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THE ROLE OF TYPES IN PALAEOBOTANICAL NOMENCLATURE

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Abstract. The type in nomenclature of fossil plants except microscopic algae is a single specimen, which is permanently connected with the name of a taxon of any rank up to the family or any sort of fossil taxa (morpho-taxa). It cannot consist of two or more specimens called often "plesiotypes" (e.g. in *Libocedrus masonii* CHANEY et AXELROD, *Taxodium balticum* SVESHNIKOVA et BUDANTSEV), but such specimens may be indicated as the lectotype and the paratypes (in *Nitophyllites* ILJINSKAJA ex WILDE et al.). A figure alone ("iconotype") may not adequately serve for a type of fossil taxa except for microscopic algae and must always be replaced by a specimen available (in *Byttneriophyllum* GIVULESCU ex KNOBLOCH et KVAČEK). The term "type species" has been removed from the International Code of Botanical Nomenclature, because it is misleading, e.g., in cases of misapplied species names (*Doliostrobus* MARION, *nom. cons.*). Genus and family names are based on a single specimen of the selected type bringing species and should be available and properly designated (not in *Geinitziaceae* KUNZMANN). The holotype need not be a most representative specimen reflecting all features of a taxon. This statement is important for typification and treatment of composite ("whole plant") fossil taxa (e.g. in *Platanus* (*Glandulosa*) *neptuni* (ETTINGSH.) BŮŽEK et al.). The typification of morpho-taxa is sometimes problematic (e.g., *Phyllites* BRONGN. based on *Populus populina* (BRONGN.) KNOBLOCH) or needs conservation (*Cupressinocladus* SEWARD here newly lectotypified by *Thuiopsis massiliensis* SAPORTA instead of previously suggested *Thuites salicornioides* UNG. (≡ *Tetraclinis salicornioides* (UNG.) KVAČEK ≡ *Libocedrites salicornioides* (UNG.) ENDL.). The language in which the designation of the holotype can be published is so far optional and may lead to misunderstandings (*Ditaxocladus* GUO et SUN vs. *Fokieniopsis* MCIVER et BASINGER). Problems may arise when previously published taxa are revised superficially or formally, without inspection of the type material itself. .

■ fossil plants, nomenclature, typification.

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Introduction

The following notes on typification of fossil plant names, which are presented here, should guide palaeobotanists dealing with various plant groups in this difficult field of nomenclature from experience gained during several decades of my palaeobotanical practice. The topic was presented on the 8th IOP conference in Bonn in 2008 (Kvaček 2008).

Typification is one of basic principles of botanical nomenclature and this principle reads:

"The application of names of taxonomic groups is determined by means of nomenclatural types." (McNeill et al. 2006, ICBN – Vienna Code). The article 7.2 of ICBN defines the nomenclatural type as "that element to which the name of a taxon is permanently attached, whether as a correct name or as a synonym." This rule has been in force since 1. 1. 1958 (Art. 37.1). Besides other parts of the code that handle the topic of typification, some are more important for the correct taxonomical work with fossil plants but often neglected. The following statements from the code are particularly essential:

"The nomenclatural type is not necessarily the most typical or representative element of a taxon." (ICBN Art. 7.2). It is clear for a family or genus that includes subordinate taxa sharing only just a few diagnostic features. But also the type of a species name may not be a most typical element. We may understand that the type specimen of names of fossil species may represent a single organ, e.g. a leaf impression, while the other detached organs of the same plant may serve as the paratypes of the same species name or need not be included among types at all. The current usage accepts usually one organ only for a morpho-species name (e.g., leaf, wood, pollen, etc.) but this is not at all absolutely necessary considering the code.

Another important requirement given in the code is included in Art. 7.11: For purposes of priority it is necessary that the type is clearly designated. It means that the type is definitely accepted as such by the typifying author. The latest edition of the code (McNeill et al. 2006) includes also a new addition to this article often neglected in the palaeobotanical literature: The type element is clearly indicated by direct citation including the term "type" (typus) or an equivalent (sic! in any language) and on or after 1. Jan. 2001 the typification statement must include the phrase "here designated, hic designatus or an equivalent". This last novelty in the typification procedure is very often overlooked and omitted. This statement is to be added when dealing with any rank up to the family. The present benev-

olent version of the code in respect of langue requires the Latin or English diagnosis or description (Art. 36. 3) but may cause misunderstandings, when a non-Latin or non-English language is used for the text of typification.

