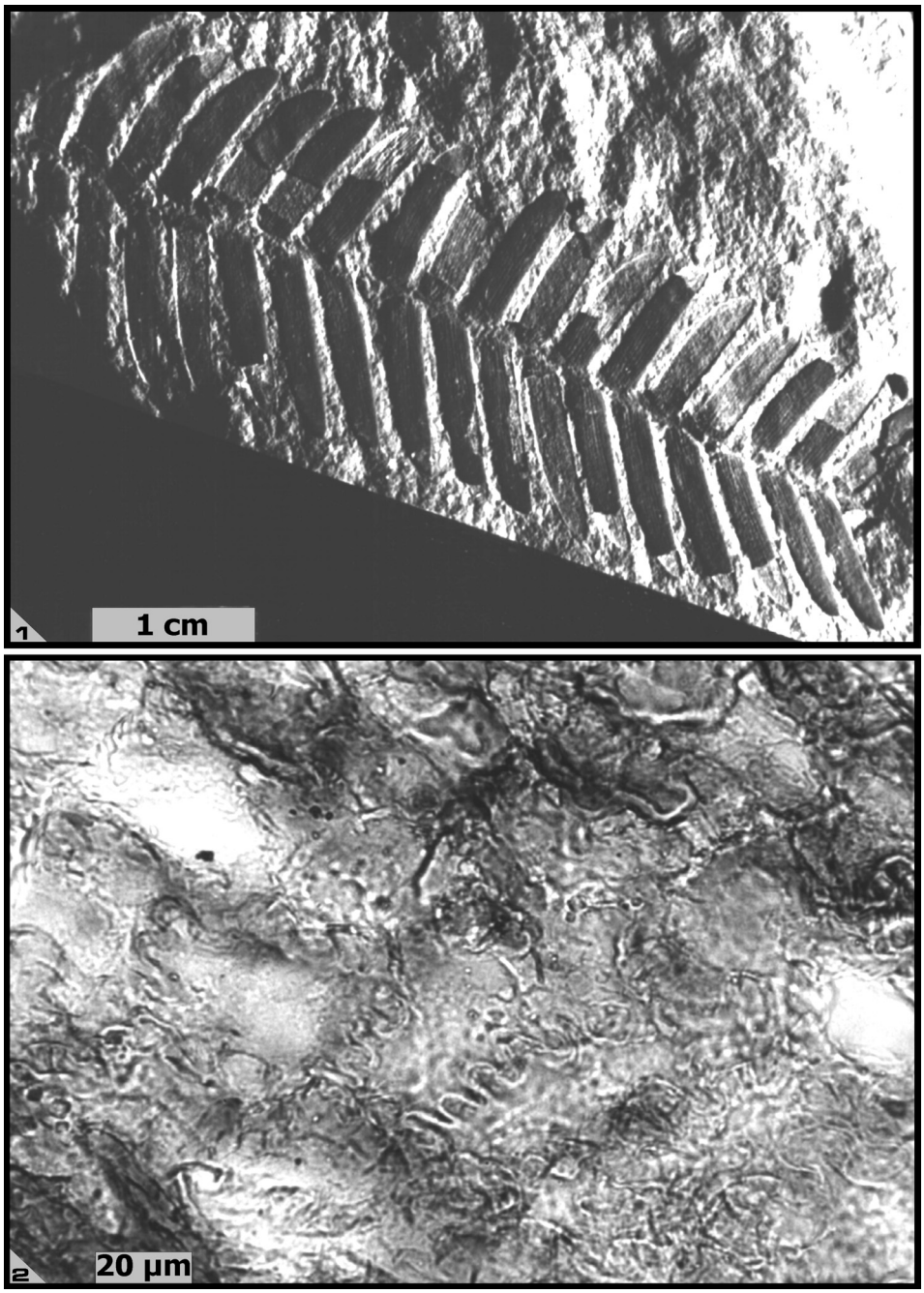

Plate I. *Banatozamites remotus* sp. nov. 1. General view of the leaf. 2. Adaxial cuticle with epidermal cells, outer sight.