The following examples from my previous studies may illustrate difficulties with typification of earlier or presently published taxa of fossil plants. Most of this research has been carried out in cooperation with other colleagues as indicated in the references and acknowledgments.

In search for documentation material of various authors, the following collections and sites have been examined or consulted: Hungarian Museum of Natural History, Budapest – BP (Lobkowitz collection from Bílina and adjacent sites), Geologische Bundesanstalt, Wien – GBA (type material to Ettingshausen's Flora von Bílin), National museum in Prague – NM (Březánky and other sites in North Bohemia), Faculty of Science, Charles University, Prague – PRC (cuticle collections, Bílina Mine, Markvartice, Plesná core V 146 etc.), Staatliches Museum für Mineralogie und Geologie zu Dresden – MMG (Kučlín, Paleogene floras in Germany), British Museum of Natural History, London – BMNH (Célas), Swedish Museum of Natural History, Stockholm – NHMRS (Célas), Muséum National d'Histoire Naturella, Paris – P (Fénestrelle, Aix-en-Provence, types to the works by Saporta), Eidgenossische Technische Hochschule, Zürich – ETH (Öhningen, original material to the works by Heer), Florida Museum of Natural History, Gainesville – UF (Sand Draw locality of the Fort Union Formation in Wyoming, USA), University of California Museum of Paleontology, Berkeley (Bridge Creek flora and other sites in USA), Nanjing Institute of Geology and Paleontology, Chinese Academy of Sciences, Nanjing (Altai flora),

Not figured type material of a species

Only since 1st Jan. 1912 a requirement has been included for valid publication of the new name of a fossil taxon in the specific or lower rank, namely that the diagnosis or description should be accompanied also with an illustration or a figure or a reference to an effectively published illustration (Art. 18.1). Since 1st Jan. 2001, these illustrations must additionally reproduce the type. Before 1912 the species were validly published without illustrations (e.g., Unger 1850) and in such cases the author who ventures to undertake the revision must be guided by the text of the whole protologue and later publications, in which the illustrations may have appeared, if no original labels attached to the specimens are available.

Dombeyopsis lobata UNGER was published by Unger (1850) in Genera et species plantarum fossilium, to which no illustration appeared at the time of publication. Searching for the original material of Unger in the Joanneum museum, Graz, I did not succeed to recover any specimen labeled as *Dombeyopsis lobata*. However, a considerable part of the type material of Unger from the Bílina environs and belonging to the Lobkowitz collection was recovered in the Hungarian Natural History Museum, Budapest (Hably et al. 2001). Among them was also found a specimen that was illustrated by Unger (1860) and Ettingshausen (1869) as *Ficus dombeyopsis* and *Ficus tiliaefolia,* respectively, together with the synonym *Dombeyopsis lobata*. Therefore, this specimen (Pl. 1, fig. 1) was selected as the lectotype (Kvaček 2005). In this collection much more type material of Unger was recovered, but the original labels were destroyed (Hably et al. 2001). The selection of the lectotype was possible only by comparing the description and later publications that handled it from the type locality Bílina. At this occasion, also the type specimens of *Craigia bronnii* (UNGER) KVAČEK, BŮŽEK et MANCHESTER (≡ *Ulmus bronnii* UNGER, 1847 partim), which represent fruits of the same plant as foliage of *Dombeopsis lobata*, came to light and the lectotype could be selected (Kvaček 2005). This specimen must have replaced the previously suggested neotype (Bůžek et al. 1989) according to ICBN, Art. 9.11 (Pl. 1, figs 4, 5).

Cordia tiliaefolia A. BRAUN was published by A. Braun (1845) also without any illustration. Only Heer (1856) later published a series of pictures of this plant, now treated as *Byttneriophyllum* GIVULESCU ex KNOBLOCH et KVAČEK. In this case Knobloch and Kvaček (1965) suggested one of the illustrations in Heer (1856) as a type specimen without checking, if it really exists. However, we may doubt that any of the specimens studied by Heer and at present mostly housed at the Eidgenossische Technische Hochschule, Zürich, were at hand of Alexander Braun, who worked at the university of Karlsruhe. The type suggested by Knobloch and Kvaček (1965) is at present missing (personal communication Pika-Biolzi, Zürich). Therefore, one new here selected specimen re-figured in Pl. 2, fig. 2 from Heer (1856, pl. 83, fig. 11), Öhningen, NO-D24-40-1:3 (ETH, Zürich)) is proposed for the new neotype, pending the original material of A. Braun would not be found in Karlruhe later.

Type material of a species missing

In many cases, the type material of a species name was illustrated, but is at present missing. Because an illustration cannot serve as a type (iconotype) for names of fossil species, it is necessary in such cases to choose a lectotype from among the existing not figured material identified by the original author or a neotype, preferably from the same area. The selection of the neotype requires undertaking a detailed taxonomical work considering all details of the protologue. Thus Manchester and Hably (1997) properly designated a new specimen from the type locality Kučlín as a neotype for *Raskya vetusta* (ETTINGSHAUSEN) MANCHESTER et HABLY, an extinct plant distributed in the European Palaeogene, which was previously erroneously interpreted as quadrivalvate perianth remains of *Abelia*. The basionym *Ononis vetusta* ETTINGSHAUSEN (1869) is based on specimens from the Late Eocene diatomite of North Bohemia that Ettingshausen handled, which have not been recovered in the Lobkowitz collection in Budapest or elsewhere. The selected neotype does not express all features, particularly the central spindle-like body of the fruit but certainly corresponds to the lost original type material.

Language of typification optional

As stated above in the introduction, the language in the typification procedure is optional. It is rather unfortunate

and may cause misunderstandings. The genus *Ditaxocladus* was described by Guo and Sun (in Guo et al. 1984) and typified by *D. planiphyllus* GUO et SUN based on two organs. Foliage shoots and a "cone", which was later recognized as a fruit of *Nordenskioeldia*. The species was described in the English part of the paper but the holotype of *D. planiphyllus* (Pl. 2, fig. 2) was unfortunately designated only in a Chinese letter in the figure captions. However, only this specimen is permanently connected with the taxon name both generic and specific. McIver and Basinger (1990) overlooked this fact and created for the same type of foliage a junior synonym *Fokieniopsis*. According to the principle of priority, this generic name must be replaced by *Ditaxocladus*. This extinct conifer with globose seed cones (Guo Shuang-xing and S. R. Manchester, personal communication) differs only in subtle details of foliage from *Tetraclinis salicornioides* (UNGER) KVAČEK, viz. in elongate vs. broad foliage sprays, slightly vs. strongly undulate cellular anticlinal walls and thin non-papillate vs thick papillate cuticles (Pl. 2, figs 1-2, 5-7) and more importantly in seed cones, which are in the latter case quadrivalvate (Kvaček et al. 2000).

Holotype or lectotype as a single specimen

As stated in the code (Art. 8.5, 9.13) the holotype, lectotype or neotype must be always a single specimen (leaf impression, carbonized fruit, pollen grain) and in cases when it is divided into more parts (wood sections, cuticle preparations, spores in situ etc.) these must be clearly designated as taken from the type specimen and belong to the type (Rec. 8A.3). The slab bearing often more fossils ("the hand specimen") does not conform to this definition.

A species name cannot be based on more specimens (in US palaeobotany often called plesiotypes). Just one single specimen as defined above must be clearly designated as the type. Iljinskaja (1963) based her *Nitophyllites zaisanicus* on two specimens designated as a type and considered these large leaf remains to belong to Algae (hence the generic name). The plant was later recognized as foliage of Araceae and a lectotype had to be established. This was done by Wilde et al. (2005) and only since that time the genus is available as validly published (see Art. 37.1).