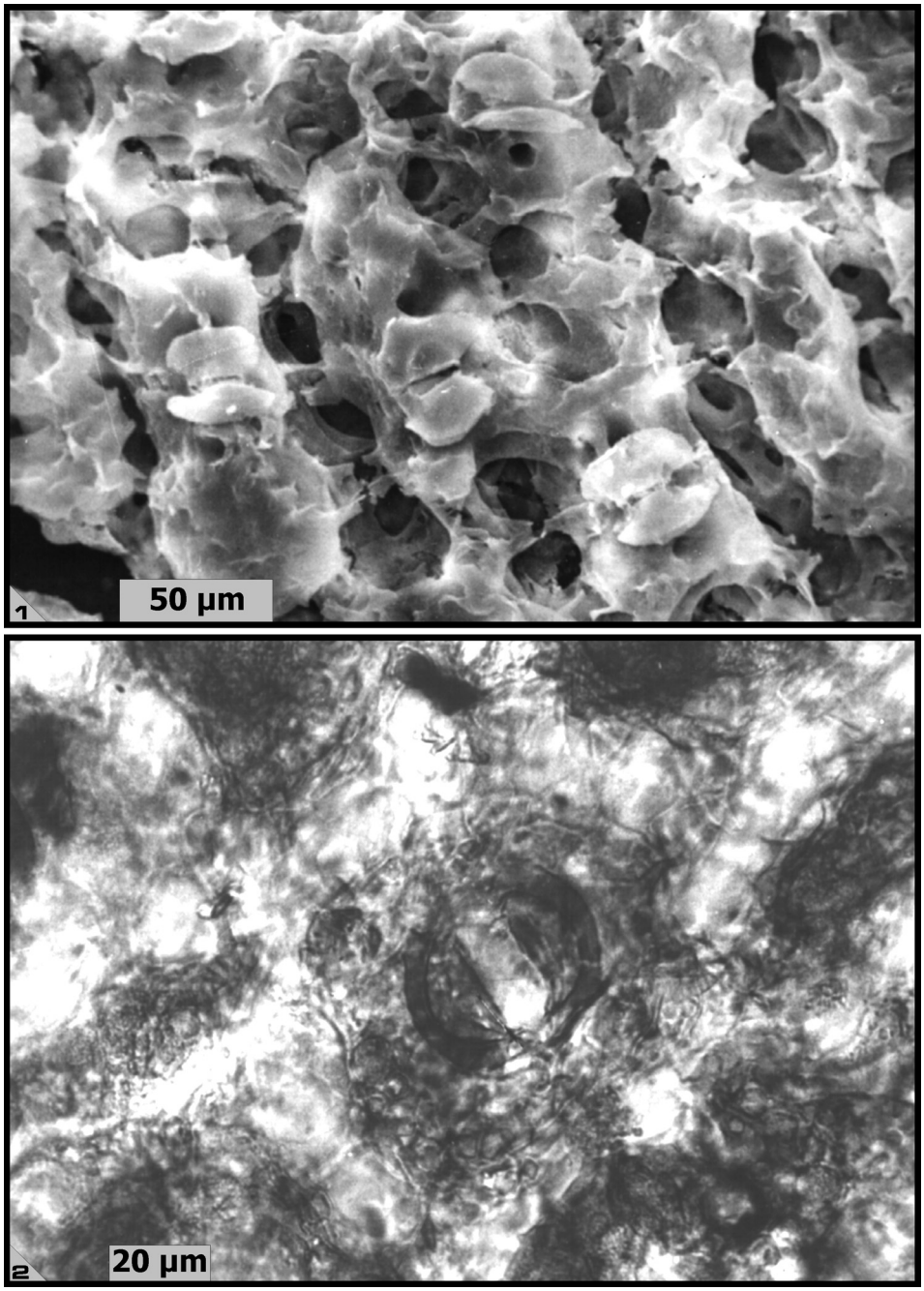

Plate II. *Banatozamites remotus* sp. nov. 1. Abaxial cuticle with paracytic stomatal apparati, inner sight. 2. Stomata with covering roof, outer sight.