Another case is *Taxodium balticum* SVESHIKOVA et BUDANTSEV (1960), which was based on a holotype composed of three detached fossils of different organs. Hence, the species name must be also considered invalidly published because the designated type does not correspond with the definition of the type (Art. 8.1-3). This peculiar Early Oligocene conifer with spiny cone scales has recently been treated by Kunzmann et al. (in press) as a morpho-form belonging to *Taxodium dubium* (STERNBERG) HEER with cone scales normally without spiny processes. These authors considered the stepwise lost of ornamentation during the Paleogene due to evolutionary processes in fossil bald cypress in Europe.

Also *Calocedrus masonii* (CHANEY et AXELROD) AXELROD (1992) was invalidly published on the basis of several specimens from the Oligocene Mascall flora in Oregon, which Chaney and Axelrod (1959) called syntypes and paratypes (housed at the University of California, Berkeley) but none of them designated as the holotype (Fields 1996, Kvaček and Rember 2007). This species awaits a proper revision, typification and validation.

Typification of composite fossil plants ("whole plants")

Typification of composite plants in the fossil state has been solved so far variously. Some authors ascribe detached organs to independent morpho-species and morpho-genera, some others to a single name of the composite taxon. Both procedures are in line with the current edition of ICBN, only one must be aware of the rules that the typification should be principally the same as for living plants.

One of the most striking examples of the approach to assign detached organs to independent morpho-species and genera is the *Macginitiea* plant published by Manchester (1986). He used five morpho-genera *Macginitiea* WOLFE et WEHR for foliage, *Plataninium* FELIX emend. WHEELER et al. for wood, *Macginicarpa* MANCHESTER for female inflorescences, *Platananthus* MANCHESTER for male inflorescences with pollen in situ and *Macginistemon* MANCHESTER for detached groups of stamens. Types were designated only in the case of *Platananthus* and *Macginicarpa* while typification was neglected in the cases of new combinations, when it is in fact not required but is necessary for the typification of a new genus.

In the case of a composite plant of *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK et al., this species name was typified by a female infructescence (Kvaček et al. 2001) while the other organs were assigned either to different morpho-forms for foliage or left without any separate morpho-taxa (Kvaček and Manchester 2004). Based on evidence of co-occurrence and the same type of peculiar epidermal anatomy on stalks and foliage it was assumed that these organs belonged to the same plant, which deviates from a common plane tree by specific glandular trichomes (Pl. 1, fig. 9). These differences were expressed by establishing an independent subgenus *Glandulosa* KVAČEK, MANCHESTER et GUO (2001).

Grímson, Denk and Zetter (2008) have recently used a similar approach for naming a composite species *Tetracentron atlanticum* GRÍMSON et al. Besides the holotype representing an almost complete leaf impression, they established several paratypes based on other specimens of foliage and fruits, and they left dispersed pollen without any separate morpho-taxon. In this case, the fact that various organs of a *Tetracentron* plant co-occur in the Miocene of Island, serves as the only piece of evidence of interconnection.

Types of generic names

The type of names of fossil genera is always a single specimen, i.e. the holotype, lectotype or neotype of the selected species name. The term of the so-called type species disappeared from the botanical code contrary to the zoological nomenclature. Even in the case of typification of a generic name only a single available specimen (not a mere illustration) serves for this purpose. Admittedly, not always are names of fossil genera properly typified. A clear case of a proper typification is shown on the extinct monotypic

genus of fossil Juglandaceae, *Polyptera* MANCHESTER et DILCHER, based on the holotype of *P. manningii* MANCHESTER et DILCHER (Manchester and Dilcher 1982). The type was established in a simple way because it belongs to a name of a new entity both generic and specific. A more complicated case of *Cedrelospermum* SAPORTA was successfully solved by Manchester (1989). Saporta (1889) used this genus to include also winged seeds of *Calocedrus* ("*Cedrelospermum" refractum* SAPORTA) or other so far enigmatic plants. Manchester (1989) emended this concept and selected the type specimen of the generic name (*Cedrelospermum aquense* (SAPORTA) SAPORTA – re-figured in Manchester (1987, pl. 1, fig. 4)) restricting the extent of *Cedrelospermum* to the fruits of an extinct Ulmaceae. Various species of *Cedrelospermum* are known today in the Tertiary of Europe and North America, partly as foliage shoots with attached fruits (Manchester 1989, Wilde and Manchester 2003).

Sometimes, the generic names were based on misapplied types and had to be proposed for conservation. One of them is a generic name *Doliostrobus* MARION, *nom. cons*. In his earlier publication Marion (1884) cited *Araucarites sternbergii* as a basionym, which was ultimately based on *Araucaria sternbergii* CORDA, a lycopod cone from the Bohemian Carboniferous. Later on Marion (1888) created an independent species *Doliostrobus sternbergii* MARION, based on the material from Célas in France. Based on the material from Célas, *Doliostrobus* MARION (1888) was proposed and accepted to conservation (Kvaček 2002a). In this way, the name of this extinct conifer commonly occurring in the European Eocene and Oligocene (Kunzmann 1999, Kvaček 2002b) has been validated and becomes available.

Typification in morpho-taxa

The types of names of morpho-genera are designated in the same way as of ordinary taxa. Again, the type of the selected morpho-species must serve for the whole genus. Two examples illustrate the correct approach to such typification. *Araciphyllites* WILDE, BOGNER et KVAČEK (2005) was described on the basis of the material from Messel and *Araciphyllites tertiarius* (ENGELHARDT) WILDE et al. was selected as the type-bringing morpho-species. A new morpho-genus *Hydrochariphyllum* KVAČEK was monotypic at the time of publication. Its name is automatically typified by the type of a single species *Hydrochariphyllum buzekii* KVAČEK from the Miocene of North Bohemia (Kvaček 1995). Names of morpho-genera are often difficult to lectotypify and often need conservation. *Cupressinocladus* SEWARD was initially typified by *Cupressinocladus salicornioides* (UNGER) SEWARD (i.e., *Thuites salicornioides* UNG.) by Andrews (1955) as the first cited and illustrated species. At the time of publication by Seward (1919), another earlier published morpho-genus name was available and should have been applied – *Libocedrites* ENDL., a monotypic genus based on *Libocedrites salicornioides* (UNG.) ENDL. (Bůžek et al. 1976). In the meantime this conifer was recognized as an extinct species of *Tetraclinis* (Kvaček 1989). Therefore, it becomes necessary a new lectotypification of *Cupressinocladus* SEWARD, which is proposed here by *C. massiliensis* (SAPORTA) SEWARD ≡ *Thuiopsis massiliensis* SAPORTA (1865, p. 72, pro parte, pl. 1, fig. 6 (non pl. 4, fig. 2) – lectotype housed in the Muséum National d'Histoire Naturelle, Paris, No.16289, Fénestrelle, southern France, Early Oligocene – refigured here in Pl. 2, figs 4, 5), which well corresponds to the current practice. This procedure fits particularly in the situation when the representatives of the Cheirolepidiaceae were removed from *Cupressinocladus* to *Watsoniocladus* SHRINIVASAN (1995). The presented proposal must be approved by the congress and conserved in the future.

Many widely used morpho-genera with a broad content are very difficult or even impossible to typify. A striking example is *Phyllites* BRONGN. with its only species *Phyllites populina* BRONGN. at the time of publication (i.e. *Populus populina* (BRONGNIART) KNOBLOCH), which in fact became a synonym of *Populus* L.

The types in fossil families

The type of the name of a fossil family is the same as that of the generic name on which it is based. A clear example represents the family Lepidodendraceae, based on the type of *Lepidodendron* STERNB., which is housed in the Sternberg's collection in Prague (Kvaček J. and Straková 1997). Besides such clear cases, there are also several, which require more attention. One example may illustrate the situation. The recently established family Geinitziaceae KUNZMANN, which is based on the genus *Geinitzia* ENDLICHER *nom illegit. superfl.* was not properly typified at the time of publication (Kunzmann 1999), because the type-bringing genus *Geinitzia* requires revision and a new typification (Kunzmann submitted).

Conclusions

We can conclude that clearly typified names of fossil taxa essentially contribute to the stability of nomenclature. The presented ideas will hopefully attract more attention of palaeobotanists to properly handle typification procedures. Nevertheless, much more careful taxonomic studies of the relevant specimens, not only illustrations, are needed to remove inconsistencies against the ICBN in the current practise.

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Explanations of the plates

PLATE 1

***Dombyeopsis lobata* UNGER**

1. Leaf impression, the lectotype selected by Kvaček (2005), refigured from Unger (1860, pl. 6, fig. 1 as *Ficus dombeyopsis* UNG. *nom .illegit. superfl.*), Bílina, BP 59.686.1, × 1.6.

***Byttneriophyllum tiliifolium* (A. BRAUN) KNOBLOCH et KVAČEK**

2. Leaf impression, the neotype selected here, re-figured from Heer (1856, pl. 83, fig. 11), Öhningen, NO-D24-40-1:3 (ETH, Zürich), × 1.5.

***Craigia bronnii* (UNG.) KVAČEK, BŮŽEK et MANCHESTER**

3. Impression of a capsule valve, the neotype to be suppressed, selected by Bůžek et al. (1989, fig. 3, as *Pteleaecarpum bronnii*), Břešťany, NM G 4395, × 2.
4. Impression of a capsule valve, the lectotype newly selected by Kvaček (2005), refigured from Unger (1847, pl. 26, fig. 2), Březánky, BP 55.2308.1, × 1.7.

***Platanus neptuni* (ETTINGSH.) BŮŽEK, HOLÝ et KVAČEK**

5. Twig with a simple leaf impression (the epitype of mf. *reussii* (ETTINGSH.) KVAČEK et MANCHESTER selected by Kvaček and Manchester 2004), refigured from Kvaček and Manchester 2004, fig. 5a, Kučlín, NM G 8112, × 1.2.
6. Simple leaf impression, the holotype of mf. *reussii*, re-figured from Ettingshausen (1866, pl. 14, fig. 4), Kučlín, GBA 6145, × 1.5.
7. Female infructescence, the lectotype selected by Kvaček et al. (2001), re-figured from Ettinsghausen (1866, pl. 7, fig. 11), Kučlín, BP 55.2491.1, × 3.5.
8. Male inflorescence, Markvartice, NM G 2957, × 4.
9. Adaxial leaf cuticle showing typical glandular trichome and a stoma, core 146, Plesná, PRC V 146-268, × 360.

PLATE 2

***Ditaxocladus planiphyllus* GUO et SUN**

1. A foliage shoot narrow elliptic in outline, Altai flora, Xinjiang Province, coll. Nanjing Inst. Geol. Pal. 790 HK-3-4, uncatalogued, × 1.
2. A foliage spray, the holotype designated by Guo et al. (1984), Altai flora, Xinjiang Province, coll. Nanjing Inst. Geol. Pal. 790 HK-3-4, PB 9863, × 1.

***Tetraclinis salicornioides* (UNGER) KVAČEK**

3. A broad foliage spray, re-figured from Ettingshausen (1866, pl. 10, fig. 4), Žichov, BP 59.995.1, × 1.2.

***Cupresinocladus massiliensis* (SAPORTA) SEWARD**

4. Drawing of the holotype re-figured from Saporta (1865, pl. 1, fig. 6, as *Thuiopsis mssiliensis*), Fénestrelle, P 16289, × 2.
5. Impression of the holotype, Saporta (1865, pl. 1, fig. 6), Fénestrelle, P 16289, × 2.

***Ditaxocladus* sp.**

6. Leaf cuticle showing stomata with low Florin rings and non-papillate ordinary cells, Sand Draw, Wyoming, USA, UF 23561, × 270.

***Tetraclinis salicornioides* (UNGER) KVAČEK**

7. Leaf cuticle showing stomata with distinct Florin rings and papillate and strongly undulate anticlinal walls of non-modified cells, Markvartice, PRC MR 134B, × 270.

***Doliostrobus taxiformis* (STERNBERG) KVAČEK var. *sternbergii* (MARION) MAI et WALTHER**

8. Cone scale, the lectotype selected by Kvaček (1971), Célas, BMNH V.1439, × 5.
9. Seed, Célas, NHMRS S.105288, × 5.
10. A foliage shoot, Kučlín, MMG, Kin 1, × 1.

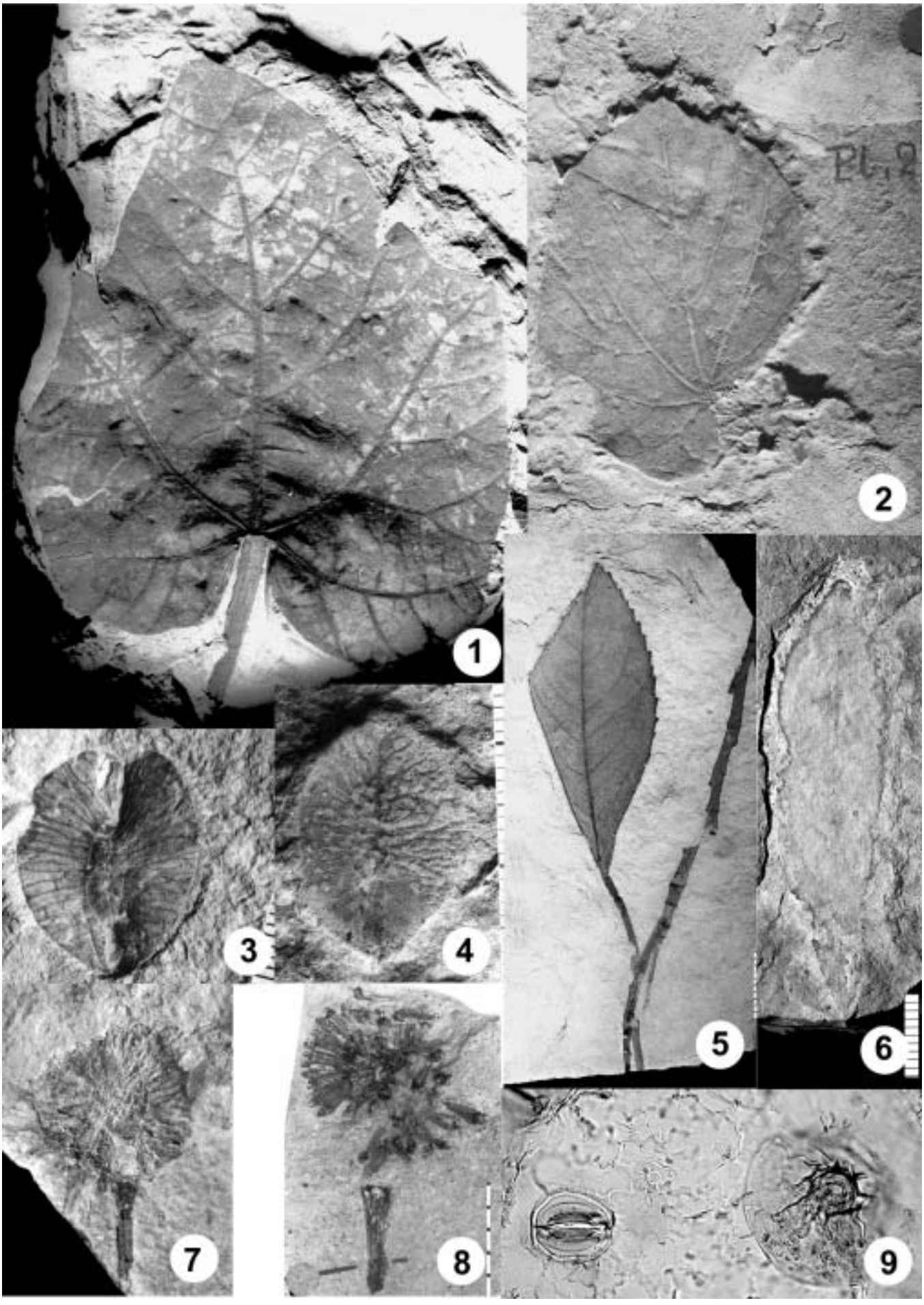
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PLATE 2